VOL. 21 NO. 3 PAGES 96 www.expresspharma.in

EXPRESS PHARMA

INDIA'S FOREMOST PHARMA & BIOTECH MAGAZINE SINCE 1994

FEBRUARY 2026, ₹ 40

PIOMA chemicals
Partnering Through Innovation

36 YEARS Since 1989

BIOPOL®
real carbomer

Benzene & Harmful Residual Solvent Free Range of Carbomers from Italy

Grades
Carbomer 934P NF, 971P NF, 974P NF
Carbomer 940 NF, 980 NF
Carbomer U10, U20 & U21
Carbomer Crystal

The right ingredient can make all the difference in your formulations

Talk to us
for more information

502, Natraj Commercial Complex Condominium, 194, Sir M.V. Road, Andheri (East), Mumbai - 400069, Maharashtra, India.
Tel: +91-22-45212000 | Email: products@pioma.net

VOL. 21 NO. 3 PAGES 96 www.expresspharma.in

EXPRESS PHARMA

INDIA'S FOREMOST PHARMA & BIOTECH MAGAZINE SINCE 1994
FEBRUARY 2026, ₹40

+

Interview

Nandakumar Kalathil
Country General Manager - India, Agilent Technologies

Uday Kadam
Chief Operating Officer (API Holdings), Chief Business Officer (B2B)

FRIENDSHORING PHARMA'S NEXT SUPPLY CHAIN BET?

With friendshoring gaining attention in global supply chain conversations, this story looks at what it could mean for the India pharma inc

Siliconized Vials

EVERY DROP COUNTS!

Further minimize interactions between glass surface and drug product

•

Less adhesion of high viscosity drug products to the inner surface of the vial

•

Higher restitution rates

•

Less residual drug volume

NIPRO PHARMAPACKAGING

NIPRO PHARMAPACKAGING INTERNATIONAL
Dlokhuisstraat 42, 2800 Mechelen, Belgium | pharmapackaging@nipro-group.com | www.nipro-group.com

GANDHI
Automations Pvt Ltd

India's No.1 Entrance Automation & Loading Bay Equipment Company

Differential Air Pressure

Washable & Pressure Resistant

High Speed Doors - Prime NEO CR

- Superior sealing to avoid dust entry, maintain asepsis and sterility.
- Easy to clean & disinfect, door is resistant to spray water.
- High door efficiency & low permeability values EN 12426 EN 12427 : < 12m³/m²h Δ 50 PA.
- Size upto: 4000 mm (W) x 4000 mm (H).
- The door is pressure resistant while providing smooth operation cycles.
- Structurally designed to be resilient against twisting and denting.
- Heavy duty motor : 230V three phase, opening speed upto 2.0 m/s with inverter system.

Dock Levelers | Dock Shelters | Fire Rated Shutters / Doors | Rolling Shutters | Sectional Overhead Doors

STAR EXPORT HOUSE (Government of India Recognised)

World's Safest Door

TÜV AUSTRIA CERTIFIED
EN ISO 9001 20100233018576
EN ISO 14001 20104233018577
ISO 45001 20116233018578

CE

IGBC MEMBER

24X7 TOLL FREE 1800 209 0200
From Anywhere in India

Corporate Office : Chawda Commercial Centre, Link Road, Malad (W), Mumbai - 400064, India
Tel : +91 22 6672 0200 / 0300 (200 Lines) | Fax : +91 22 6672 0201 | Email : sales@geapl.com | Website : www.geapl.com

ROQUETTE
Offering the best of nature™

reaping
infinite possibilities
with growth

To seek and to find is what makes us human. And to think of ways we can better our existence and in the process make it even better for fellow mankind is what great ideas are made of. But how good is an idea if it does not have the thrust of execution to make it come alive. But once the two meet, the possibilities are infinite and who better to know that, than the ones who have been instrumental in linking them for more than 3 decades.

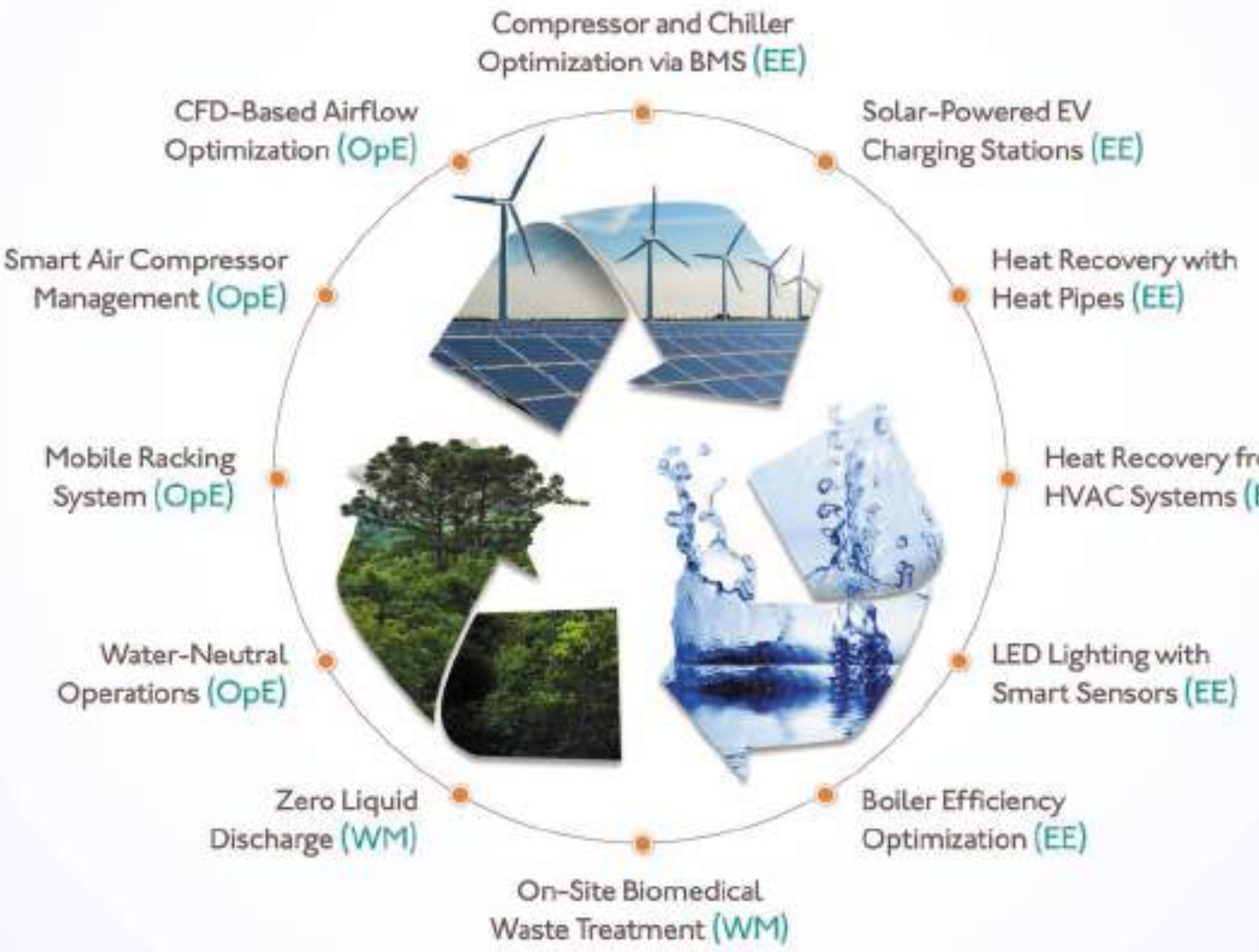
Signet

An IMCD company

pharmaaccess
Engineering a Healthier Life

Integrated Engineering & Turnkey
Pharma Facility Solutions

Sustainability Engineered into Every Layer



EE : Energy Efficiency | OpE : Operational Efficiency | WM : Waste Management

| +91 98207 75650 | + 91 22 6819 3888
| sales@pharmaaccess.net
| www.pharmaaccess.net

WE ARE ENGICUTION EXPERTS
ADVANCED ENGINEERING
PERCISION EXECUTION

HIMEDIA
For Life is Precious

MiCroBiology®
Understanding Microbes

Ensure Safety of Your **Culinary Craft** with **Dehydrated Culture Media**

Dehydrated Culture Media to test Microbiological Quality

Your Health is Our Responsibility

Ensuring Uncompromised Safety in Every Bite

For Your Microbes Choose Amongst

ORIGIN
- Animal Free
- Veg
- Chemically Defined

FORM
- Powdered
- Granulated
- Encapsulated

www.himedialabs.com

info@himedialabs.com

+91-22-6147 1919

ISO 9001:2015 CERTIFIED · ISO 13485:2016 CERTIFIED · WHO GMP · CE

• • • expect only quality from us™

Range of HiMedia Products

MICROBIOLOGY	CELL BIOLOGY	MOLECULAR BIOLOGY	PLANT TISSUE CULTURE	HYDROPONICS SOILLESS FARMING	LAB CONSUMABLES & INSTRUMENTS	CHEMICALS & BIOCHEMICALS

Capsugel® | Lonza

Introducing the

Vcaps® Plus Zephyr Inhance™ capsules

The next generation HPMC - based capsule with optimized consistency for dry-powder inhalation (DPI) applications

For more information, scan the QR or
Please call: +91 124-6052900 or Visit us at www.capsugel.com

IIHMR UNIVERSITY

Admission Open 2026

Two-year full-time Programs

- MBA (Hospital and Health Management)
- MBA (Pharmaceutical Management)
- MBA (Healthcare Analytics)
- MBA (Development Management)
- Master of Public Health
- Master of Public Health
  Offered by Johns Hopkins Bloomberg School of Public Health, USA in cooperation with IIHMR University, Jaipur, India

Executive Programs

- Executive MPH
- Executive MHA
- Executive MBA (CSR & ESG Management)

PhD Programs

Full-time and part-time in
Hospital Management, Health Management
Pharmaceutical Management, Development Management
Public Health, Digital Health/Healthcare Analytics

40+ Years

Legacy in Health Management Research

#1

Ranking from Education World

For Admission Scan this QR Code

APPLY NOW

+91 9145989952, +91 9358893199

admissions@iihmr.edu.in www.iihmr.edu.in


SCHOTT
Secure lyophilization starts with FIOLAX® pharmaceutical glass tubing
Even the smallest defects in glass can weaken primary pharmaceutical containers and can lead to breakage during lyophilization. With SCHOTT´s unique perfeXion® process, each FIOLAX® Type I glass tube is inspected at 1,000 data points, aiming for zero defects.
Achieve reliable packaging. Protect formulations. Scan the code to learn more.
schott.com
SCHOTT GLASS INDIA PVT. LTD.
santosh.jadhav@schott.com | 00 91 22 4094700

Talc from Elementis

TRANSCHEM CORPORATION PHARMA PVT LTD
EVERYTHING EXCIPIENT

Transchem offers different grade of talcs under the name of Microtalc Pharma from Elementis, one of the largest producers of talc.

About Elementis

- Own Talc resources which ensures long term supply security
- Known Talc ore resources for the next 70 years
- Proven reserves of a 100 million tons of talc ore
- Innovation through close cooperation with customers and research institutes
- Talc is sterilized by natural and efficient heat treatment to ensure safety.

Characteristics:

- High purity ensures hypoallergic product
- High lamellarity ensures inert product
- High hydrophocity makes it a perfect glidant
- High whiteness
- Bacteria controlled
- High surface area

Product Details:

Product ID	PSD D50 (µm)	PSD D98 (µm)	Bulk Density g/cm³	Brightness RY%	Moisture %
Micro Talc Pharma 8	2.2	9.0	0.20	95	0.2
Micro Talc Pharma 15	5.4	18.0	0.30	93	0.2
Micro Talc Pharma 30	8.0	26.0	0.45	93	0.2
Micro Talc Pharma 50	12.0	50.0	0.50	92	0.2

All products are in compliance with the current version of PH.Eur, USP NF, ChP and JP

ELEMENTIS

Transchem Corporation Pharma Pvt. Ltd.
D421/422, Neelkanth Business Park, Station Road, Vidyavihar (W), Mumbai - 400086
Email: sales@transchemcorp.com
Phone: +91 022-49711633
Web: www.transchemcorp.com

Discover Ashland's new comprehensive offering dedicated to our range of low nitrite excipients for oral solid dosage forms, including the latest addition to our portfolio, **benecel™** low nitrite hypromellose. Learn more about strategies to mitigate nitrosamine formation and discover how our new low nitrite excipients can support your formulation challenges.

For more information or a sample request, please contact our solver Seema Singh at seema.singh@ashland.com

ashland.com/benecel-low-nitrite

ashland.com / efficacy usability allure integrity profitability™

Ashland
always solving

PAHWA GROUP
Innovation is life

Bry-Air
years of excellence

Uncontrolled humidity in
pharmaceutical industry leads to

- Process inefficiency
- Contamination
- Quality issues
- Reduced shelf life
- Regulatory compliance issues

CONTROL MOISTURE©
for pharma excellence

Bry-Air...Your Humidity Control Partner

BRY-AIR (ASIA) PVT. LTD.
21C, Sector-18, Gurugram - 122015, Haryana, India
bryairmarketing@pahwa.com www.bryair.com

Connect with our Airgineers® for Solutions
+918826990350
1800 102 7620

OVERSEAS OFFICES Malaysia • China • Switzerland • Brazil • Mexico • Nigeria • Vietnam • Indonesia • Philippines • Thailand • Korea • Japan • UAE • Saudi Arabia • Bangladesh • USA • Canada

PAHWA GROUP Innovation is life

Bry-Air Leaders in Dehumidification...Worldwide
DRI Innovative Air Solutions
delair The Compressed Air Treatment System Company
TDS

BAA/Pharma/2024-25

SOVEREIGN

FEB 2026

DADACHANJI GROUP

SOVEREIGN

DELIVERING HIGH-QUALITY INJECTABLES WORLDWIDE

Sovereign Pharma is a quality-focused, **EU and WHO-GMP Geneva–certified** manufacturing facility specializing in terminally sterilized and aseptically filled injectables.

Established in 2003 as a Contract Manufacturing Organization (CMO), Sovereign Pharma has built a strong global reputation for regulatory excellence, consistent quality, and large-scale manufacturing capability, supplying injectable products to pharmaceutical companies across international markets.

With a production capacity of **~350 million pieces per annum**, Sovereign Pharma manufactures and **sells over 1 billion injection doses annually**, supporting critical therapies worldwide.

With a strong emphasis on process control, data integrity, and regulatory compliance, Sovereign Pharma ensures every injectable product meets the highest global quality standards. Advanced manufacturing systems, validated processes, and a culture of continuous improvement enable consistent batch-to-batch reliability—critical for life-saving injectable therapies.

More than a manufacturer, Sovereign Pharma is **a long-term partner**—delivering reliable supply, technical expertise, and global regulatory support. **Backed by the Dadachanji Group**, we advance injectable manufacturing for the future.

RELENTLESS INVESTMENT. FUTURE-READY MANUFACTURING.

As part of The Dadachanji Group, Sovereign Pharma continues to invest aggressively in capacity expansion and technological upgrades.

Over ₹500 crores have been invested by the Group in the last three years, including ₹250 crores dedicated to modernizing Sovereign Pharma's facility with **advanced isolator-based filling lines**, further strengthening its already EU, ANVISA, and MHRA-approved site.

TRUSTED BY REGULATORS ACROSS THE GLOBE

WWW.SOVEREIGNPHARMA.NET

INFO@SOVEREIGNPHARMA.NET

Vitafoods India

Title Partner

KSM-66 Ashwagandha

WORLD'S BEST ASHWAGANDHA

informa markets

11-13 February 2026

Pavilion 1-3, Jio World Convention Center, Mumbai

Be part of India's leading nutraceutical event

Pre-register and save 30% on your visitor pass!

Scan to book your pass

Discover, engage and grow with

10,000+	200+	40+	40+
expected attendees	exhibitors	countries represented	expert speakers

Explore exhibitors from the 4 key sectors

Ingredients & raw materials sector

Branded finished products

Services & equipment

Contract manufacturing & private label sector

Join us in Mumbai from **11-13 February 2026 at Pavilion 1-3, Jio World Convention Center** to be part of India's only nutraceutical event that brings the entire supply chain under one roof.

For enquiries contact:

Pranav Navare | M: +91 77383 23257 | E: pranav.navare@informa.com

www.vitafoodsindia.com

Follow us on in

eppendorf

Start Separation at Ease

with Centrifuge Solutions from Eppendorf

You deserve the best laboratory equipment to ensure that your separation tasks run smoothly every time. That's why our goal is to provide optimized solutions for you and your requirements: From microcentrifuges and benchtop centrifuges to high-speed floorstanding- as well as ultracentrifuges, our extensive portfolio now offers comprehensive solutions in the areas of molecular biology, biochemistry and cell biology.

Complemented by a wide range of rotors, adapters and consumables, as well as service offerings, our portfolio supports now all of your separation applications.

With our now complete centrifuge portfolio we give you the promise of separation at ease, enabling you to focus on what matters most: your research.

www.eppendorf.com/your-centrifuge-solution

JRS Fibers for Life.

EMDEX®

Dextrates, NF

Multifunctional Binder and Filler

- Multifunctional Excipient
- Soluble DC Binder and Filler in One
- Excellent Flow and Compaction
- Superb Taste and Tablet Appearance

JRS PHARMA JRS FAMILY

- Excipients • Coatings
- Technical Services • Biopharma Services

RETENMAIER INDIA PVT. LTD.

B/816, Lodha Supremus II, Road No.22, Wagle Estate, Thane (W)
Maharashtra - 400 604.

Tel: 022 4024 3817-21 | Email: info-india@jrs.de | www.jrspharma.c

EXPRESS PHARMA

Chairman of the Board
Viveck Goenka

Sr. Vice President-BPD
Neil Viegas

Vice President-BPD
Harit Mohanty

Editor
Viveka Roychowdhury*

Editorial Team
Lakshmipriya Nair
Kalyani Sharma
Neha Aathavale
Swati Rana

DESIGN
Art Director
Pravin Temble

Senior Designer
Rekha Bisht

Senior Artist
Rakesh Sharma

Marketing Team
Rajesh Bhatkal
Ashish Rampure

Production Co-ordinator
Dhananjay Nidre

Scheduling & Coordination
Pushkar Waralikar

CIRCULATION
Mohan Varadkar

CONTENTS

INTERVIEWS

MANUFACTURING


SANJAY SHARMA


Naresh Gaur


Bhagwan Pandhare


Anurag Chauhan


Duraisamy Rajan Palani

PACKAGING

Express Pharma®

Regd. With RNI No.MAHENG/2005/21398. Postal Regd.No.MCS/164/2025 - 27. Printed and Published by Vaidehi Thakar on behalf of The Indian Express (P) Limited and Printed at The Indian Express Press, Plot No.EL-208, TTC Industrial Area, Mahape, Navi Mumbai-400710 and Published at Mafatlal Centre, 7th floor, Ramnath Goenka Marg, Nariman Point, Mumbai 400021.

Editor: Viveka Roychowdhury.* (Editorial & Administrative Offices: Mafatlal Centre, 7th floor, Ramnath Goenka Marg, Nariman Point, Mumbai 400021)

* Responsible for selection of news under the PRP Act.

India-EU FTA offers new hope

The signing of the India-EU Free Trade Agreement after almost two decades of negotiations is being hailed as the 'mother of all deals' for its impact across segments.

The deal is expected to be signed this year, and may come into effect early next year. While we await the fine print, it is already obvious that a lot hinges on the India-EU trade deal.

Sudarshan Jain, Secretary General, Indian Pharmaceutical Alliance analyses that the expected removal of EU tariffs of up to 11 per cent on pharmaceuticals will enhance trade and support greater access to innovative medicines for Indian patients. He also points out that the agreement reinforces the intellectual property framework under the TRIPS Agreement and the Doha Declaration, which will further strengthen trade opportunities and collaboration between India and the EU.

At the individual company level, such FTAs give management the runway to make long term investments. As Ashok Nair, MD, RPG Life Sciences puts it, "The agreement creates a strong incentive for Indian companies to invest further in quality, compliance and innovation aligned with global standards. Over time, this will support capacity expansion, employment generation and greater R&D investments within India, while ensuring that European patients benefit from reliable as well as cost-effective pharmaceutical solutions."

Namit Joshi, Chairman, Pharmexcil stresses that the India–EU FTA is not a short-term export stimulus; it is a long-term competitiveness framework that empowers MSMEs and positions Indian pharma for resilient, quality-led growth. He reasons that the FTA delivers structural competitiveness as near-zero tariff access significantly strengthens the position of Indian formulations, APIs, and value-added medicines in the EU, a development that is particularly consequential for India's pharma MSMEs, many of whom possess strong quality capabilities but face cost and access barriers in highly regulated markets. Reduced tariffs and smoother market entry will directly enhance their ability to scale exports, invest in compliance, and integrate into European supply chains.

From Pharmexcil's lens, this agreement enables stable, long-term, and predictable pharmaceutical trade, benefiting European healthcare systems and consumers through improved affordability, continuity, and security of supply, supported by India's high-quality and reliable manufacturing base. Joshi also places equal importance on the agreement's balanced approach to intellectual property, which reaffirms TRIPS-aligned protections while safeguarding India's strengths in generics and public health, thereby providing regulatory certainty and confidence for MSMEs as well as large manufacturers.

The India-EU FTA could be particularly game changing for MSME pharma companies. As Saurabh Agarwal, Director, HAB Pharma explains, "The removal of the 11 per cent tariff meaningfully alters the cost–competitiveness equation, enabling Indian manufacturers to participate in one of the world's most regulation-intensive healthcare markets on far more equitable terms. Improved cooperation on non-tariff barriers, customs facilitation, and regulatory alignment will significantly reduce friction for MSME exporters—where time, cost, and predictability are decisive factors."

Out of turmoil, could come the trigger for really moving the needle beyond transactions to a new global order built on mutual growth

But policies and FTAs take a long while to actually materialise, more so one with a bloc of 27 countries. And execution and interpretation challenges could slow down implementation.

Take the US Biosecure Act for instance. When it was first being discussed in 2024, India's pharma companies were upbeat that the Act might create a sweet spot for India's pharma contract development and manufacturing organisations (CDMOs) as it proposed restricting US government transactions with Chinese based pharma CDMOs. However, the watered down version of the Act, which was signed into law by President Trump on December 18, 2025, diminishes the opportunity for India's CDMO segment. Contrary to initial speculation, the Act does not name specific countries or companies on the restricted list.

In a recent BNP Paribas India report, dated January 2026 Tausif Shaikh, pharma and healthcare analyst referred to conversations with China-based CDMO, WuXi Biologics, highlighting that the company secured 86 new projects in 1H25, with over half coming from the US. WuXi is also building new capacities in the US. Thus Shaikh speculates that the earlier expectation of Indian companies benefiting from the diversification of the supply chain from China has now tapered due to the muted version of the revised Biosecure Act. The Office of Management and Budget (OMB) has to publish a list of "biotechnology companies of concern" (BCC) within a year of enactment, which is by December 2026, so that's the next tracking point on this policy.

The tricky nature of trade negotiations, policy formation and implementation keeps industry on tenterhooks. But out of turmoil, could come the trigger for really moving the needle beyond transactions to a new global order built on mutual growth. Especially with the hanging sword of the ongoing tariff war with the US. Let us hope that the India-EU FTA lives up to these promises.

VIVEKA ROYCHOWDHURY, *Editor*
viveka.r@expressindia.com
viveka.roy3@gmail.com

150 Years | KILIAN Tableting Excellence

Kilian since 1875

FRITZ KILIAN
Ateliers de construction de machines spéciales à comprimer, à remplir et à doser
Berlin-Hohenschönhausen, Goeckestrasse 35-36
TÉLÉPHONE: BERLIN-HOHENSCHÖNHAUSEN 594643
ADR. TÉLÉGR.: DOPPELPRESSER BERLIN-HOHENSCHÖNHAUSEN

Since 1875

Innovative tableting equipment,
from small R&D and simulator presses
to the largest production presses
for highly demanding products.

SIGACHI®
Experience Excellence..

SCAN HERE - To know more about Our Excipients Portfolio

HiCel™ MCG

HiCel™ MCG is a product of Microcrystalline Cellulose (MCC) and Carboxy methyl Cellulose Sodium (Na-CMC). When dispersed in water under high shear mixing, MCG acts as a protective colloid by forming a viscous and thixotropic gel.

FUNCTIONS

Suspension Stability: The wide range of viscosities, gel strength and dispersion characteristics of HiCel™ MCG make it suitable for suspension stability. When it is used with a polymer solution, gel network of insoluble cellulose fibrils is formed, results in long time suspension stability.

Emulsion and foam Stabilization: HiCel™ MCG in water act as physical barriers which hold the air cells in and stabilizes the foam and helps in maintaining the homogeneous state of the system resulted in emulsion stability.

Thixotropic properties: MCG is readily dispersed in water with moderate mixing to form white, opaque, colloidal thixotropic gels. Under shear the gel network readily breaks down, once the source of shear is removed, the gel will reform. HiCel™ MCG 591 shows thixotropic gel containing a finite yield value.

Thickening mouthfeel: HiCel™ MCG thicken with flavorable mouthfeel and without creating a gummy or pasty texture. Unlike some vegetable gum, insoluble microcrystals provide a clean mouthfeel and do not mask flavor.

Grades	Applications
HiCel™ MCG 581	•High functional gelling agent in suspensions & emulsions •Accelerates disintegration and dispersion
HiCel™ MCG 591	•Used as stabilizer & thickner in all type of suspensions & emulsions also used is sprays •It binds ingredients together and increases the mechanical strength of the tablet
HiCel™ MCG 611	•Ready-to-use or reconsituanble in dry suspension, required low shear force •Excellent water uptake capacity, very good stabilizer and thickener

Registered Office: 229/1 & 90, 2nd Floor, Kalyans Tulsi Ram Chambers, Madinaguda, Hyderabad, Telangala - 500049.
040 4011 4874 enquiry@sigachi.com

SEW EURODRIVE

Driving the world

SEW LOGISTICS AUTOMATION

Inspired by Nature, Engineered for Precision

At SEW-EURODRIVE, we're inspired by the remarkable engineering in nature and strive to bring the same smart design and precision to our products.

Just as expert coordination is in bees' DNA, our motion control solutions work in programmed harmony with your warehouse and logistics processes with minimal energy use.

Our Industry 4.0 solutions – designed to deliver precision, dynamic control, intelligence and energy savings for Automated Storage and Retrieval Systems (ASRS), sorters, and conveyors – are fully customisable and built to German standards. And with expert support across India, we ensure uninterrupted logistics handling.

Precision: It's in our D.N.A.

Bees are nature's synchronisation experts. These industrious creatures coordinate their movements to organise their hives quickly and precisely, ensuring the smooth operation of their bustling ecosystem.

SEW-EURODRIVE LOGISTICS AUTOMATION SOLUTIONS:

Automated Storage and Retrieval Systems (ASRS)
Vertical and Horizontal Sorters | Gantry Cranes
Automated Guided Vehicles (AGVs) | Rail Guided Vehicles (RGVs)
Vertical Roller Conveyors (VRCs)

+91 96866 24322 marketing@seweurodriveindia.com
www.seweurodriveindia.com

BMS is committed to pioneering AI-driven innovation in pharma commercialisation

AI is reshaping pharma commercialisation, transforming how companies engage healthcare professionals and deliver scientific content. **Adam Lenkowsky,** Chief Commercialization Officer, Bristol Myers Squibb and **Anvita Karara,** Vice President, Worldwide Commercialization Excellence, Bristol Myers Squibb, share how BMS is embedding AI and GenAI into its commercial strategy, including the launch of its Mosaic Content Hub in India, and what lies ahead, in an interview with **Swati Rana**

Adam Lenkowsky

Anvita Karara

AI adoption in pharma commercialisation is accelerating globally. From an industry standpoint, what key shifts are you seeing today in how companies engage healthcare professionals?
Adam Lenkowsky: The future of commercialisation is about meeting clinicians and patients where they are – and doing so in meaningful ways. We're committed to building trust and helping to arm them with data that will drive better patient outcomes.

By collecting and analysing data, we're gaining insights into patient journeys, identifying unmet needs, and tailoring our approach to ensure more patients receive the right treatments at the right times.

We're evolving our commercialisation strategies to reach more patients who can benefit from our medicines sooner.

AI solutions are enabling a new delivery model for patients in a world where classic methods are no longer as effective. Digital, data-driven tools allow us to predict, meet and react to customer needs in a more tailored manner, craft custom content and drive differentiated impact with our medicines.

BMS is preparing to announce a major AI-led commercial milestone. How does this initiative position the company differently in an increasingly competitive global market?
Anvita Karara: Bristol Myers Squibb (BMS) is committed to pioneering AI-driven innovation in pharma commercialisation. We are setting a new industry benchmark for how advanced technologies can enhance decision-making, accelerate operations, and deliver tailored engagement at scale, ultimately transforming patient lives.

BMS is proud to announce the launch of a first of its kind, end-to-end, Gen-AI enabled Mosaic Content Hub in Mumbai, India. This innovative initiative will accelerate Bristol Myers Squibb's commercialisation through enhanced digital capabilities, which will precisely identify healthcare practitioners' needs in real-time, enabling rapid creation of patient-centric content that is timely and tailored.

How AI and GenAI will reshape medical content delivery, enabling faster, more precise, and more personalised information for healthcare professionals across disease areas like oncology, cardiovascular disease, immunology, and hematology?
Karara: The Mosaic Content Hub enables BMS marketers to efficiently produce and deploy tailored content, allowing the company to provide tailored marketing materials to customers and ultimately, patients faster and with greater impact.

To date, the AI-powered The Mosaic Content Hub has been successfully piloted across three US brands—Reblozyl, Camzyos, and Cobenfy with plans to onboard additional brands and expand globally.

India is becoming central to global digital and analytics strategies in pharma. What role does India play in BMS's current AI transformation journey?
Lenkowsky: India will play an essential role in powering BMS to become the industry's fastest growing innovator. For more than 20 years, BMS has been committed to the nation of India, and this continued investment highlights our belief in its future, with a presence in Mumbai, Bengaluru and Hyderabad.

As we look toward 2026, how does BMS plan to further embed AI and

OPTIMA

Your home for turnkey
Fully integrated solutions
from one partner

H6-10:
High-speed filling with precision and care

- Optimized for GLP-1: gentle handling and accurate dosing
- Proven reliability in commercial manufacturing
- Output up to 38,000/h
- Processes RTU syringes (glass & plastic), vials, and cartridges
- Optional vacuum filling & stoppering
- Statistical IPC for consistent quality
- Handles watery to highly viscous, non-toxic to toxic products

Sterile filling

Containment

OPTIMA pharma GmbH
74523 Schwaebisch Hall | Germany | pharma@optima-packaging.com | www.optima-packaging.com/pharma

OPTIMA India Packaging Machines Pvt. Ltd.
unit 110, 1st floor | Brigade Rubix, Plot No. 20 | HMT main road | Bangalore 560013 | info-in@optima-packaging.com
Phone: +91 80 4652 5900 | www.optima-packaging.in

GenAI into its commercial and scientific engagement models?

Lenkowsky: End-to-end digital transformation is integral to all elements of our business - From molecule design to clinical trials and beyond, AI can be applied across our efforts to bring more medicines to more patients faster.

Patients are at the center of everything we do. We're leveraging AI-powered analytics and solutions to transform how we deliver medicines and outcome-driven care.

BMS is fostering a culture of digital fluency and equipping our entire organisation with the skills and expertise necessary to shape an AI-augmented future.

What are the biggest challenges—technological, organisational, or regulatory—that pharma companies face while scaling AI-driven commercialisation?

Karara: Traditional commercial playbooks for reaching clinicians and patients are evolving rapidly in the AI era, especially post-pandemic where classical methods are less effective. That shift has pushed pharma companies, including BMS, to rethink how we engage these audiences on the platforms they rely on, and to do so in ways that are both meaningful and relevant.

Traditional commercial playbooks for reaching clinicians and patients are evolving rapidly in the AI era, especially post-pandemic where classical methods are less effective. That shift has pushed pharma companies, including BMS, to rethink how we engage these audiences on the platforms they rely on, and to do so in ways that are both meaningful and relevant

From a technology perspective, one of the biggest challenges is closing the gap between what AI can do and how teams actually use it in practical, day-to-day ways.

At BMS, this is particularly critical for commercial teams that increasingly rely on digital channels to engage HCPs. We're investing in AI tools and talent development initiatives to equip our teams with the skills, resources, and insights they need to thrive in an AI-enabled environment.

Operationally, pharma companies face the challenge of identifying physicians' educational needs in real time and creating personalised content at scale - without sacrificing quality or speed.

To help address this, the Mosaic Content Hub is designed to accelerate BMS's global commercialisation efforts by bringing creatives and technologists together to leverage AI and modernise how patient-centric content is developed and delivered at scale.

With multiple therapy areas and growing data complexity, how is AI helping BMS deliver more relevant and timely scientific information to HCPs?

Karara: BMS is launching a world-class Generative AI–powered innovation hub in Mumbai, the Mosaic Content Hub, setting a new industry benchmark for AI-enabled commercialisation.

The Mosaic Content Hub, developed in collaboration with Accenture, will change the way marketing content is created, tailored, and delivered to accelerate time to market and elevating customer engagement and patient care.

By leading the adoption of transformative AI solutions and advancing digitally enabled experiences, BMS is strengthening its position as a pharma innovator, deepening our commitment to patients, and unlocking new value through strategic partnerships.

How is BMS balancing speed of innovation with governance, compliance, and human oversight?

Karara: Data privacy and compliance are foundational to our business practices. All AI-enabled processes within the The Mosaic Content Hub adhere strictly to global and local data regulations, including GDPR and India's data protection laws.

Our partnership with Accenture ensures robust data governance frameworks, and all content is generated with compliance at top of mind to protect provider information.

What would be BMS's outlook for 2026?

Lenkowsky: We are at a pivotal moment, both as a company and as an industry. BMS's science-powered and patient-centric story is accelerating, driven in part by transformational advancements in Artificial Intelligence and Machine Learning (AI/ML).

We are strategically leveraging and integrating AI tools across BMS to unlock efficiency, democratise access to data, boost productivity and enhance decision making – all with the goal of helping our global workforce reinvent our industry.

Looking ahead, what key AI-driven trends will define pharma commercialisation in India and globally over the next few years?

Lenkowsky: The future of pharma commercialisation will be defined by meeting healthcare providers and patients on the digital platforms they rely on most—and ensuring those engagements are relevant, personalised, and impactful. AI has the potential to meaningfully evolve interactions between marketers and clinicians, enhance patient targeting so the right patients receive the right treatments at the right time, and expand reach.

swati.rana@expressindia.com
swatirana.express@gmail.com

LABWARE®

Laboratory Automation Configured for Your Industry

www.labware.com

Quick-commerce players are rapidly gaining share in acute, event-based medicines

Quick commerce is reshaping pharma distribution. But the real transformation is happening deeper in the supply chain. **Uday Kadam,** COO, API Holdings, Chief Business Officer (B2B) explains how data-driven inventory, real-time visibility, and disciplined credit management are redefining availability and efficiency across India's pharma trade, in an exclsuive interview with **Lakshmipriya Nair**

Quick commerce has changed delivery expectations. What has it changed deeper in the pharma supply chain?
Quick commerce didn't just make pharma delivery faster—it shifted the supply chain from distributor-led, forecast-based systems to hyperlocal, data-driven platforms focused on immediate patient needs rather than operational efficiency alone.

Where do medicine stock-outs usually begin? At the factory, the distributor or the pharmacy?
For end consumers, most stock-outs happen between distributors and pharmacies. Factory-level stock-outs for high-demand products are rare, except during API

shortages caused by geopolitical or regulatory issues.

These distributor-to-pharmacy stock-outs are usually due to poor demand forecasting, credit limits that restrict reordering, priority given to high-volume pharmacies, sudden seasonal or outbreak-driven demand spikes, limited shelf space at pharmacies, and pharmacists avoiding expiry risk.

Is faster last-mile delivery enough, or is better inventory planning the real need?
It's a mixed picture. Quick-commerce players are rapidly gaining share in acute, event-based medicines, where consumers prefer fast delivery and don't buy repeatedly.

However, chronic medicines need careful inventory planning. For these planned, repeat purchases, consumers are more price-sensitive and tend to prefer better value over faster last-mile delivery.

Which parts of pharma distribution still rely too much on manual processes?
Many small and mid-sized distributors still manage inventory manually or through basic spreadsheets instead of modern WMS systems. This results in manual stock counts, poor tracking of batches and expiry dates, frequent stock errors, and higher losses due to overstocking, stockouts, and expired products—driving up operating costs.

Returned stock handling is also largely manual. Returns

CONTRIBUTOR'S CHECKLIST

❒ Express Pharma accepts editorial material for regular columns and from pre-approved contributors / columnists.
❒ Express Pharma has a strict non-tolerance policy of plagiarism and will blacklist all authors found to have used/refered to previously published material in any form, without giving due credit in the industry-accepted format. All authors have to declare that the article/column is an original piece of work and if not, they will bear the onus of taking permission for re-publishing in Express Pharma.
❒ Express Pharma's prime audience is senior management and pharma professionals in the industry. Editorial material addressing this audience would be given preference.
❒ The articles should cover technology and policy trends and business related discussions.
❒ Articles for columns should talk about concepts or trends without being too company or product specific.
❒ Article length for regular columns: Between 1200 - 1500 words. These should be accompanied by diagrams, illustrations, tables and photographs, wherever relevant.
❒ We welcome information on new products and services introduced by your organisation for our various sections: Pharma Ally (News, Products, Value Add), Pharma Packaging and Pharma Technology Review sections. Related photographs and brochures must accompany the information.
❒ Besides the regular columns, each issue will have a special focus on a specific topic of relevance to the Indian market.
❒ In e-mail communications, avoid large document attachments (above 1MB) as far as possible.
❒ Articles may be edited for brevity, style, and relevance.
❒ Do specify name, designation, company name, department and e-mail address for feedback, in the article.
❒ We encourage authors to send their photograph. Preferably in colour, postcard size and with a good contrast.

Email your contribution to:
The Editor,
Express Pharma,
Business Publications Division,

The Indian Express (P) Ltd,
Mafatlal Centre, 7th floor,
Ramnath Goenka Marg,
Nariman Point, Mumbai 400021
viveka.r@expressindia.com
viveka.roy3@gmail.com

due to expiry, damage, or recalls are sorted and recorded by hand, with ad-hoc decisions on resale versus disposal and little system integration. This increases errors, slows reverse logistics, and erodes margins.

How does real-time inventory visibility help distributors and pharmacies work better every day?

At Ascent, our proprietary WMS gives us real-time visibility into inventory across all warehouses, helping us make better ordering decisions and prevent stock losses proactively rather than relying on periodic audits.

For pharmacists, our Retailio platform shows real-time inventory availability, allowing them to place orders with confidence. With an industry-leading line cut of under 0.1 per cent, our integrated WMS and OMS ensure predictable, stress-free replenishment for pharmacies.

What makes expanding pharma distribution in tier-2 and tier-3 cities more complex?

Distributors focus on capital efficiency, and expanding into Tier-2 and Tier-3 cities requires much tighter control over the product assortment. Slower sales of long-tail medicines can reduce returns and increase inventory carrying costs.

Expansion into these markets also brings higher credit risk, weaker recovery rates, and lower operating leverage, as average revenue per pharmacy is lower—making profitability and scale harder to achieve.

Where is working capital getting stuck in the pharma trade today?

Credit and slow-moving inventory are the two biggest working-capital challenges in the market. Pharmacists typically receive interest-free credit from multiple distributors. In Tier-1 cities, where no single distributor has a dominant share, pharmacies rotate between these credit lines, which increases receivable days for all distributors.

Distributors often have to accommodate this until they reach sufficient scale and operating leverage, stabilise EBITDA, and can then tighten credit terms by selectively deciding who to extend credit to and for how long.

Slow-moving inventory is another major issue affecting both pharmacies and distributors. With the right systems, slow-moving stock can be identified early to reduce its impact. At Ascent, our WMS provides real-time visibility into such inventory, allowing us to proactively liquidate stock at discounts or use permitted sales returns to manage working capital more efficiently.

How is Ascent helping pharmacies improve availability while managing credit and cash flow?

Ascent distributes medicines to over 100,000 pharmacies across 20 states in India. Through our pharmacist-facing platform, Retailio, we deliver a best-in-class experience built on transparency, attractive deals, and consistent service.

Retailio digitises critical workflows across the business cycle, helping pharmacists operate with confidence and trust. Pharmacies benefit from real-time expiry settlements, complete order tracking, transparent pass-through of schemes, and full visibility into payments.

Our cloud-based proprietary WMS connects all Ascent warehouses, enabling pharmacies in any cluster to order from two to three warehouses on average. This India-first capability gives pharmacies access to a much wider assortment while allowing Ascent to maintain industry-leading inventory efficiency.

lakshmipriya.nair@expressindia.com
laxmipriyanair@gmail.com

Automation, digitalisation, and integrated workflows are redefining India's life sciences landscape

Nandakumar Kalathil, Country General Manager – India, Agilent Technologies, shares insights into Agilent's performance, strategic investments, and long-term vision for the Indian market. He discusses key industry trends, the growing role of automation, digitalisation, and AI, and how Agilent is strengthening local capabilities through solution centres, innovation hubs, and sustainability-driven initiatives, in conversation with **Swati Rana**

How has the year (2025) been for Agilent in the pharma sector?
Although we are nearing the end of the calendar year, we are at the start of our fiscal year, as our fiscal closes in October. From that perspective, FY2025 has been a fantastic year for us—not just in terms of performance, but also in terms of the initiatives we have seeded to fuel long-term growth in India.

We have made multiple investments aimed at accelerating innovation in the country, and these are paying off. We are seeing robust growth across pharma and biopharma, driven largely by increased investments in innovation. Customers are shifting toward high-value, complex solutions that require advanced technologies, and we have focused our investments on turning technology into real capabilities. This has helped us expand market share and capture the right opportunities. As an example, our recent investments in the India Solution Center and the Biopharma Center are strengthening our ability to address evolving customer needs.

As we enter FY2026, we see these growth drivers continuing, and India is well prepared to support this momentum.

What major market trends and challenges are you observing in India's life sciences markets, and how is the company addressing them?
The Indian life sciences and analytical market is evolving faster than ever, driven by strong macroeconomic fundamentals and increased technology adoption across laboratories. Growth in pharma and biopharma is being driven by innovation and increased investment in R&D, while applied markets are seeing growth through lab modernisation and the need for advanced analytical capabilities.

At the same time, supply chain resilience and the need for faster innovation—without compromising quality—remain key challenges. This is where automation, digitalisation, and integrated workflows play a critical role. By accelerating scientific progress through these approaches, we help labs meet growing demands more efficiently and reliably. Our India Solution Center further strengthens this by enabling end-to-end workflow demonstrations tailored to local requirements.

What is Agilent's long-term strategy for the Indian market, and how do recent investments such as solution centres support this vision?
Our intent in India is very clear—we are here to play the long term. Innovation is at the core of our strategy, whether it's product innovation, capability building, or solution development. For India specifically, localisation is a major focus. Our investments in FY2025 were aimed at building local capabilities while ensuring global-quality standards.

The India Solutions Center in Manesar, for example, is a hub for strategic innovation and enables us to deliver tailored solutions based on what Indian customers actually need. Similarly, the Biopharma Center of Excellence in Hyderabad allows customers to experience real lab scenarios, whether driven by regulatory requirements or technology adoption, before they invest.

How important is R&D and innovation to the company, and how are you investing in this area?
Innovation spans across every part of our organisation. We reinvest a significant portion of our earnings into research and development. This has resulted in the launch of advanced products such as our Infinity III LC systems equipped with InfinityLab Assist Technology, which provides predictive feedback and enhanced automation.Infinity III Advanced HPLC systems, which are future-ready and embedded with AI-driven predictive capabilities.

We have also introduced new LCMS platforms and advanced consumables designed to deliver more reliable analysis. Beyond products, our investments extend to infrastructure development, talent acquisition, and digital transformation. Innovation is not just about products—it's about converting those products into end-to-end solutions for our customers.

What are the key growth drivers for the pharma and

biopharma sectors today?
It's no longer about a single product—it's about enabling the workforce and integrating end-to-end workflows. Customers are looking to automate and optimize existing workflows to improve productivity and reliability. AI plays an important role here, not as a buzzword, but as an enabler that helps manage data, improve efficiency, and accelerate scientific outcomes.

GLP-1 therapies are gaining significant momentum globally. How is Agilent contributing in this area, particularly for the Indian market?
GLP-1 represents a major growth opportunity for biopharma labs, and we have proactively built the capabilities required to support this segment. We offer complete end-to-end workflows tailored to labs at different stages—from early adopters to mature facilities that need compliance-ready solutions.

Our approach combines scientific solutions with flexible business models, ensuring startups can scale quickly while advanced labs can meet regulatory expectations. The Biopharma Center of Experience in Hyderabad plays a critical role by allowing customers to access and experience these workflows firsthand

Our approach combines scientific solutions with flexible business models, ensuring startups can scale quickly while advanced labs can meet regulatory expectations. The Biopharma Center of Experience in Hyderabad plays a critical role by allowing customers to access and experience these workflows firsthand.

Several centres have been launched in India recently. How are these centres enabling co-innovation, localisation, and deeper customer engagement?
In 2025, we made significant investments to build capabilities for Indian customers. The India Solutions Center enables integrated workflows from early research through production and quality testing. The Biopharma Center of Experience serves as an innovation hub for advanced biopharma solutions. We also inaugurated the India Refurbishment Center in Manesar in December, which delivers Certified Pre-Owned instruments and supports a circular economy through trade-in, buyback, and sustainable lifecycle programs.

We also launched India's first Agilent Refurbishment Center, which supports a circular economy by extending the life of instruments while maintaining global quality standards. Alongside this, the India Education Center focuses on skill development, hands-on training, and competency building—for both customers and our internal teams.

Talent remains a major challenge across the industry. How is Agilent addressing skill gaps beyond internal initiatives?
Skill development is both a challenge and an opportunity. We work closely with industry leaders, research institutions, academia, and regulators to advance skills across the ecosystem. Through initiatives such as Agilent University, we offer flexible, self-paced, and lab-based training programs tailored to different competency levels.

As technology evolves, skill enhancement will remain an ongoing priority, and we see it as a shared responsibility to move the ecosystem forward.

Sustainability is becoming increasingly important across industries. What role does it play in Agilent's strategy?
Sustainability is embedded into our overall strategy. Several of our systems, such as the 1290 Infinity III LC, have earned sustainability recognition under the ACT® ecolabel program, and our global refurbishment programs support circular economy principles.All our newly launched products are My Green certified, reflecting built-in sustainability goals. Our India Solution Center and Biopharma Center of Experience are also Ag-certified labs, promoting sustainable practices in daily operations.

The India Refurbishment Center further supports sustainability by enabling a circular economy—extending product life cycles and making advanced technologies more accessible.

Can you share insights into Agilent's investment focus in India and growth outlook?
Our investments in India are customer-led. We invest where our customers need us—whether in technology, capabilities, resources, or geographic reach. All investments are aligned with global standards while ensuring local accessibility.

These investments are helping deepen customer partnerships, which in turn drives sustainable growth. We are also transforming internally to become more market-centric and responsive to evolving customer needs.

What will be Agilent India's top priorities over the next five years?
Our priorities remain focused on innovation, localisation, and customer partnerships. We will continue expanding infrastructure, workflow capabilities, and organisational strength. The goal is to generate meaningful outcomes—new solutions, faster innovation, and deeper collaboration with customers across pharma, biopharma, applied markets, and advanced diagnostics.

How is Agilent strengthening its presence in advanced diagnostics?
We offer cutting-edge technologies and solutions that support next-generation diagnostics and cancer research. Our platforms are empowering advanced research and diagnostic workflows, helping labs move faster and deliver more precise outcomes.

Looking ahead, how do you see Agilent India's growth trajectory shaping up over the next two years amid evolving pharma and biopharma demand?
Independent industry forecasts indicate that India is poised to remain the fastest-growing instrumentation market globally. We also see companies in India accelerating capital investments to build local manufacturing and analytical capabilities. This shift is creating sustained demand for advanced analytical tools, quality-control systems, and bioprocess technologies across the value chain.

Given these sectoral tailwinds and India's continued infrastructure investments, we expect India to remain one of the most dynamic and strategic growth engines for Agilent globally. Our focus will be on deepening customer partnerships, expanding local capabilities, and delivering lifecycle-driven solutions that support India's expanding scientific and industrial ecosystem.

swati.rana@expressindia.com
swatirana.express@gmail.com

Advanced excipients: India's gate to high-value drug formulation

Excipients are becoming a strategic lever in India's move toward high-value, globally competitive drug formulations. **Saransh Chaudhary,** President – Global Critical Care, Venus Remedies and CEO, Venus Medicine Research Centre (VMRC), explains why regulation and innovation are pushing excipients to the forefront of pharma strategy

When the Central Drugs Standard Control Organization (CDSCO) revised Good Manufacturing Practice norms under Schedule M in December 2023, it set in motion one of the most consequential quality upgrades for Indian pharma in recent decades. By aligning Schedule M more closely with WHO GMP expectations, regulators signalled that the era of minimal compliance is over. Hundreds of small and mid-sized manufacturers that were long accustomed to traditional batch processes and straightforward generics now need to modernise their facilities and quality systems if they wish to remain globally relevant.

At the same time, a quieter but equally significant shift is underway. The Drugs Rules have been amended to require manufacturers to disclose the qualitative list of excipients on labels under Rule 96, with effect from 31 March 2026. For the first time, excipients are moving from the background to the foreground of regulatory scrutiny. Ingredients once treated as passive "fillers" are now central to how India will be judged on transparency, safety and quality.

In that sense, excipients are no longer peripheral. They are becoming one of the levers that can shape India's future competitiveness in complex formulations.

Why excipients matter more than ever

India's excipient industry has significant headroom to grow, both in scale and sophistication. For years, formulators have struggled with poorly soluble active pharmaceutical ingredients, sensitive biologics and the demands of modified-release dosage forms. These challenges cannot be solved by APIs alone. They require excipients that do more than just bulk up a tablet or stabilise a solution.

Across research centres and development labs, scientists are now examining intelligent polymers, lipid-based systems and amorphous stabilisers that can improve solubility, protect fragile molecules and control drug release in very specific parts of the body. Conferences hosted by IPEC India, CPHI and academic institutions such as IISc Bengaluru are increasingly devoted to topics like solubility enhancement, stability improvement and patient adherence, underscoring how excipient science is moving closer to the centre of formulation design.

Co-processed excipients are a good example of this shift. By combining the properties of two or more materials into a single engineered system, they can improve compressibility, flow and disintegration while simplifying the manufacturing process. For many Indian generic manufacturers, co-processed excipients offer a relatively low barrier entry into more sophisticated formulation capabilities that would otherwise require much larger investments.

Over the next decade, as continuous manufacturing becomes more common and biologics gain a larger share of pipelines, excipients will only grow in importance. To realise this opportunity, large companies, smaller manufacturers and early-stage innovators will need to work in the same direction: towards advanced materials, data-informed formulation design and alignment with international quality expectations

Regulation as a catalyst, not a constraint

The revised Schedule M guidelines, together with the broader quality framework under ICH Q8, Q9, Q10 and Q12, are reshaping how Indian manufacturers think about quality by design. These expectations come at an important moment. India is increasing its focus on complex injectables, biosimilars and controlled-release dosage forms, while also seeking to reduce dependence on critical excipients sourced from outside the country. Schemes such as Pharma Vision 2030 and the Production-Linked Incentive programme are encouraging investment into higher-value products and supporting the build-out of more advanced manufacturing infrastructure.

The new excipient labelling mandate under Rule 96 adds another layer of discipline. Requiring the qualitative disclosure of excipients on the innermost container for relevant products is more than a labelling change. It improves traceability, strengthens pharmacovigilance and makes it easier for regulators, prescribers and patients to understand what goes into a medicine. Over time, this can help build trust in Indian brands in both domestic and export markets.

These policies also open space for new types of players. Start-ups, academic spin-outs and incubation centres can begin to focus on "pharma-ready" excipients tailored for local APIs, climate conditions and therapeutic needs. If India can develop and validate its own portfolio of high-quality functional excipients, it will not only reduce import dependence but also create an export opportunity in a segment that has traditionally been dominated by a few global suppliers.

The next frontier: Digital and data-driven excipient design

A parallel transformation is unfolding in how excipients are designed, screened and selected. Advances in artificial intelligence and molecular modelling are allowing researchers to simulate drug–excipient interactions before they ever reach the lab bench. By using predictive algorithms and in silico screening, development teams can narrow down candidates, anticipate compatibility issues and forecast stability outcomes in a fraction of the time that traditional trial-and-error methods would take.

These tools will be especially important for continuous manufacturing, where reproducibility and tight process control are essential. Data-driven approaches can help ensure that excipient performance remains consistent across batches and sites, reducing variability and unplanned costs.

For complex molecules such as peptides, proteins and other biologics, AI-assisted molecular design can also help identify polymer and lipid systems that protect against degradation or aggregation. Coupled with advanced analytics, rheology mapping and modern characterisation techniques, this can support the development of a new generation of engineered excipients that are designed around specific therapeutic and manufacturing needs rather than adapted from legacy materials.

The road ahead

India stands at a crossroads where excipient innovation can meaningfully reshape its position in the global pharmavalue chain. Moving from commodity-grade materials to engineered, functional excipients is not just a scientific upgrade; it is a strategic one. It underpins manufacturing modernisation, strengthens regulatory credibility and opens new export avenues.

Over the next decade, as continuous manufacturing becomes more common and biologics gain a larger share of pipelines, excipients will only grow in importance. To realise this opportunity, large companies, smaller manufacturers and early-stage innovators will need to work in the same direction: towards advanced materials, data-informed formulation design and alignment with international quality expectations.

If India can combine regulatory reform, scientific capability and purposeful investment, advanced excipients may well become one of its most important advantages in the next phase of pharmaceutical growth.

Can Indian biosimilars and generics restate accessibility in global underserved markets?

Hari Kiran Chereddi, MD & CEO – HRV Pharma & NHG Pharma highlights that India's success in generics is no longer enough, as the world now demands advanced biologics, biosimilars, and personalised medicines. He further emphasises on the need for stronger regulation, innovation, and investment so India can lead in next-generation therapies and expand global access to cutting-edge healthcare

Pharmacy of the world, a name that India has earned through the provision of low-cost, quality generics to patients geographically. India now produces close to 20 per cent of the world's generic medicines and more than 60 per cent of the demand for vaccines worldwide. The global healthcare landscape is evolving with patients no longer asking for affordable drugs alone, but are seeking innovative biologics, biosimilars, and personalised medicines.

The conversation is no longer about India retaining the position as one of the world's largest generics suppliers; it is about establishing leadership with nextgeneration therapies and redefining access to underserved therapeutic categories.

Generics: The bedrock of access

Generic medicines have revolutionised the affordability of healthcare globally. India's scale of production, regulatory capacity, and low-cost supply chains supported the global spread of ARVs for HIV/AIDS in Africa, oncology medicines in Latin America, and critical antibiotics in Asia as a few examples.

But the generics business is coming of age. Price erosion, patent cliffs levelling out, and increasing regulatory pressures are compressing margins. India needs to approach generics not as the end game but as the springboard for innovation to continue playing its role as the pharmacy of the world.

Biosimilars: The next frontier of access

Treatments using biologics for oncology, autoimmune disorders, and orphan diseases amount to almost half of the worldwide pharma market in value. At these prices most low- and middle-income nations get excluded. Biosimilars, the generics equivalent for biologics, do provide a great opportunity to expand access across the board. India is already a strong player in this sector; it already has over 100 approved biosimilars and has established global supply capacity with players such as Biocon, Dr. Reddy's, Intas, etc., With cost savings of 20–40 per cent relative to innovator biologics, Indian biosimilars have the potential to repeat the generics revolution on an even larger scale. But there are challenges. The manufacture of biosimilars requires advanced biologics manufacturing, clinical comparability trials, and credibility with regulators in the US and EU. To lead the way here, India will need to invest in advanced biologics facilities, develop scientific sophistication in cell line development, and align regulatory norms with the most stringent global norms.

Precision medicine: Beyond "one-size-fits-all"

The future of medicine is in personalising treatments to the patient profile—genomics, proteomics, and AI-driven information. Precision medicine is no longer limited to academic laboratories; it's about bringing commercial pipelines and treatment guidelines globally to India, thereby presenting this as both a challenge and an opportunity.

The task is obvious: advanced R&D capacities, large-scale biobanking, and assured data governance remain embryonic. The potential is larger; India has unparalleled genetic diversity, an accelerant in its digitising healthcare environment, and computational science cost advantages. With the combination of AI and biopharma production and clinical studies, India can bypass into:

- **Strong regulatory ecosystems** – Need for establishing strong regulatory ecosystem (like USFDA, EMA, PMDA) through voluntary compliance, quicker DMF/CEP submissions, and implementation of global GMP/GDP best practices. Regulatory trust will be the "currency" of biosimilar and biologic acceptance.
- **Invest in biologics infrastructure** – Support public–private partnerships and incentives for cell culture facilities, fermentation units, and bioanalytical laboratories. The Indian PLI schemes should move toward complex biologics as well.
- **Academia–industry linkages** – Focus more on translational research centers where all parties like universities, startups, and the pharma industry work together on biosimilars, monoclonal antibodies, and even on gene therapy.
- **Leverage AI and digital health** – Utilise AI for predictive compliance, supply-chain optimisation, and precision medicine R&D. India's IT backbone naturally enhances its digital bio-pharma integration capabilities.
- **Develop global market access** – In addition to the US and the EU, we need to look at Africa, Southeast Asia, and Latin America. Countries where demand for affordable biosimilars and precision therapies is escalating. It will be important to partner with local distributors, regulators, and governments.
- **Maintain talent development** – Specialised programmes in manufacturing of biologics, regulatory affairs and bioinformatics need to be introduced in universities and also scaled up to ensure the workforce is future ready.

A new definition of accessibility

While the early writings in the story of India's pharma journey was that of making generics affordable, the next chapter should be the one to make innovative medicines available. We don't just need low priced medicines, we need access to therapies that can alter the course of autoimmune conditions, rare diseases and cancer. By building on its established strengths India can redefine medicine access for billions. It will not only solidify our position as the pharmacy of the world, but also advance our position to become a global health innovator.

FRIENDSHORING PHARMA'S NEXT SUPPLY CHAIN BET?

With friendshoring gaining attention in global supply chain conversations, this story looks at what it could mean for the India pharma inc

By Neha Aathavale

For decades, globalisation has shaped supply chains around a single organising principle: produce where it is cheapest and most efficient, and move goods across borders at scale. But in an increasingly fractured world marked by geopolitical tensions, trade restrictions and policy-driven realignments, that logic is quietly being reworked. Supply chains are no longer evaluated solely on cost and capacity, but increasingly on trust, reliability and political alignment.

Friendshoring is gaining momentum, and the pharma industry is no exception.

However, the question is whether it is emerging as a targeted risk management exercise or it represents a permanent shift away from global supply networks. Equally important is how India is being positioned within this framework by industry stakeholders.

Setting the context

Friendshoring has moved from a conceptual strategy to an actionable consideration for pharma companies as they reassess vulnerabilities in their supply chains. Supply chains are no longer evaluated solely on cost efficiency; they have direct implications for patient access, regulatory compliance, and operational resilience.

Nihar Medh, Global Head of Supply Chain at Piramal Pharma, says the pandemic and geopolitical pressures "exposed the fragility of highly concentrated sourcing models, particularly for critical APIs and key starting materials." He adds that today, "supply continuity, resilience, and predictability carry equal weight alongside cost efficiency," highlighting how risk management has become as important as cost considerations.

However, rather than signalling a complete withdrawal from global networks, friendshoring is being adopted as a targeted approach. Companies are identifying these vulnerable points and diversifying selectively. As Shrikant Gade, Sr VP Procurement, FDC notes, "Most pharma companies are not wholesale relocating entire supply chains in the short term, given capital intensity, regulatory complexity and established global networks. Instead, friendshoring is being adopted selectively—often focusing on high-risk nodes such as API production, critical packaging materials, or essential drug manufacturing where geopolitical risk or supply fragility is greatest." In practice, this means focusing on areas of critical risk while maintaining the advantages of global efficiencies elsewhere.

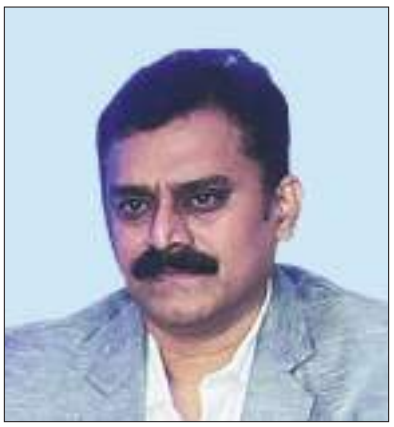
Regulatory alignment has also emerged as a major factor in choosing trusted geographies. Kaifeel Shaikh, VP - Domestic Distribution & Global Logistics–EXIM, Indoco Remedies points out that companies are prioritising countries with strong IP protections and harmonised regulatory standards. He explains, "Aligning R&D and advanced manufacturing with friendly nations with strong, enforceable IP laws is a major priority. Sourcing from countries with regulatory standards harmonised with the FDA, EMA, or PMDA drastically reduces compliance risk and accelerates time-to-market." Regulatory trust has become central to decisions about where critical production occurs, rather than a background consideration.

Operational efficiency and responsiveness are also driving friendshoring. Diversified regional supply chains can shorten lead times, improve responsiveness to demand shifts, and reduce logistical risks. Medh observes, "Regionally diversified supply chains improve lead times, increase responsiveness to demand shifts, and enable more efficient inventory and logistics management, while also reducing the environmental impact associated with long distance transportation." By spreading operations across reliable geographies, companies are building resilience without abandoning the advantages of global production networks.

Geopolitical tensions and trade disruptions continue to reinforce these shifts. Neeraj

India is increasingly being viewed as a long term strategic partner rather than only a China+1 alternative, even though diversification initially accelerated engagement

Nihar Medh
Global Head of Supply Chain,
Piramal Pharma



The pharma industry is undergoing a fundamental strategic re-structuring

Kaifeel Shaikh
Vice President - Domestic Distribution & Global Logistics–EXIM,
Indoco Remedies

Adoption today tends to be strategic and targeted rather than sweeping, with companies integrating friendshoring principles as part of broader diversification, regionalisation and risk mitigation efforts

Shrikant Gade
Senior Vice - President Procurement,
FDC Limited

Tariff and trade uncertainty is already prompting companies to change their production plans and explore new contracts to relocate manufacturing

Neeraj Bansal
Partner & Head, India Global,
KPMG India

Bansal, Partner and Head, India Global, KPMG in India, reiterates, "recent survey estimates show that pharma supply chain challenges will remain the most impactful industry trend over the next 12 months. This shift has been accelerated by a fresh wave of geopolitical disruptions, export controls and now even tariffs and trade restrictions, which are directly disrupting supply chains."

AT A GLANCE

- **From cost to continuity:** Pharma supply chains are being recalibrated to prioritise reliability, regulatory trust and geopolitical alignment alongside cost.
- **Selective, not sweeping:** Friendshoring in pharma is emerging as a targeted risk-management tool, focused on critical and vulnerable supply nodes rather than full-scale relocation.
- **Regulation shapes geography:** Alignment with global regulators and strong IP frameworks is increasingly influencing where advanced manufacturing and sourcing decisions land.
- **Operational resilience matters:** Shorter lead times, regional diversification and supply predictability are becoming strategic advantages.
- **Implications for India:** As global pharma diversifies away from concentrated hubs, India's role is evolving from cost-efficient supplier to strategic manufacturing and supply partner.

Pharma's special case

While friendshoring strategy is gaining momentum, it also comes with its distinct set of challenges. With pharma supply chains being tightly regulated, and highly specialised. Disruptions are not just operational, they can affect access to essential medicines.

The sector's complexity makes selective risk management essential. Shaikh highlights that pharma supply chains are time-sensitive and intricate, with many critical components concentrated in a few regions. He notes that the areas of highest concern include "Active pharmaceutical ingredients (APIs) and key starting materials, sterile injectables, biologics, monoclonal antibodies, vaccines, cell and gene therapy, and certain specialty raw materials and intermediates." These nodes are particularly vulnerable because production capacity is limited and alternatives are scarce.

Beyond manufacturing complexity, regulatory compliance and quality standards play a decisive role in sourcing decisions. Gade points out that global clients are increasingly evaluating geographies based on regulatory compliance, legal reliability, IP protection, governance transparency, data access, and geopolitical alignment. In pharma, even minor lapses in regulatory adherence can have outsized consequences, making trusted geographies non-negotiable for critical products.

Operational factors add another layer of nuance. Medh explains that regionally diversified supply chains help companies "improve lead times, increase responsiveness to demand shifts, and enable more efficient inventory and logistics management," while also mitigating environmental impact. However, advanced intermediates, complex chemistries, and high-complexity manufacturing often remain globally integrated, as companies continue to rely on established hubs where expertise, scale, and ecosystem maturity are concentrated.

The high stakes also extend to data integrity and intellectual property protection, particularly for biologics and novel therapies. Shaikh underscores that aligning R&D and manufacturing with nations that uphold strong IP laws is critical. Clients expect geographies where IP is respected and data access is secure, ensuring that innovation and quality are safeguarded throughout the supply chain.

Taken together, these factors explain why pharma companies approach friendshoring with caution. It is not about replacing global networks but selectively enhancing resilience where risk is highest.

This selective approach raises the question of how companies define the geographies they can rely on most. Understanding what makes a country "trusted" sheds light on India's evolving role in global pharma supply chains.

What makes a geography 'trusted'

As pharma companies evaluate friendshoring strategies, the concept of trusted geographies has become central to decision-making. For global clients, trust is multi-dimensional, encompassing regulatory compliance, intellectual property protection, operational transparency, data integrity, and geopolitical alignment. Medh explains, "Trusted geographies combine regulatory rigor, governance discipline, data transparency, and geopolitical stability to support dependable, long-term pharmaceutical supply partnerships."

Regulatory alignment is often the starting point. Countries with consistent inspection outcomes, harmonised standards with global regulators, and a robust compliance culture are considered more reliable. Shaikh notes that aligning R&D and manufacturing with nations that have strong, enforceable IP laws and regulatory standards "drastically reduces compliance risk and accelerates time-to-market." This ensures that critical production remains uninterrupted while meeting global quality expectations.

Geopolitical stability and predictability are equally critical. Companies increasingly avoid sourcing from regions where political tensions or trade restrictions could threaten supply continuity. Gade observes that clients consider not only regulatory and operational reliability but also "alignment with US, EU, and Japan-led trade and sanctions regimes" and a low probability of forced supply redirection during crises. These considerations underpin strategies such as dual sourcing and China+1 diversification.

India's role in this landscape has grown beyond being a fallback option. Medh points out that the country is "increasingly being viewed as a long-term strategic partner rather than only a China+1 alternative," thanks to its depth in chemistry, manufacturing capabilities, regulatory experience, and scale of execution. Shaikh adds that India's policies, robust pharma infrastructure, and high number of US FDA-approved plants signal reliability to global clients.

From a market perspective, Bansal notes that this shift has created expanded opportunities for Indian manufacturers. He observes, "The EU and the UAE are actively strengthening pharma supply chains and increasingly engaging India as a trusted partner, creating expanded opportunities for Indian API and formulation manufacturers." At the same time, India's dependence on imported APIs, particularly from China, underscores the need for ongoing domestic capacity building to mitigate risks and solidify its strategic position.

In effect, India is transitioning from a tactical diversification option into a critical node in global pharma supply chains. Companies are leveraging its regulatory maturity, skilled workforce, and manufacturing scale to anchor essential production while retaining flexibility elsewhere. Trusted geographies like India allow pharma companies to combine resilience, compliance, and speed in a world where geopolitical and trade uncertainties are increasingly shaping strategic sourcing decisions.

Sensitive nodes

Even within trusted geographies, pharma companies are selective about which parts of their supply chains are friendshored. The focus is on nodes where disruption could have the most immediate impact on patient access, regulatory compliance, or operational continuity. Medh explains, "Client concern is sharpest where disruption directly threatens access and patient outreach. APIs and key starting materials remain the most sensitive, especially where supply is geographically concentrated or alternatives are limited."

Sterile injectables, critical for hospital medicines and vaccines, are another priority, alongside complex biologics and biosimilars. Shaikh highlights that "monoclonal antibodies, vaccines, cell and gene therapy, and certain specialty raw materials and intermediates" are high-risk areas due to capacity scarcity and chemical complexity. Cold-chain logistics also remain a vulnerability, given the dependence on specialised providers and cross-border transport.

At the same time, not all parts of the pharma supply chain are being regionalised. Finished dosage manufacturing for small molecules, early-stage R&D, and non-critical raw materials often continue to rely on globally integrated networks.

Operational and economic considerations influence this balance. Companies weigh the

benefits of resilience against scale, cost, and capability depth. Medh points out that friendshoring "is a targeted strategy focused on critical vulnerabilities, balancing resilience with scale, capability depth, and economics." In practice, this means that while critical APIs, sterile injectables, and advanced intermediates are being regionalised or dual-sourced, other components and manufacturing processes continue to leverage established global hubs where expertise and ecosystem maturity are concentrated.

This selective approach sets the stage for understanding what capabilities global clients now expect from Indian CDMOs, including scalable capacity, regulatory readiness, data security, and speed, which will define India's strategic role in friendshored supply chains.

CDMO test

With selective friendshoring targeting high-risk nodes, global pharma companies are increasingly focused on the capabilities of contract development and manufacturing organisations (CDMOs) in trusted geographies. Indian CDMOs, in particular, are under spotlight for their ability to deliver resilience, regulatory compliance, and operational agility across complex supply chains.

Medh notes that clients are seeking CDMOs that can combine multiple capabilities: "In the wake of the Biosecure Act, clients are asking Indian CDMOs to strengthen capabilities in a balanced way. Capacity scale still matters, but with an emphasis on flexible and modular capacity that can adapt quickly without quality trade offs."

"Regulatory readiness remains fundamental, with expectations of constant inspection readiness, strong quality systems, and confidence across multiple regulatory regimes. Data security and digital maturity are rising priorities, covering data integrity, cybersecurity, and controlled transparency," he adds.

In essence, the expectation is for CDMOs to deliver scale with agility, compliance with confidence, and speed with discipline.

These requirements align with the broader trend of risk-aware global sourcing. Indian CDMOs benefit from the country's established regulatory infrastructure, skilled workforce, and proven track record in high-volume and complex manufacturing, which collectively support these client expectations.

At the same time, geopolitical and trade uncertainties continue to influence planning. Bansal states that "tariff and trade uncertainty is already prompting companies to change their production plans and explore new contracts to relocate manufacturing. CDMOs are reevaluating reliance on China and increasingly turning to nearshoring and friendshoring for supply chain security." This is creating opportunities for Indian manufacturers, particularly in APIs, essential drugs, and shortage-prone categories, as companies look to diversify and secure supply from reliable partners.

India's positioning is evolving from a diversification option to a long-term strategic partner. As Medh points out, "Global clients see India as a dependable base for high-quality APIs, intermediates, and finished dosages, backed by a strong regulatory track record, skilled talent, and proven global delivery." Government incentives, such as production-linked schemes, and the country's growing capabilities in complex biologics and advanced therapies further strengthen this narrative.

For Indian CDMOs, the challenge is balancing capacity expansion, regulatory readiness, and technology upgrades with speed and flexibility. Companies that can meet these multidimensional requirements are positioned not only to serve existing markets but also to anchor new supply chain hubs as global pharma navigates friendshoring strategies.

India's path forward

Selective friendshoring is reshaping how global pharma views investment, policy, and strategic partnerships. Companies are increasingly prioritising reliability, regulatory alignment, and political predictability over purely cost-driven decisions. As Bansal observes, recent geopolitical disruptions and trade restrictions "have exposed critical vulnerabilities in global drug supply chains, including overdependence on concentrated production hubs and the risk of shortages."

For India, this creates opportunities to strengthen its role beyond being a short-term China+1 alternative. The country is recognised for its manufacturing depth, regulatory track record, and skilled workforce, making it an attractive partner for high-quality APIs, intermediates, and finished dosages. Indian CDMOs, in particular, are expected to meet multidimensional demands; scalable production, regulatory readiness, and operational flexibility, positioning them as strategic anchors in global supply networks.

At the same time, India's reliance on imports for nearly 70 per cent of its APIs highlights a critical vulnerability. Bansal notes that reducing this dependency and expanding
domestic API capacity will be essential for securing both domestic supply and export commitments. Policy incentives, private sector investment, and innovation-led initiatives will play a decisive role in consolidating India's position.

Beyond traditional US and China linkages, global companies are increasingly looking to Western Europe, Japan, Korea, Singapore, and parts of North America to build diversified supply chains. This opens avenues for India to deepen collaborations while helping create a more balanced and resilient pharma ecosystem.

In a world where trust, compliance, and capability now define supply chain partnerships, India's challenge will be to translate its scale and regulatory strength into a permanent, long-term strategic role. Building domestic capacity, fostering innovation, and strengthening public-private collaboration will determine whether the country becomes a cornerstone of friendshored pharma supply chains or remains primarily a diversification fallback.

neha.aathavale@expressindia.com
nehaaathavale75@gmail.com

The invisible threat: Why packaging inks are the next major recall risk for pharma

Jatin Takkar, Head – Product Safety & Regulatory, Siegwerk India argues for a shift from checkbox compliance to a 'safe-by-design' approach, starting with ink chemistry to protect patients, brands, and India's global pharma credibility

For decades, the food & pharmaceutical industries have relied on packaging to be the final, infallible guardian of its products. Yet, high-profile contamination events and evolving global standards have exposed a critical truth: the protector, if not meticulously controlled, can become the source of profound risk. Achieving true compliance and securing consumer safety demands that the industry moves beyond simply ticking regulatory boxes to embrace a proactive, 'Safe by Design' philosophy that starts with the chemistry of packaging inks.

The fundamental expectation of pharmaceutical packaging, be it a blister foil, a folding carton, or a label, is to protect the active pharmaceutical ingredient (API) from external factors like moisture, light, and microbial ingress. Packaging is basically the barrier against the outside world.

However, the raw materials used in packaging materials, particularly printing inks, represent a significant, often unmonitored contamination pathway. The chemicals from the inks, applied to the outer layer, can migrate into the drug itself, compromising patient safety.

The Indian ink industry, especially in the absence of explicit, mandatory pharma-specific guidelines for packaging inks, has historically deployed several controversial chemicals. These include:

● **Toluene:** A common solvent, Toluene is classified as a CMR (Carcinogenic, Mutagenic, or Reprotoxic) Category 2 substance. While the Food Safety and Standards Authority of India (FSSAI) and the Bureau of Indian Standards (BIS) have banned its use in food packaging inks, its prevalence elsewhere poses a critical cross-contamination risk that contradicts fundamental food and drug safety principles.

● **Mineral oils (MOAH/MOSH):** Components of mineral oils, specifically the Aromatic Hydrocarbons (MOAH), are considered potential genotoxic carcinogens that have been widely documented to migrate from packaging (especially recycled board) into products. The use of mineral oil-based inks undermines the principle of providing a safe packaging material.

● **Benzophenone and photoinitiators:** These compounds are essential for UV-curing inks, but their unreacted residues are highly prone to migration. Benzophenone, in particular, has repeatedly haunted the pharma industry, resulting in issues due to its discovery in packaging component where it can permeate the material and contaminate the product itself.

These are only the most recognised threats. The future of packaging safety is already under threat from numerous other chemicals, including:

● **Per- and Polyfluoroalkyl Substances (PFAS):** Often used for grease resistance, these "forever chemicals" are facing global bans due to extreme persistence and health concerns.

● **Synthetic dyes:** Many synthetic dyes contain aromatic amines, which are linked to carcinogenicity and mutagenicity, posing a quiet but severe risk when used in primary or secondary packaging.

The cost of non-compliance

Packaging safety is no longer just a technical issue; it is a business imperative that impacts:

● **Consumer safety and trust:** The ultimate failure is the patient/customer-level impact. High-profile incidents, such as the Sartan contamination (where N-nitrosamine carcinogens were found in certain blood pressure tablets, leading to massive global recalls) and the tragic Diethylene Glycol (DEG) contamination in Indian-made cough syrups, obliterate consumer trust and permanently scar brands and nations.

● **Perceived safety:** Even the fear of contamination can destroy consumer confidence overnight, especially when international scrutiny is involved.

● **Indian exports and global Image:** When a product is recalled globally, it severely restricts international market access, damaging India's image as a reliable global pharmacy and threatening its export economy.

Pharma industry needs to understand what is safe packaging inks

Given the absence of a specific mandate, the pharma Industry must proactively define its requirements for packaging safety. True safety begins with understanding the core concept of migration-optimised inks.

A migration-optimised ink is far more than just "Toluene-free ink". It is a solution "Safe by Design," meaning every single component, from solvents, binders and pigments to photoinitiators and additives, has been carefully selected and assessed to minimise the risk of chemical transfer into the drug.

Key considerations for the pharma industry must include:

1. Strict raw material selection: The supplier must adhere to a positive list approach, where only substances explicitly evaluated for their migration limits are used, following the highest global standards.

2. Mitigation of non-intentionally added substances (NIAS): NIAS are chemical compounds that have not been intentionally added to the packaging component but may be present as impurities, reaction by-products, or degradation products. A truly safe ink supplier must have stringent quality control and supply chain transparency to identify and mitigate NIAS formation.

3. Debunking marketing gimmicks: The industry should not be misled by simple marketing claims like "Toluene-free inks" or "Mineral Oil-free inks." The replacement of just one hazardous chemical with an unverified or less-controlled alternative often results in "regrettable substitution," where the replacement chemical poses a new, equally dangerous, or even unknown risk. Safety is about the careful selection of all raw materials, not the mere replacement of one.

Addressing the regulatory gaps

The pharma sector, unlike the food industry, lacks specific, dedicated guidelines for printing inks used on its packaging. This regulatory absence creates a dangerous scenario: Pharma companies, whose core expertise lies in drug formulation and manufacturing, are inadvertently placed in the role of packaging and ink safety experts - a field where they inherently lack deep knowledge.

The closest concept often adopted by the pharma industry as a best practice is the Food Grade Ink concept, which in the Indian context, translates to the BIS Standard – IS 15495. While adopting IS 15495 is a crucial first step for domestic compliance, it is fundamentally insufficient for global export markets.

For companies dealing with exports, particularly in highly regulated markets like the EU and the US, a much higher degree of sensitivity and care is required. These global markets demand adherence to global standards that rigorously consider the chemical migration aspects. Therefore, companies must adopt globally benchmarked standards.

Securing the future of pharma

The path to safeguarding the pharma supply chain runs directly through the chemistry of its packaging. The days of treating packaging as a commodity are over. Pharma companies must recognise the inherent risks associated with printing inks and elevate their standards to global best practices immediately. This vigilance requires strong, knowledgeable partners who not only possess the correct know-how and expertise in migration concepts but also deeply understand the complex, fragmented regulatory landscape and, critically, operate with complete transparency.

FACTORY OF THE FUTURE

Intelligent, connected, sustainable

As pharma manufacturing accelerates toward a digitally driven future, the industry is redefining how quality, efficiency, compliance, and sustainability are achieved. From Pharma 4.0 architectures and AI-powered automation to real-time quality assurance and autonomous operations, data and intelligence are rapidly becoming the backbone of modern manufacturing. Yet this transformation is not only about technology adoption—it is equally about governance, skills, regulatory alignment, and human accountability. Industry leaders from across the pharma value chain share their perspectives on how automation, digitalisation, artificial intelligence, and process analytics are reshaping manufacturing. They share their perspective on the evolution of digital architectures, the growing role of AI and robotics, the shift from reactive to proactive quality systems through PAT, the challenges of cybersecurity and workforce readiness, and the importance of embedding trust, governance, and human oversight into advanced GMP environments.

Building the digital backbone of Pharma 4.0 manufacturing

Pharmaceutical manufacturing is undergoing a profound transformation, evolving from traditional manual and experience-based operations toward data-driven, intelligent systems empowered by Artificial Intelligence (AI) and advanced digital technologies. This shift, often referred to as Pharma 4.0, integrates automation, real-time data analytics, and seamless connectivity to enhance efficiency, quality, compliance, and sustainability.

Digital Architecture Framework

A robust Digital Architecture Framework — commonly aligned with the ISA-95 (Purdue Reference Model) — provides a hierarchical structure for system integration. It typically comprises the following layers:

- **Level 1** – Equipment & Sensing Layer Data generation at the shop floor through Programmable Logic Controllers (PLCs), IoT sensors, Process Analytical Technology (PAT) tools, balances, and other instrumentation.
- **Level 2** – Control Systems Layer Real-time process monitoring and control via Supervisory Control and Data Acquisition (SCADA), Distributed Control Systems (DCS), Building Management Systems (BMS), and Environmental Monitoring Systems (EMS).
- **Level 3** – Manufacturing Execution Layer Execution and electronic recording of manufacturing processes through Manufacturing Execution Systems (MES) and Electronic Batch Recording (EBR).
- **Level 4** – Business & Quality Management Layer Integration of quality, manufacturing, and supply chain systems, including Laboratory Information Management Systems (LIMS), Quality Management Systems (QMS), Document Management Systems (DMS), and Enterprise Resource Planning (ERP).
- **Level 5** – Intelligence & Integration Layer Advanced analytics, AI/ML applications, data lakes/warehouses, visualisation tools, dashboards, and emerging technologies such as digital twins.

Sanjay Sharma, Senior VP & Head Manufacturing Science and Technology, Zydus Pharmaceuticals

The overarching vision of this architecture is to create a fully integrated, data-driven manufacturing ecosystem. It enables seamless information flow from the shop floor to the top floor (and vice versa), delivering real-time visibility, predictive quality assurance, and accelerated, informed decision-making.

Key elements of automation in pharma manufacturing

Automation extends far beyond isolated robotic applications, encompassing system-wide transformation through data integration, AI, and human-machine collaboration.

1. Advanced Robotics and Collaborative Automation Robotics represent one of the most prominent trends in pharmaceutical automation:

- **Industrial Robots** — Ideal for high-precision, repetitive tasks such as sorting, inspection, and packaging; these are relatively straightforward to implement.
- **Collaborative Robots (Cobots)** — Designed for safe human-robot interaction, they excel in assembly lines and pick-and-place operations.
- **AI-Enabled Advanced Robots** — Emerging solutions capable of independently managing complex, variable tasks.

2. AI and Machine Learning Integration AI extends automation into higher-value, cognitive domains:

● **Predictive Analytics and Quality Control** — Sophisticated algorithms analyse historical and real-time machine data to detect anomalies, predict deviations, and recommend proactive interventions — significantly reducing batch failures.

Autonomous Process Control — By establishing "golden batch" profiles from historical data, advanced process control systems can automatically adjust Critical Process Parameters (CPPs) in real time to maintain optimal process conditions.

Phased adoption strategy

The adoption of these technologies follows a risk-based approach, prioritising areas with lower patient risk, mature solutions, and strong regulatory alignment.

● **Warehouse operations** — First to achieve high levels of autonomy due to their logistical nature (material movement, storage, and inventory management). Proven technologies include Automated Storage and Retrieval Systems (AS/RS), Automated Guided Vehicles (AGVs)/Autonomous Mobile Robots (AMRs), RFID/barcode systems, and AI-driven demand forecasting. Many large-scale pharmaceutical facilities have already implemented fully autonomous warehousing.

● **Packaging operations** — Next in priority, particularly secondary packaging, which is highly repetitive and structured. With advanced robotics and vision systems, both primary and secondary packaging lines are progressing toward lights-out (minimal human intervention) operations.

● **Core manufacturing processes** — Focus shifts to continuous processing, supported by PAT, real-time advanced data analytics, and autonomous control systems. This approach has received strong encouragement from global regulators (e.g., FDA and EMA) for its potential to improve consistency, reduce variability, and enhance quality.

In summary, modern automation in pharmaceutical manufacturing transcends individual robots or isolated tools. It represents a holistic, system-wide evolution — underpinned by robust digital integration, AI-driven intelligence, and collaborative human-machine workflows. These advancements deliver increased throughput, superior product quality, enhanced regulatory compliance, greater operational flexibility, and improved sustainability, positioning forward-thinking organisations to meet the demands of an increasingly complex and patient-centric industry.

From end-product testing to real-time quality: The rise of PAT-driven manufacturing

The pharmaceutical and biopharmaceutical industries are undergoing a fundamental shift from traditional, end-product quality testing toward real-time, process-driven quality assurance. Moreover, regulators believe that the in- process testing is done to verify that the process is moving as designed at various stages of manufacturing rather than testing the quality of the product. Being destructive testing, only statistical analysis of any sample of a batch is possible and if done at the end stage, considerable time, efforts & resources will get wasted, in case of any failure. Thus, there is a major shift happening in the industry thought process.

In the centre of this transformation is Process Analytical Technology (PAT)—a framework that enables continuous monitoring, automated control, data-driven decision-making and optimization of manufacturing processes. PAT plays a critical role in enabling real-time, autonomous quality assurance, reducing reliance on manual interventions while improving product consistency, efficiency, quality, regulatory compliance, and operational excellence.

PAT integration: Various PAT tools are available in the market which can be integrated in line or online with the process equipment to chart the course of manufacturing process. This integration allows manufacturers to understand process behaviour as it happens, forming the foundation for autonomous quality assurance.

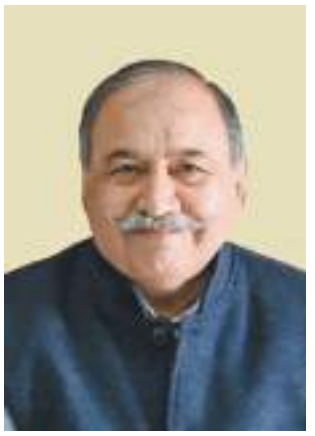
● Advanced sensors and analysers (e.g., NIR, Raman, mass spectrometry)
● Multivariate data analysis (MVDA) and chemometrics
● Automation and control systems
● Data management and real-time analytics

Through real-time measurement of CPPs and CQAs; PAT proactively enables autonomous quality systems that operate with minimal human oversight.

● Immediate detection of process deviations
● Real-time corrective actions before product quality is compromised
● Reduced batch failures and rework

Regulatory agencies, including the FDA and EMA, actively encourage PAT adoption as part of modern pharmaceutical manufacturing. PAT supports compliance by:

● Providing traceable, high-frequency data for audits and investigations
● Reducing operator-dependent variability and manual errors
● Enabling real-time release testing (RTRT) by demonstrating process control



Naresh Gaur, Executive VP, Operations, Stallion Laboratories

By shifting from retrospective analysis to real-time insight, PAT eliminates delays between production and quality decisions, a prerequisite for autonomous operations and helps in real time release of batches

By shifting from retrospective analysis to real-time insight, PAT eliminates delays between production and quality decisions, a prerequisite for autonomous operations and helps in real time release of batches.

PAT is especially critical for continuous manufacturing, where traditional batch testing is impractical. In these environments, PAT ensures uninterrupted quality monitoring and rapid response to disturbances.

In essence, PAT transforms quality assurance from a reactive checkpoint into an intelligent, self-regulating system—unlocking the future of autonomous manufacturing.

Although digitalisation and automation are not something very recent with two of the leading Indian companies having their plants certified as Light Houses by World Economic Forum, however it will not be incorrect to say that most of the organisations are still work in progress. Everyone wants to be there but lacks clarity & vision. The road map for creating an autonomous system is yet to be prepared in most of the organisation. Some of the organisations have started going for Digital Maturity assessment and initiated actions accordingly to fill up the gaps.

Having said that, pharma professionals/ work force with desired skills are mostly unavailable with most of the leadership believing that some sort of skill development training is required in this aspect.

With the rise of AI adoption, people having knowledge of various levels of AI, its capability & usage on the shopfloor are needed across the entire pharma ecosystem. Operators & shopfloor managers will have to deal in digital processes, the kind of reports they need from the massive data being churned so as to be meaningful and provide course correction or action plan. They will need more digital analytical skills and knowledge of terminology used in the digital ecosystem to adapt and be an agile practitioner.

There exists a huge gap in supply vs demand of workforce for managing autonomous systems and strong need by the pharma academia to include this in their curriculum and start Digital Academies for Pharma professionals.

Automation in packaging: Driving consistency, compliance, and scalable manufacturing

Packaging and manufacturing are distinct areas, but both offer significant opportunities for automation—particularly in packaging, where repetitive tasks such as packing, palletising, sealing, and labeling can be handled faster, smarter, and in more sustainable ways. Automation enables high-speed operations with greater throughput, quicker changeovers, and optimised use of materials during setup and transitions, directly improving operational efficiency.

A key advantage of automation is real-time monitoring, which significantly reduces errors while enhancing quality, compliance, and traceability. By maintaining consistency at high speeds, automation eliminates the variability associated with manual processes. Advanced online inspection systems equipped with high-resolution cameras continuously monitor operations, enabling early defect detection, waste reduction, and improved product quality.

Automation also plays a critical role in regulatory compliance. By minimising risks such as mislabeling, cross-labeling, or the use of incorrect or mixed labels, automated systems help prevent regulatory violations, product recalls, and market losses. This not only protects manufacturers but also strengthens trust in the product and the brand.

Bhagwan Pandhare,
MS&T - Packaging Development,
Alembic Pharmaceuticals

The value of automation lies in a combination of speed, accuracy, cost efficiency, and flexibility—each closely linked to the other. Increased speed drives higher productivity, while accuracy enhances quality and compliance. Cost efficiencies make products more affordable for consumers while improving profitability for manufacturers. Flexibility allows rapid adaptation to product variations and changing market requirements.

Automation has also transformed the role of MS&T (Manufacturing Science and Technology) teams, especially in packaging scale-up and technology transfer. Traditionally serving as the bridge between R&D and commercial manufacturing, MS&T teams have evolved into more data-driven, proactive, and digitally integrated functions. Today, they leverage automation and data analytics to model scale-up scenarios, simulate packaging processes before physical transfer, and reduce dependence on manual trial-and-error approaches.

Standardised automated workflows make it easier to replicate processes across sites and product lines, significantly reducing the risk of failures during scale-up. Importantly, automation and data-driven insights help minimise the number of actual scale-up batches required—delivering substantial cost savings, particularly when working with high-value or costly APIs.

AI, predictive analytics, and the shift toward autonomous pharma operations

Over the next three to five years, AI-driven quality intelligence combined with predictive analytics is expected to have the most significant impact on pharmaceutical manufacturing. These technologies are maturing rapidly and are already delivering measurable returns on investment, often faster than robotics or digital twins. Across the industry, digital strategies are moving away from reactive control toward predictive management—leveraging historical and real-time data to anticipate quality deviations and process drift before issues arise.

What makes this combination particularly powerful is its scalability. AI models can be built on existing data infrastructures such as MES, e-logs, LIMS, and historian systems without requiring major capital investments or plant redesigns. Digital twins, while promising, rely heavily on the maturity of predictive models and robust data foundations and are likely to follow once organisations achieve deeper data-driven process understanding. Robotics and autonomous mobile robots (AMRs) are also advancing, though adoption remains slower due to validation complexities and high integration costs. That said, robotics integrated with AI is emerging as a key enabler for "dark factories" in pharma, an area where a few organisations have already begun making progress.

As manufacturing environments become more autonomous and interconnected, cybersecurity has emerged as a critical pillar of operational trust. The most significant risks lie at the convergence of operational technology (OT) and information technology (IT), where manufacturing equipment, MES platforms, and cloud-based analytics systems interact. Recent ransomware incidents targeting utilities, HVAC systems, and isolators have exposed vulnerabilities on production floors when digital defenses fail to keep pace with connectivity.

Anurag Chauhan, AGM,
Digitalisation & Automation,
Amneal Pharmaceuticals

The increasing use of AI introduces additional risks related to model integrity and data provenance. Since model outputs directly influence product quality and compliance, any tampering with AI models, critical process parameter data, or audit trails could lead to regulatory non-compliance or even product recalls. Ensuring secure, validated, and traceable data flows is therefore becoming as important as process control itself.

Robotics and advanced handling systems are also transforming operations in sterile and high-risk manufacturing environments. In response to tighter regulatory expectations, particularly under EU Annex 1, robotic isolators and automated material transfers are increasingly essential. By reducing human intervention, these systems significantly lower contamination risk and particle generation—areas under growing regulatory scrutiny.

From a safety perspective, robotics is redefining how potent APIs and cytotoxic materials are handled. High-risk tasks such as aseptic fill-finish operations and material transfer in toxic zones are progressively being automated, improving operator safety while delivering greater process consistency and repeatability.

Advances in process analytical technology (PAT) are further enabling the shift from reactive to proactive quality control. Real-time NIR, Raman, and imaging sensors now provide continuous visibility into manufacturing processes, reducing reliance on end-batch testing. For example, in oral solid dosage manufacturing, online blend uniformity analysis is replacing intermittent offline sampling, with PAT-based insights determining process endpoints instead of fixed time assumptions. Similar transitions are occurring in tablet manufacturing, where content uniformity testing is increasingly supported—or replaced—by PAT tools.

When combined with AI and multivariate analytics, PAT systems can predict deviations before they occur. Seamless integration of PAT data with MES, LIMS, and batch review systems enables manufacturers to move toward continuous verification and proactive quality oversight, fundamentally changing how quality is managed across the production lifecycle.

Designing trustworthy AI for GMP: Balancing automation with accountability

AI and advanced analytics are fundamentally reshaping how quality decisions are made in regulated manufacturing, but the question is not whether we can trust automation of GMP frameworks — it is how we design systems where technology enhances compliance without diluting accountability.

For decades, GMP-driven quality assurance has relied on periodic checks, manual reviews, and retrospective investigations. Today, with real-time data capture across equipment, processes, and environments, and with the advent of agentic AI, a shift from reactive quality management to predictive and preventive quality intelligence is now possible. Advanced analytics can identify subtle process deviations long before they manifest as non-conformances, flag emerging risks in real time, and recommend corrective actions based on historical and contextual data. This is not simply automation — it is a new layer of decision intelligence that makes quality systems more proactive, consistent, and transparent. However, GMP is ultimately built on the principle of accountability. Regulators expect not only that the right decisions are made, but that there is traceability of how and why those decisions were made.

Duraisamy Rajan Palani, Founder & CEO, Archimedis Digital

Archimedis Digital is at the forefront of this transition in the Indian pharma ecosystem, leveraging its AI-enabled compliance stack to transform periodic compliance into real-time assurance, span vast and heterogeneous datasets, and help organizations align with an increasingly dynamic regulatory landscape. At Archimedis Digital, we believe that AI governance and Human-in-the-Loop (HITL) are the most fundamental requirements for compliant implementation of any advanced AI system in a GMP environment. Organisations must invest in governance frameworks that define how algorithms are validated, how models are monitored for drift, and how audit trails are maintained. This ensures that every AI-enabled decision is compliant and meets regulatory expectations. In parallel, any agentic AI-driven decision-making should always be anchored by human accountability through HITL. The final sign-off by the Human-In-The-Loop is not a limitation of technology, but a necessary safeguard for accountability and responsibility.

Technology adoption in this space is still evolving, and trust in AI-driven quality systems will grow as the industry matures its validation practices for digital tools, much as it did for computerised systems over the past two decades. Those who succeed will be the companies that embed governance, explainability, and human-accountability at every level of AI-transformation.

Smarter supply chains for a healthier India

Kishan Kumar, MBA Graduate Student, Southern Connecticut State University, US points out that India's pharma future will be decided as much by logistics as by manufacturing. He explains how AI-enabled, intelligent supply chains can make India a more reliable and trusted global pharma partner

As a nation known for generations as the "Pharmacy of the World," India's reputation was based upon both manufacturing capability and an established system of generic drugs. However, the world of international pharmaceuticals is undergoing significant change. Post-pandemic economic growth, changes in global geopolitics due to the "China+1" model and increasingly stringent international regulation are shifting supply chain management from a basement function to a high-level corporate concern. To meet projections that have the Indian pharma sector valued at $130 billion by 2030, the industry will need to evolve beyond the traditional models of logistics and move toward becoming what Gartner calls an "Intelligent Enterprise" driven by AI.

The geopolitical pivot: Capitalising on China+1

India has an extraordinary chance to grow by leveraging the 'China+1' strategy—used by multinational pharma companies that are looking for alternatives to China as they create diversified sourcing and manufacturing models. This will require more than simply lower labor costs: India's pharma industry needs to develop a supply chain that matches the same level of visibility and dependability that can be found in the global marketplace.

AI is a technology that can close this gap. When India's pharma companies use AI-based systems, they provide the level of transparency required by Western partner companies.

Whether it is tracking active pharma ingredients sourced internationally or providing a digital verification of quality and consistency of final mile delivery of a biologic product to a remote village in India, AI creates the digital handshake that ensures the quality and consistency of products produced in India, making India the most attractive "plus one" in the global market.

Beyond spreadsheets: Predictive demand forecasting

The Indian pharma market is unique in its complexity with fragmented market conditions and more than sixty thousand generic brands available to consumers. Because of these conditions, the "bullwhip" effect has occurred historically, caused by minor fluctuations in retail demands that result in large, costly fluctuations in both production and inventory levels for the company providing the product. The traditional method of forecasting is no longer reliable because it has been based on historical sales patterns and simple spreadsheet calculations.

Machine learning (ML) offers an alternative solution to traditional methods of forecasting. Algorithms used in ML are capable of ingesting nontraditional types of data including:

1. Epidemiological trends of disease outbreaks
2. Weather patterns to predict seasonal increases in respiratory or tropical illnesses
3. Macroeconomic trends to adjust for changes in consumer purchasing power due to inflation

Pharma companies using predictive models instead of reactive models can improve their forecasting accuracy up to 95 per cent, which can ensure that products reach customers at the right location and at the time of need when a surge occurs, resulting in almost complete elimination of two major problems faced by all pharma companies: stock-outs and expired inventory.

Precision at scale: ML-driven inventory optimisation

The logistics of the pharma industry is limited by only two things: tight profit margins and strict expiration dates (shelf lives). Because of the need to store pharma inventory in a highly controlled environment, the inventory holding costs for pharma inventory are much higher than for typical retail inventory. As a result, the "middle-mile" is transforming to be more efficient by using AI-driven smart warehousing.

Unlike traditional warehousing, which often experiences "dwell time," (the amount of time a product spends idle), AI is used to eliminate dwell time through dynamic slotting and picking. The AI analyses the real-time demand signals and uses them to automatically determine the best place to put high velocity or sensitive items (such as biologics) to pick at the most opportune time possible. This limits the number of times that an item is physically handled and ensures that items with the shortest expiration date will flow quickly through the warehouse, thereby limiting the opportunity for the item to expire.Beyond the walls of the warehouse, AI allows for dynamic rebalancing to take place nationally. Because India is made up of many different states, stock shortages and surpluses occur regularly. For example, if an AI platform verifies there is an overstock of a particular antibiotic in a warehouse located in Maharashtra and determines there will be a shortage of that same antibiotic in a warehouse located in Karnataka, it can autonomously issue a transfer order to redistribute the excess to the area experiencing a shortage.

As a result of the real-time rebalancing of stock that takes place between warehouses in each state, the supply chain becomes a fluid, responsive system rather than a collection of separate silos. Pharma companies can also reduce the amount of capital being held in "safety stock" and assure that life-saving medications are available when they are needed, long before a crisis arises.

Figure 1: The AI Digital Handshake. The illustration shows how AI-based transparency systems and digital verification methods help Indian pharmaceutical logistics companies fulfill Western global partners' demanding standards during the "China+1" period

The cold chain frontier: IoT and AI integration

Because of India's tropically warm environment, maintaining the "golden mean" temperature for vaccines and other specialised biologic drugs has been notoriously challenging. This is why most of the total lost value occurs during the cold chain process. Traditional data loggers are merely recording devices that report on a failure once it has occurred; however, with the integration of AI and

the Internet of Things (IoT), thermal integrity for vaccines and biologic drugs is now evolving alongside proactive preventative systems.

When utilising a continuous flow of real-time data on temperature, humidity and light exposure, AI converts the cold chain from a passive monitoring mode to an active preventive mode. As an example, AI can recognise the slight vibration patterns of a compressor in a refrigerated truck as indicative of an impending mechanical failure. Once this information is identified by the system, the system alerts the driver to take action to move the shipment to the closest validated cold storage facility. The potential risk associated with the shipment has been eliminated.

The sophistication of the monitoring systems used in this type of process culminates in a comprehensive digital audit trail. Although anecdotal assurances may have been sufficient in the past, global regulatory bodies such as the US Food and Drug Administration (FDA) and the European Union Good Manufacturing Practices (EU GMP) require a data-driven based approach to ensure compliance with environmental regulations. A digital audit trail creates an unalterable and verifiable record of quality for each point of contact in the supply chain. Manufacturers can certify their compliance with regulations; make audit processes easier; and, most importantly, they can ensure that the efficacy of the drug remains uncompromised when going from the manufacturing site to the patient by tracking the journey of the finished product back to the raw materials used to create it.

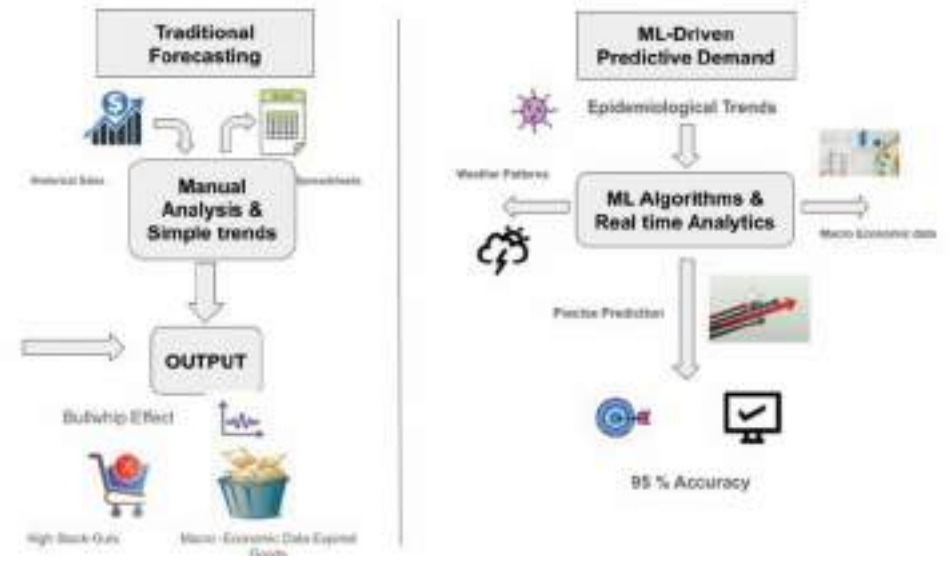


Figure 2: Illustration of traditional forecasting vs machine learning (ML): By analysing epidemiological and weather patterns, AI can improve forecasting accuracy to 95 per cent, virtually eliminating stock-outs

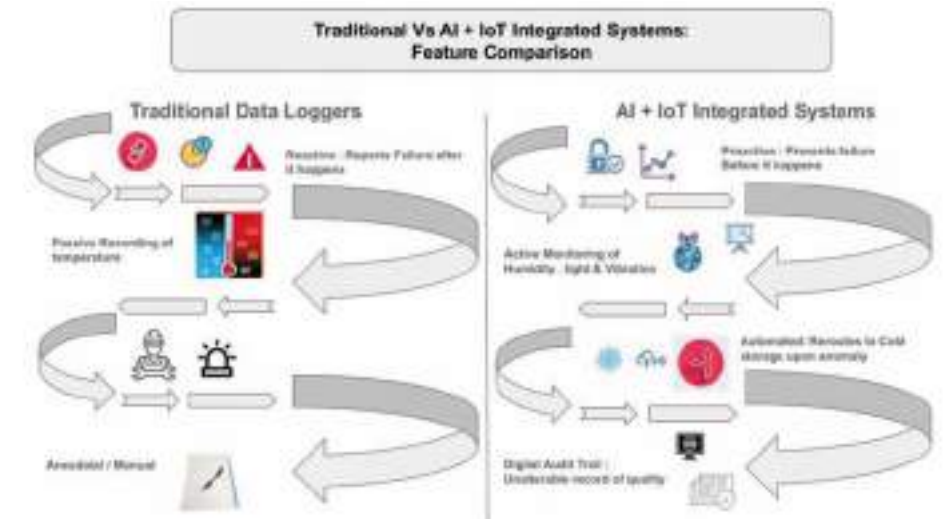


Figure 3: Conceptual illustration that shows the shift from passive monitoring to active prevention. The comparison demonstrates that AI and IoT integration provides superior protection than basic data recording because it enables real-time defense systems that stop system threats from happening

The road ahead: Building the intelligent enterprise

The implementation of AI in logistics operations requires more than technological updates because it stands as a fundamental requirement for Indian pharma leaders to achieve success in the upcoming 10 years. The future business model of Indian pharma leaders requires them to establish AI as their core operational foundation.

Organisations need to achieve three critical development stages to transform into an "intelligent enterprise":

1. Data democratisation: The current obstacles that block manufacturing from sharing data with sales and logistics departments need to be eliminated.

2. "Pilot scaling" refers to the method that allows AI testing to move from limited small-scale research to complete organization-wide implementation of AI systems.

3. The talent upstreaming program teaches logistics professionals to work with automation systems through analytical training, which enables them to achieve effective system collaboration.

To create a healthier India, the intelligent capabilities of our supply chains will determine whether healthcare will be accessible to all citizens. The Indian pharma industry will maintain its position as the Pharmacy of the World through AI implementation, which will also establish the nation as the world's leading technologically advanced and dependable partner.

> Whether it is tracking active pharma ingredients sourced internationally or providing a digital verification of quality and consistency of final mile delivery of a biologic product to a remote village in India, AI creates the digital handshake that ensures the quality and consistency of products produced in India

References

1. EY and Organization of Pharmaceutical Producers of India. "Reimagining Pharma and Healthcare for India@100," 2023. Available at: https://www.ey.com/en_in/insights/health/pharma-and-healthcare-for-india-100-a-century-of-change-on-the-horizon

2. Gartner. "Gartner Glossary: The Intelligent Enterprise," 2024. Available at: https://www.gartner.com/en/information-technology/glossary/intelligent-enterprise

3. Indian Pharmaceutical Alliance. "Indian Pharma 2030: From Volume to Value," 2021. Available at: https://www.ipa-india.org/static-files/pdf/publications/ipa-mckinsey-report-2030.pdf

4. McKinsey & Company. "India: The Promise and Possibilities for Global Companies," 2023. Available at:https://www.mckinsey.com/industries/industrials/our-insights/india-the-promise-and-possibilities-for-global-companies

5. U.S. Food and Drug Administration. "CFR - Code of Federal Regulations Title 21, Part 11: Electronic Records," 2024. Available at: https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/CFRSearch.cfm?CFRPart=11

6. European Commission. "EudraLex Volume 4: Good Manufacturing Practice Guidelines," 2022. Available at: https://health.ec.europa.eu/medicinal-products/eudralex/eudralex-volume-4_en

Procurement lessons from India's pharma sector

Arjit Agarwal, Principal Consultant, Business Consulting, Nexdigm highlights that as pharma supply chains navigate unprecedented disruption, procurement is emerging as a strategic lever to build resilience, manage risk and safeguard global medicine supply

India's pharma industry has traditionally been known as the 'pharmacy of the world,' exporting cheap generics and vaccines to the world. However, over the last few years, a sequence of disruptions ranging from border shutdowns and raw material supply disruptions to geopolitical tensions and logistics congestion have put the endurance of pharma supply chains to the test. These setbacks have transformed procurement into a strategic function that aims not just at minimising costs but also at managing risks, ensuring continuity, and long-term viability.

Challenges of procurement in uncertain times

India's pharma supply chains are highly reliant on imported Active pharmaceutical ingredients (APIs), especially from China, covering almost 70 per cent of demand. Global transport disruptions, export restrictions, and price volatility tend to equate into value chain bottlenecks. The procurement leaders now have to steer through these uncertainties and provide seamless supply of life-saving drugs, ensure compliance, and keep costs under control.

Changes in procurement strategy for enhanced resilience

In order to create agility and protect from disruptions, a few significant changes have been witnessed across the sector:

- **Supplier diversification and localisation:** Indian companies are cutting dependence on one-country sourcing by diversifying to new geographies and placing investments in domestic production under the Production Linked Incentive (PLI) scheme, which has already backed the manufacture of 35 priority APIs.
- **Strategic supplier partnerships:** Long-term supplier collaboration is taking over from transactional relationships. Joint planning, common risk assessments, and co-innovation are becoming norms.
- **Digital procurement and visibility:** Procurement teams are implementing e-sourcing, AI dashboards, and supply chain control towers. Studies

indicate digital adoption among Indian pharma is set to grow at a 19.2 per cent CAGR from 2024-2029, allowing for improved forecasting and real-time risk monitoring.
- **Risk mapping and scenario planning:** Firms are stress-testing supply chains by creating second- and third-tier supplier maps, conducting disruption scenarios, and making contingency planning for geopolitical and environmental threats.
- **Sustainability and compliance:** As international buyers insist on ESG compliance, Indian pharma is integrating sustainability into procurement choices through more sustainable packaging, ethical sourcing, and tighter supplier audits.

Industry examples from India

1. Serum Institute of India diversified its supply base for vials, stoppers, and cold-chain logistics to prevent single points of failure in mass-scale vaccine manufacturing.
2. Dr Reddy's Laboratories expedited digital procurement, with increased transparency and responsiveness in purchasing.
3. Sun Pharma made investments in backward integration for key APIs, limiting dependence on external vendors.
4. Cipla has integrated sustainability into procurement by implementing green packaging and supplier ESG mandates.

The road ahead for pharma procurement

Procurement in the Indian pharma industry has evolved into a strategic function integral to decision-making. The future will be shaped by flexibility through diversified sourcing and increased domestic capacity, digital maturity with predictive analytics and AI-driven insights and sustainable practices against global ESG standards.

With 71.7 per cent of bulk drug imports continuing to originate from China in FY24, becoming genuinely resilient is still a work in progress, but Indian companies are taking tangible action to minimise vulnerabilities and enhance long-term competitiveness.

Building resilient pharma supply chains

In a world characterised by uncertainty, resilience is the currency of trust. Procurement in India's pharma industry has become a strategic catalyst for cost-effectiveness, compliance, and supply chain continuity. By instilling resilience in each sourcing action, Indian pharma companies are poised to enhance their position as predictable global partners and protect medicine security globally.

PHARMA EXTRUSION

Continuous processing of pharmaceutical masses

Leistritz with its lines in GMP design is the market leader in the demanding field of pharmaceutical extrusion.

THE EXTRUSION PROCESS IS SUITABLE FOR:

- Integrating an API into a matrix (e.g.wax,cellulose, starch...)
- Pelletizing of a tablet premix
- Compounding of antibacterial TPU premixes
- Removing volatile components from a formulation
- Coating for transdermal applications
- Implementation of various dosage forms
- Reactive extrusion

type	screw diameter (mm)	torque screws (Nm)	screw speed (rpm)	drive power (kW)	L x W x H (approx. mm)
NANO 16	16	42	500	2.24	1,200 x 800 x 1,100
ZSE 12 HP-PH	12	20	1,000	2	1,500 x 700 x 1,200
ZSE 18 HP-PH	18	71	1,200	7.1	2,290 x 700 x 1,270
ZSE 27 HP-PH	27	268	500 & 1,200	15	3,650 x 1,150 x 1,800
ZSE 40 HP-PH	40	830	400	37	4,000 x 1,400 x 2,100
ZSE 50 HP-PH	50	1,570	400	70	4,630 x 1,800 x 2,120

LEISTRITZ EXTRUSION LINES CAN BE SUPPLIED WITH

PAT (process analytical technology)

INLINE PROCESSING MONITORING ALLOWS TO

- identify optimum screw speed.
- determine optimum dispersion and homogeneity.
- detect dosage elevations.
- identify off-spec batches, waste and contamination.

KILITCH HEALTHCARE INDIA LTD.

Accrediations

9001:2015 | 14001:2015 | WHO

Manufacturing Sections

- Small Volume Ampoule
- Small Volume Vial
- Three Piece Ophthalmic Vial
- Two Piece Preservative Free Ophthalmic Vial
- Prefilled Syringes in Blister pack
- Sterile medicated Swab Sticks

Our Esteemed Clients

Zydus | FDC | USV | ENTOD PHARMACEUTICALS LTD

Head Office:
Kilitch Healthcare LLP,
902/B Godrej Colesium, Behind Everad Nagar,
Near Priyadarshani Cirlce, Sion (East),
Mumbai – 400022.
Tel. : 022 6137 2222
Mr. Divya Mehta : +91 9819724957

Factory:
Kilitch Healthcare India Ltd.
R-905/904, T.T.C. Indl. Area,
M.I.D.C, Rabale, Navi Mumbai - 400 701.
Tel. : 022 2769 9174, 6516 2146

www.kilitchhealthcare.com | info@kilitchhealthcare.com

150 years of Romaco Kilian: The story of an East-West German company

Kilian's story tells of the rise, fall and resurgence of a Berlin company steeped in tradition, which is now based in Cologne. It is the story of the entrepreneur Fritz Kilian, who turned a small locksmith's workshop in Berlin into a successful company that is still a leading manufacturer of tablet presses today. It is the story of a visionary whose legacy has endured the test of time and continues to this day.

In the beginning: the late 19th century

In a small locksmith's workshop in the Lichtenberg district of Berlin, 150 years ago, the foundations were laid for the tradition-steeped Romaco Kilian company we see today. In this workshop, which his father had founded in 1875, the young Friedrich Franz Otto Kilian discovered his passion for engineering. Following his apprenticeship as a mechanic, in 1886 the young man took over his father's business following the latter's untimely death, and developed a keen interest in compression techniques.

Kilian nameplate bearing the stylized powder mill logo

Fritz Kilian was commissioned by pharmacies in Berlin to develop various compression devices. These included a manual spindle press for producing pastilles, for which he obtained his first patent in 1891. As his next major goal, he devoted himself to designing an automatic tablet press. His prototype impressed the German Imperial Military Administration, and this catapulted his order book to a whole new level. Fritz Kilian had now made a name for himself as an entrepreneur. He moved into new premises and named his company the "Fabrik pharmaceutischer Maschinen und Geräthschaften" (Factory of Pharmaceutical Machines and Apparatus). In 1898, he obtained a patent for his universal press – the eccentric tablet press 4D, in which printing of the finished tablets was also incorporated.

Company founder Fritz Kilian Sr. (first on the left, front row) with family in 1914

Company premises of the Fritz Kilian Maschinenfabrik in Berlin-Hohenschönhausen, photo taken in 1922

Straight to the top

To cope with the rise in incoming orders, Fritz Kilian established new company premises including residential quarters in Berlin-Lichtenberg and, in 1899, began trading under the name "Fritz Kilian Maschinenfabrik" (Fritz Kilian Machine Factory). He chose a powder mill bearing his initials as the company logo, demonstrating his expertise in the handling of the raw materials involved in tablet production – knowledge that, even then, was critical for end product quality. His customer-focused, end-to-end approach and foresight as regards the importance of compressed products for various industries were key to his entrepreneurial success.

In 1905, a second factory was built in Berlin-Hohenschönhausen, significantly expanding Fritz Kilian's production capacity. This laid the perfect groundwork for a modern company with a workforce of over 100 and numerous branches in other countries, including in the U.S. and UK. At the 1913 EXPO in Gent, Belgium, he was awarded the "Grand Prix" for his automated machines for the production of pharmaceutical products. Throughout his long career, he protected many of his inventions with more than 60 patents. Up until his retirement aged 74, the company continued to grow steadily in terms of sales, profits and portfolio expansion. Fritz Kilian emerged unscathed from the Wall Street Crash in the late 1920s, in part because the pharmaceutical industry was less affected by the general downturn. The bitter turning point only arrived with the onset of the Second World War.

Assembly workshop at the Kilian plant in Berlin-Hohenschönhausen

Relentless decline

In 1940, Fritz Kilian stepped back from active involvement in the company and passed the business on to his two sons, Fritz and Hans. In retrospect, this was the beginning of the end. In 1941, Fritz Kilian Jr. was killed when a bomb was dropped on his night train to Hanover, where he was heading on business. A year later, in 1942, Fritz Kilian Sr. died of a stroke at the age of 76.

His other son Hans Kilian had taken over his father's machine factory in the middle of wartime and somehow managed to keep the business going. The good news: the two production plants in Hohenschönhausen and Lichtenberg in Berlin survived the end of the war virtually unscathed, and Hans Kilian saw a realistic chance of resuming full production with most of the old workforce. He had purposefully decided against moving with his family to Hamburg, thereby sealing his fate.

In 1946, Hans Kilian was arrested by the Soviet military administration and initially detained at the prison in Berlin-Hohenschönhausen. From there, he was transported to the Special Camp Sachsenhausen near Oranienburg where he is thought to have died, in 1947 already, of tuberculosis. The reasons for his arrest were never officially confirmed. His wife Eva then managed to flee with their three children to her mother's home in Delmenhorst.

After the sudden disappearance of Managing Director Hans Kilian, operations at the Maschinenfabrik Fritz Kilian finally ceased. Some employees, including Head of Production Werner Rühe and Head of Engineering Fritz Greter, managed to flee to the Western Occupation Zone – carrying numerous company documents and format drawings with them in their luggage.

Kilian's "Heinzelmännchen" – the vintage "helpful elf" tablet press from the year 1918

Resurgence in Cologne

In the same year that her brother-in-law had died, the widow of Fritz Kilian Jr. took the initiative to rebuild the company and, together with Rühe and Greter, the two heads of department who had also fled the East, contacted the heirs of Fritz Kilian Sr. They soon found a production partner, Strunk, and in 1948 the newly founded Kilian & Co. GmbH was set up in Ehrenfeld, Cologne as the official representative of the Maschinenfabrik Fritz Kilian.

Despite the war years, international demand for Kilian products was as high as ever. A huge need for spare parts and services meant the company overcame its initial teething problems in its new setting and launched the first fully enclosed Kilian tablet press made in Cologne onto the market in 1952.

Back on track for success

Kilian was back. In 1953, wealthy English manufacturer James Frank Marshall and his wife – the widow of Fritz Kilian Jr. – acquired a majority stake in Kilian & Co. GmbH. At this point, production was outsourced to the Schmidding-Werke plant in the Niehl district of Cologne. After Marshall's death, Kilian was finally sold in its entirety to Schmidding-Werke in 1976 and remained a privately owned company until 2000. As there were no suitable successors, Kilian & Co. GmbH was then sold to the Italian group IMA S.p.A. Subsequently, Kilian was part of the globally active IMA Group for 13 years. During this period, the company also moved into the modern and spacious company premises and light-filled assembly workshop in Scarlettallee 11 in Niehl, Cologne. The current owner, Romaco, took over the tableting technology manufacturer in 2013 and incorporated Kilian in its Processing division.

Today, the successor models to Fritz Kilian's original tablet press machines have joined the portfolio of Romaco, a one stop provider with technologies that cover the entire process chain for the manufacture and packaging of pharmaceuticals and non-pharmaceutical products. Here, alongside processing machines from Innojet and tablet coaters from Tecpharm, Kilian's tablet presses are in good company. This seems to be in keeping with the inventor's intentions. After all, Fritz Kilian made a stylized powder mill his company logo way back in 1899, demonstrating – almost by the by – his expertise in powder processing.

Technical achievements

When the young Fritz Kilian brought his first apparatuses onto the market, he was by no means the first. From the mid-19th century, many manufacturers of tablet press machines were already active in Europe and the U.S., all trying to outdo one another with their latest inventions. It is therefore all the more remarkable that, with his inventions, the initially quite penniless Fritz Kilian managed to assert himself in this competitive environment, and to become one of the leading tablet press suppliers of his time. Today, Kilian is the oldest still active manufacturer of tableting technology in the market.

Looking back, several of Fritz Kilian's technical achievements were groundbreaking for modern tableting technology, and these deserve a closer look. In 1900, Kilian designed a pair of compression rollers for his rotary presses, so that the compression force could be generated by upper and lower punches. The practice, still common today, of pre-compressing products before they enter the main compression unit, was developed by Kilian. The company launched a press with three filling stations for multilayer tablets way back in 1908. The best-known rotary tableting system from the early Kilian years is probably the "Heinzelmännchen", named after the mythical helpful elves of Cologne because of its user-friendly design. And in 1919, Kilian introduced the non-wearing upper punch guide.

In the mid-1930s, Kilian's industrial production of tab-in-tab applications was another pioneering invention that grew in popularity after the war. At this time, tablets were increasingly becoming the method of choice for taking antibiotics. However, the core containing the active ingredients needed to be dry-coated to protect the unstable substances and mask the bitter taste of the medicine. Kilian had set the standard for the tab-in-tab production process, which helped the company gain a foothold in Cologne in the early 1950s and remain an active player in the international market until this day.

The modern successors to Kilian technologies impressively continue the legacy of company founder Fritz Kilian: on show at interpack in Düsseldorf, Germany (Hall 16, Booth D22) from May 7 to 13, 2026.

Concluding remarks

This article is based on the memoirs of Hans-Jürgen Kilian (son of Hans Kilian and grandson of Fritz Kilian Sr.). The memories endure, and so do the stories they inspire.

Summary

Romaco Kilian looks back at its 150-year history. It all began in 1875, in a small locksmith's workshop in Berlin, where Fritz Kilian built his first tablet press machines. Major contracts from the German Imperial Military Administration paved the way for the Fritz Kilian Maschinenfabrik to become a leading supplier of tableting technology in just a few decades, with over 100 employees and several branches around the world. The inventions of this visionary entrepreneur were protected by more than 60 international patents. Only World War II abruptly interrupted the company's success story. The years between 1941 and 1947 saw the deaths of both founder Fritz Kilian Sr. and his two sons Fritz and Hans, whom he had trained to be his successors. The two factories in Berlin then ceased their operations.

However, 1948 already heralded a new beginning in Cologne, where Fritz Kilian's heirs and some of his closest employees rebuilt the company together with partners from the industry. Global demand for spare parts and services was unwavering, which helped the company to restore its business relationships. The first tablet press made in Cologne arrived on the market in 1952, and Kilian fought its way back onto the winning track. Kilian was sold to Schmidding-Werke in the 1970s, and remained in private ownership until the turn of the millennium. In 2000, the company became part of the Italian IMA Group, until the tradition-steeped company was acquired by Romaco in 2013 to expand its Processing division.

The world has inventor Fritz Kilian to thank for several trailblazing developments, such as his design of the first automatic rotary press, which featured a pair of compression rollers for generating compression force with upper and lower punches. One of the best-known models of the early Kilian years was the "Heinzelmännchen" – the user-friendly "helpful elf" rotary tableting system. Kilian also set the standard for the industrial production of tab-in-tab tablets in 1935. With the widespread use of antibiotics in tablet form from the 1950s onwards, this technology grew in importance in the post-war years and secured the financial status of Kilian & Co. GmbH for the future.

Romaco Group

Romaco is a leading international supplier of processing and packaging equipment specializing in engineering technologies for pharmaceutical products. The Group provides individual machines, lines and turnkey solutions for manufacturing, filling and packing powders, granulates, pellets, tablets, capsules, syringes, liquids and medical devices. The company also serves the food and chemical industries. Through its various technologies, Romaco is committed to sustainable production and to systematically reducing CO2 emissions.

The Romaco Group has its headquarters in Karlsruhe (Germany) and is part of the Truking Group, a globally operating high-tech enterprise based in Changsha (China). Truking's core competency is handling and filling pharmaceutical liquids.

Romaco operates from six production sites worldwide, with a broad portfolio comprised of seven established product brands. Noack and Siebler (Karlsruhe, Germany) supply blister, heat-sealing and rigid tube filling machines. Macofar (Bologna, Italy) markets technologies for filling sterile and non-sterile powders and liquids. Promatic (also Bologna, Italy) specializes in cartoners, track & trace systems and case packers. Kilian (Cologne, Germany) is a leading manufacturer of tablet presses. Innojet (Steinen, Germany) is in the business of granulating and coating fine solid particles. Tecpharm (Barcelona, Spain) offers tablet coating technologies.

More than 930 highly skilled and committed Romaco employees are dedicated to the development of future product technologies and to the continuous implementation of internal improvement processes. The Romaco Group's multi-brand system solutions are sold worldwide through eight Sales & Service Centers and a dense network of local agent organizations. Over 12,000 installations delivered by Romaco are currently in use in more than 180 different countries.

For more information on Romaco, visit our website and social media channels: www.romaco.com – Showroom – LinkedIn – YouTube

Company contact
Susanne Silva
Market Communications
Romaco Group
Am Heegwald 11
76227 Karlsruhe
Germany
T +49 (0)721 4804 0
E susanne.silva@romaco.com

Press contact
Micha L. Harris
Senior PR Consultant
Carta GmbH
Iggelheimer Str. 26
67346 Speyer
Germany
T +49 (0)6232 100 111 20
E harris@carta.eu

Beyond energy efficiency: Air-saving ejectors drive sustainability and reduce global warming in industry

Rajesh Salunkhe, Industry Segment Manager – Schmalz India points out that sustainability in manufacturing begins with fixing hidden inefficiencies on the shop floor. He shares how air-saving vacuum ejectors are helping Indian manufacturers cut energy costs, reduce emissions and stay globally competitive

It's always a pleasure to share our expertise and work experience with our esteemed customers on innovative vacuum automation solutions. As someone who has spent 18 years across automotive vacuum automation applications, I've seen how small innovations can transform entire industries. Today, one such innovation is reshaping Indian manufacturing: Air-saving vacuum generators.

Walk into any automotive supplier in India today and you'll hear the same refrain: "Reduce Carbon footprints." The industry is under relentless pressure to reduce carbon footprints, and every line must deliver zero-defect quality. Yet behind the scenes, many factories still rely on legacy vacuum systems that quietly waste 70–90 per cent of compressed air — the second-largest utility cost in manufacturing. This hidden inefficiency drains profits, inflates energy bills, and undermines sustainability goals.

Why air-saving matters

Compressed air is expensive. Every cubic meter wasted is money lost — and emissions added. In fact, energy costs for compressed air have risen nearly 20 per cent in the past three years. From Automotive OEMs to their Tier I and II supplier, that can mean lakhs of rupees in avoidable expenses annually.

Air-saving ejectors directly tackle this challenge. By consuming air only when needed, they cut energy costs by up to 90 per cent. But the benefits go far beyond savings:

- Reliability in harsh Indian conditions — no electronics to fail during voltage dips or monsoon humidity.

- Zero-defect performance — stable vacuum ensures consistent quality, fewer rejects, and lower warranty costs.
- Sustainability impact — each line can reduce CO2 emissions by over four tons annually, equivalent to planting 700 trees.

This isn't just about machines. It's about enabling manufacturers to stay competitive, meet government incentives, and align with global carbon neutrality targets.

Industrial vacuum automation applications are depending on compressed air supply. Schmalz pneumatically and electrically operated air saving ejectors ensure 90 per cent compressed air savings during vacuum automation cycle time.

Result:

- Less compressed air usage
- Less electrical consumption
- Reduced carbon footprint

Automotive OEM's production process — Press Shop, BIW (Body in White), paint shop and assembly lines — major vacuum automation compressed air usage is at press shop, BIW line and assembly line. Schmalz ensures to provide right products to all the vacuum automation applications, such as our 100 per cent compressed saving ejectors – 100 per cent pneumatically and electrically.

Real-world transformation

Consider an automotive BIW (Body in White) line that replaced its non-air saving basic ejectors with air saving ejectors. The results were dramatic:

- Energy costs dropped from ₹35,000 to ₹13,300 per month — a 62 per cent reduction.
- ROI was achieved in just seven months.

Across India, suppliers are discovering that air-saving ejectors don't just cut costs — they boost reliability and sustainability. Once reserved for high-volume OEMs, these systems are now accessible to mid-tier suppliers, changing the economics of small-batch manufacturing. As I often say: "Air-saving ejectors don't just save air — they change the economics of manufacturing.

India's Paris Agreement commitments and OEM carbon neutrality targets make sustainability a competitive advantage. A 10-line facility can cut 43 tons of CO2 annually — 215 tons over five years — numbers that resonate with regulators and customers alike.

Why act now

- OEMs demand aggressive cost reductions by 2026
- Compressed air costs keep rising
- Government PLI incentives reward efficiency

Indian manufacturing stands at a crossroads. Legacy systems drain resources, while air-saving ejectors offer a proven path to lower costs, higher reliability, and real sustainability.

At Schmalz India, we invite manufacturers to schedule a free energy audit and transform their lines into models of efficiency and resilience.

Check out how we save compressed air: https://youtu.be/gIh8B7QQRmQ?si=XankF9oWSGgse6xa

SXMPi series ejectors for Press Shop

Air Saving Solution at Glass Gluing station

Air saving ejectors solutions - SCPSi 15 M IMP, SMPi 25 IMP, SCPb 25, SEAC 15 RP ECO series

Contact
Schmalz India
Marketing Department
EL 38, J Block, MIDC, Bhosari,
Pune 411026
T: 020-69115500
marketing@schmalz.co.in

Turnkey competence with local execution: OPTIMA India strengthens integrated pharma solution

Optima India combines global turnkey expertise with localized engineering and service capabilities to support India's growing aseptic manufacturing demand.

The Indian pharmaceutical industry is undergoing a structural transformation. Rising investments in injectables, biologics, biosimilars and advanced therapies are increasing demand for high-performance aseptic processing technologies. At the same time, stricter regulatory expectations, operational efficiency targets and faster project timelines are driving manufacturers toward integrated production concepts. In this environment, turnkey solutions are gaining strategic importance — particularly when supported by strong local engineering and service organizations.

OPTIMA packaging machines India Pvt. Ltd., a wholly owned subsidiary of the Optima Group, is addressing this need by combining global turnkey expertise with expanded engineering and service capabilities in India. The company's approach enables pharmaceutical manufacturers to accelerate project implementation while maintaining high quality and compliance standards.

Turnkey solutions in the Indian pharma context

Turnkey solutions in pharmaceutical manufacturing refer to the delivery of fully integrated, pre-tested and qualified systems from a single supplier. In aseptic fill-and-finish applications, this typically includes filling machines, isolators and freeze dryers designed as one coordinated functional unit. Compared to conventional multi-vendor projects, this holistic approach reduces interface complexity, minimizes project risk and shortens time-to-production.

For Indian manufacturers expanding injectable and biologics capacity, turnkey concepts offer clear advantages. Integrated system engineering ensures compatibility across mechanical components, automation platforms and containment technologies. Pre-validation strategies and standardized qualification concepts simplify regulatory compliance and commissioning — a critical factor in time-sensitive market launches.

Digital engineering as a foundation for integration

Digital engineering plays a central role in modern turnkey projects. Simulation tools are used early in the design phase to model airflow behavior, temperature distribution and decontamination cycles using vaporized hydrogen peroxide (VHP). These simulations allow precise optimization of isolator airflow patterns and injector positioning to meet regulatory requirements such as EU GMP Annex 1.

The close correlation between simulation results and physical smoke studies improves design reliability and allows potential risks to be identified before installation. This approach enhances system stability, reduces costly on-site modifications and strengthens regulatory conformity.

Expanding engineering capabilities in India

While global engineering platforms form the backbone of turnkey delivery, strong local engineering presence is essential for efficient execution and long-term customer support. Optima India has significantly expanded its engineering footprint with the establishment of a dedicated engineering services center in Pune, one of India's leading technology hubs.

The Pune facility supports global engineering activities while strengthening local project coordination, application engineering and documentation capabilities. Together with the company's headquarters in Bangalore and regional service locations, Optima India operates an integrated sales, service and engineering network.

By combining German engineering standards with Indian technical expertise, the company is building a localized knowledge base that improves responsiveness, enhances customer proximity and supports faster implementation of complex turnkey projects.

In-house testing, qualification and service readiness

Optima's Comprehensive Scientific Process Engineering (CSPE) concept enables extensive system testing and qualification at the company's global facilities before delivery. This includes verification of safety circuits, isolator leak testing, automation validation and integrated Factory Acceptance Testing (iFAT). Qualification documentation can be partially leveraged at the customer site, reducing validation workload and accelerating commissioning.

After installation, Optima India's trained service engineers provide lifecycle support covering installation, qualification, maintenance, operator training and performance optimization. Engineers undergo structured training programs at Optima's global headquarters, ensuring consistent service quality and technical alignment.

The establishment of a dedicated service hub in Ahmedabad further strengthens regional coverage and improves response times. In parallel, Optima India has expanded local spare parts distribution and is developing rebuild and retrofit capabilities, enabling customers to extend equipment lifecycles and adapt installed lines to evolving production requirements.

Project coordination and lifecycle partnership

Dedicated project management is a key element of turnkey execution. Coordinated planning across engineering, automation, installation and service teams reduces interface risks and ensures smooth project implementation in cleanroom environments.

Structured operator training programs — including on-site instruction, system-specific qualification training and digital learning modules — prepare production teams for efficient startup and stable long-term operation. This integrated lifecycle approach reflects Optima's long-term partnership strategy rather than a purely transactional equipment supply model.

As India's pharmaceutical industry continues its shift toward advanced therapies and high-value injectables, demand for integrated, flexible and compliant production platforms will continue to grow. Turnkey solutions supported by strong local engineering and service organizations are becoming a critical success factor.

With more than a decade of presence in India, expanding engineering infrastructure and a continuously growing service organization, Optima India is well positioned to support this transformation. By combining global technology innovation with localized execution excellence, the company is contributing to faster project realization, improved regulatory readiness and sustainable manufacturing performance in one of the world's most dynamic pharmaceutical markets.

Lactose India Limited unveils new specialised grades: Advancing self-reliant pharma manufacturing

By producing these grades locally, Lactose India Limited delivers end-to-end reliability! Strengthening India's pharmaceutical backbone with high-performance, globally benchmarked lactose solutions

In a significant boost to India's pharma sector, Lactose India Limited (LIL) has launched a new lineup of specialised lactose grades, marking a pivotal advancement in the country's domestic production capabilities.

Established in 1991 and headquartered along the Vadodara-Ahmedabad Expressway in Poicha, LIL is leveraging its expansive state-of-the-art 5-acre facility to deliver high-value high performance lactose products. This move not only expands their product portfolio but also aligns seamlessly with the national vision of 'Atma Nirbhar Bharat' (self-reliant India) and 'Make in India', reducing the nation's dependence on imports for critical pharma excipients.

In keeping with its commitment to responsible growth, Lactose India Limited's focus on sustainability drives operational excellence — through optimised energy-efficient processes, reduced emissions, conscious material sourcing, waste-water recycling systems to promote greener practices across its product lifecycle. Every batch reflects LIL's holistic belief that progress and environmental governance must go hand in hand

Lactose India Limited, a recognised leader in lactose monohydrate production with an installed capacity of 12,000 metric tons per annum—is set to double following a recent acquisition—is a market leader for its regular grades such as 200 Mesh, 125M, 450M, PHA, DC2050, DC60, 80M, 100M, 325M, and IMP variants in milled and sieved forms. These have served both domestic and overseas markets effectively.

The introduction of specialised segments marks a strategic evolution, targeting

niche applications in pharma, including excipients, APIs, and formulations—all housed within a single campus featuring dedicated production blocks, warehouses, and quality assurance offices, ensuring world class standards in every batch.

The new specialised grades: Innovation meets demand

The newly constructed "Lactose Specialty Segments" facility is designed to cater to regulated markets in India and abroad. Samples for several high-demand grades are now available, with select variants undergoing stability studies to ensure full compliance with global pharmacopeial standards.

Key launches include:

- **Spray dried lactose:** Designed for direct compression in tablet formulations, this grade offers superior flowability and compressibility, making it a preferred choice for high-speed manufacturing processes.
- **Anhydrous lactose:** Known for its exceptional stability in dry environments, this variant is essential for moisture-sensitive formulations, enhancing shelf life and efficacy in pharmaceutical products.
- **Inhalation grades:** Engineered for respiratory drug delivery systems, these grades meet stringent particle size and purity specification, supporting the growing demand for inhalable medications in treatments for asthma, COPD, and other pulmonary conditions and Specialised DPI - Dry Powder Inhalations
- **Low endotoxin grades:** Critical for injectable and sensitive applications, these ensure

Low endotoxins and TOC minimal bacterial contamination, aligning with pharmacopeial standards like USP and EP to safeguard patient safety.

- **Homoeopathy grades (HP):** Specialised for homeopathic remedies, providing extra-pure lactose suitable for dilution processes in alternative medicine.

These grades are available on demand, with LIL emphasising their importance as critical import substitutes. Today, India's pharma industry relies heavily on foreign suppliers for such specialised lactose products, leading to vulnerabilities in supply chains and higher costs.

Driving cost competitiveness and economic benefits

By producing these grades locally, Lactose India Limited delivers more competitive pricing, enhancing the cost-effectiveness of pharma formulations. This initiative directly contributes to foreign exchange conservation, as it replaces 100 per cent imported products, thereby reducing currency outflows and bolstering India's economic stability. Reduced dependency on international markets mitigates risks from global fluctuations, ensuring consistent availability and predictable pricing for domestic buyers.

The company's leadership emphasises that this expansion strengthens the overall product portfolio, enabling "single-point sourcing" for customers who can now procure a wide range of lactose grades from one trusted Indian manufacturer. With over three decades of manufacturing expertise, Lactose India is positioned to support the growth of local industries while fostering innovation and self-reliance.

Ensuring Clean Room Integrity with Prime Clean Reset High-Speed Doors: Minimizing Air Permeability and Leakages

High-speed doors for clean rooms are specialized industrial doors essential for maintaining controlled environments. These doors are engineered to be airtight, creating a reliable barrier between different areas of a facility. Their design ensures durability and minimal maintenance, reducing the frequency of repairs and replacements.

High-speed clean room doors offer a range of critical benefits essential for maintaining stringent environmental control. These doors enhance hygiene by providing an airtight seal that effectively isolates clean room environments, preventing the ingress of dust and other contaminants. This capability is especially crucial in sectors such as pharmaceuticals, biotechnology, and food production, where maintaining sterility is non-negotiable.

In the pharmaceutical and life sciences industries, compliance with rigorous regulatory standards necessitates the manufacture of products within controlled clean room environments. A high-performance clean room door is an integral component in ensuring the integrity of these spaces, safeguarding product quality and patient safety.

Beyond contamination control, these doors are engineered with advanced safety mechanisms, including automated sensors and emergency stop functions, which mitigate the risk of operational hazards. Moreover, high-speed clean room doors are designed to maintain precise overpressure or under pressure conditions within the environment. This is vital for preventing cross-contamination and ensuring that the clean room remains in a state of controlled integrity, even under varying operational demands.

Given the critical role these doors play in maintaining the purity and safety of highly specialized environments, selecting the appropriate door system is a decision of strategic importance.

Prime Clean Reset, our high-speed door is designed specifically for clean rooms. This innovative solution is engineered to meet the stringent requirements of controlled environments, ensuring exceptional performance and reliability. Designed with precision to meet the stringent requirements of controlled environments, Prime Clean Reset is the epitome of performance and reliability, ensuring that your clean room operations consistently meet the highest standards of regulatory compliance and product integrity.

Prime Clean Reset is suitable for clean rooms up to ISO Class 5, offering an unparalleled air permeability rate of less than 12 m^3/m^2 h at ? 50 Pa. This ensures that even in the most sensitive environments, the door effectively maintains the critical pressure differentials required to prevent contamination, thereby safeguarding your processes and products.

Engineered with cutting-edge European technology and innovative design principles, Prime Clean Reset offers rapid cycle times for both opening and closing, making it the optimal solution for medium to large entrances in clean room applications. The door's construction is specifically tailored to minimize air leakage and particulate infiltration, ensuring that it supports the rigorous cleanliness standards necessary for applications such as pharmaceutical manufacturing, semiconductor fabrication, food processing, and other highly specialized sectors.

With its robust design and reliable performance, Prime Clean Reset seamlessly integrates into your clean room infrastructure, providing a critical barrier that preserves the integrity of controlled environments. Whether you are operating in a pharmaceutical, biotechnology, electronics, or defence industry, Prime Clean Reset offers the precision, durability, and compliance needed to maintain your competitive edge in highly regulated markets.

Key features of Gandhi Automations' High-Speed Clean Room Doors include:

- **Low Air Permeability:** Designed to maintain low air permeability in pressurized rooms with both positive and negative air pressure.
- **Compact Design:** The doors are designed to fit inside the columns, with a self-supporting construction that minimizes air leakage.
- **Customizable Transparency:** They can be equipped with transparent PVC horizontal sections or vision windows for visibility.
- **Specialized Side Guides:** The special side guides ensure a tight integration of the curtain, providing high leak tightness.
- **Efficient Operation:** The doors offer high efficiency and low permeability values, compliant with EN 12426 and EN 12427 standards, ensuring < 12 m^3/m^2 h ? 50 PA.
- **Durable Control Device Enclosure:** The control device enclosure is made of Stainless-Steel SS 316, ensuring durability and resistance to corrosion.

These high-speed doors are meticulously engineered to minimize air leakage and maintain strict environmental control, making them indispensable for clean room operations. Their rapid opening and closing operation ensure that the internal facility remains isolated from external conditions, effectively upholding the cleanliness and controlled environment essential for maintaining the integrity of clean rooms.

For further information on our high-speed doors offering, contact:

Gandhi Automations Pvt Ltd
Chawda Commercial Centre
Link Road, Malad (W),
Mumbai-400064, India.
Off: +91 22 66720200 / 66720300 (200 lines)
Fax: +91 22 66720201
Email : sales@geapl.com
Website: www.geapl.com

Microfluidic Technology: An Advanced Synthesizing Platform for Nano formulations

Dr. Danish Eqbal, Dr. Alazhar Colombowala, Dr. Ganesh Gaikwad, Amar Biosystems Pvt. Ltd.
A unit of Ami Polymer

In recent years, the intersection of nanotechnology and microfluidics has emerged as one of the most promising frontiers in the advanced manufacturing of nanocarriers for drug delivery and vaccine development. This convergence is now driving innovation across healthcare and biopharma, establishing microfluidic systems as a powerful platform for both translational research and industrial-scale manufacturing.

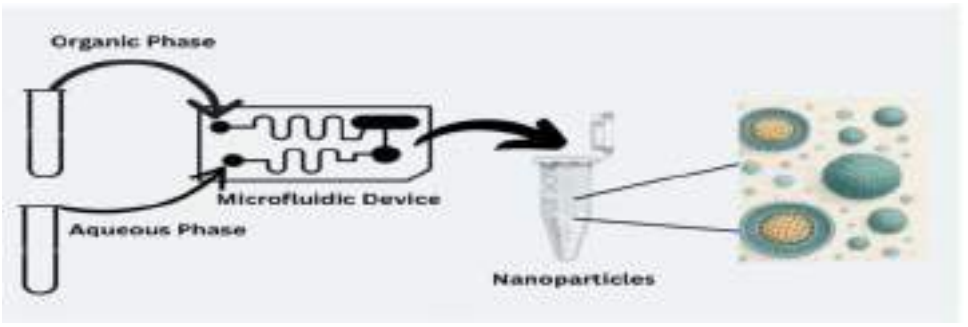


Figure 1. A schematic illustration of nanoparticle synthesis using a microfluidic chip

The Need for Advanced Nanoparticle Manufacturing:

Nano-delivery systems have revolutionized the biopharmaceutical sector, by enabling targeted, efficient, and controlled delivery of therapeutic agents. Advanced nano-systems such as lipid nanoparticles (LNPs), liposomes and polymeric nanoparticles have become key components of modern drug delivery, and gene therapy. The clinical success of RNA-based vaccines, along with the rapid progress in cell and gene therapies, has emphasized the critical need for a robust, reproducible, and scalable manufacturing platform for nanoformulations.

Microfluidics: Precise synthesis of NPs at microscale:

Microfluidics involves manipulating fluids within channels typically micrometres in size. This controlled environment makes it possible to finely tune parameters such as flow rate and mixing ratio directly influencing nanoparticle size, polydispersity and encapsulation efficiency. Microfluidic platforms are remarkably versatile, enabling the fabrication of a wide range of nanomaterials tailored for diverse biomedical applications such as

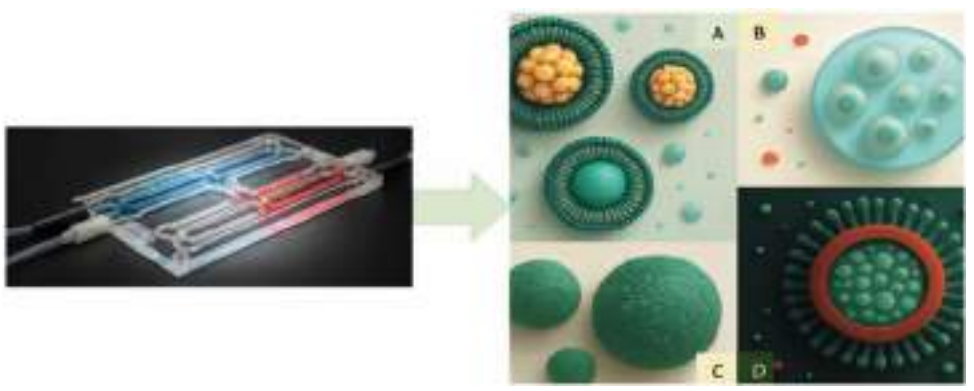


Figure 2. Schematic representation of various types of nanoparticles commonly used for drug encapsulation and nanoformulation. A. lipid nanoparticles, B. emulsions /double emulsions, C. polymeric nanoparticles, D. liposomes / hybrid nanoparticles

Lipid nanoparticles, liposomes and polymeric nanoparticles. This broad capability highlights the potential of microfluidics as a universal manufacturing platform for nanoparticles and nanoformulations, positioning it as the "factory of the future" for nanomedicine.

Engineering and Manufacturing Advantages:

From a manufacturing standpoint, microfluidic systems enable precise control over nanoparticle size and uniformity, driving their adoption over conventional bulk methods. Scalability is achieved through increased chip dimensions and throughput without loss of quality. Integrated automation, real-time monitoring and process control enhance efficiency and reproducibility, while low reagent consumption and minimal waste support sustainable manufacturing. Together, these advantages position microfluidics as a powerful platform for next-generation nanomedicine production.

Figure 3. Schematic representation of the key advantages of microfluidic systems in nanoparticle manufacturing

Future Outlook: Toward Translational Manufacturing:

The global demand for nanoparticle-based therapeutics is rapidly increasing. To meet this demand, the future lies in fully automated, microfluidic platforms capable of seamless integration into industrial pipelines. In India, Amar Biosystem Pvt. Ltd. has taken the lead in launching the fully automated microfluidic platform Nanomake-L, aiming to leverage the Make-in-India initiative, make a significant impact in the biopharma sector, and position India prominently on the global stage. Salient features of Nanomake-L include fully a automated system, a reusable chip, wide operating flow-rate range, three configurable precursor pumps, a built-in washing program, and flexible sample collection options.

As the field matures, the integration of engineering, biology, and materials science will unlock even greater potential, transforming microfluidics from a niche technology into a global manufacturing standard for nanoparticle and nano-formulation production.

Author
- Dr. Ganesh Gaikwad
& TeamAmar Bio systems Pvt Ltd
(A Unit of Ami Polymer)

EMDEX®-A Multifunctional Binder and Filler

EMDEX® is designed for a variety of tablets and lactose-free applications

EMDEX® (Dextrates, NF) is a directly compressible, water-soluble tablet binder and filler. Its unique composition of 95 per cent glucose monohydrate and different oligosaccharides derived from starch is monographed under Dextrates in the NF, with use levels ranging from one per cent to 99 per cent. EMDEX® is designed for a variety of tablets & lactose free applications[4].

◆ Superior flow, compaction, and tablet robustness in direct compression applications
◆ Does not require a glidant, due to superior flow properties
◆ Exhibits excellent mixing properties
◆ Easy to handle – does not stick to punches
◆ Non-dusting
◆ Results in smooth and shiny tablets
◆ Tablets demonstrate very low friability
◆ Metabolis es fully without osmotic laxative effect
◆ Provides patients with a pleasant, sweet taste and a cool mouth feel
◆ Does not cause dry mouth feel when compared to sugar alcohols
◆ Particle porosity improves EMDEX® solubility and flavour absorption capacity- a key advantage for tablet taste enhancement
◆ Compendial (NF), eliminating regulatory hurdles

Bulk Density	0.70 g/m3
Tapped Density	0.75 g/m3
Hausner Ratio	1.07
Angle of Repose	300
Loss on Drying	7.8-9.2 (glucose monohydrate, the assay includes crystal water)
Dextrose Equivalent	93 – 99 %
Heat of Solution	-105 J/g
Median Particle size	190 – 220 µm

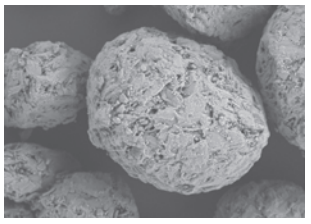
Physical Properties [4]:

◆ Made from corn starch (GMO-free EMDEX® available)
◆ Natural sweet taste of dextrose
◆ Freely and rapidly water-soluble (1000g/L)
◆ Excellent flowability
◆ Spherical, porous particles
◆ Directly compressible filler-binder
◆ High bulk density
◆ Narrow particle size distribution
◆ Calorie content- 4.0-5.0Kcal/gram

SEM of EMDEX®I

EMDEX® Benefits and Applications[5][6]:

Benefits:



Spherical particle shape and porous structure - EMDEX®

Emdex is designed for variety of tablet types and dosage forms:

◆ Chewable tablets
◆ Orodispersible tablets
◆ Effervescents
◆ Sachets
◆ Multi-layer tablets
◆ As a replacement for lactose

Applications:

◆ EMDEX® is 100 per cent water-soluble, it is also perfect for applications in which a good mouth feel or a clear solution is required.
◆ EMDEX® has excellent flowability and non-dustiness makes it appropriate to be used as flow improvement aid in sachets and stickpacks.
◆ EMDEX® exhibits narrow particle size distribution with an average particle size of 200 µm. Along with its spherical particle shape and high bulk density, this ensures supreme flow properties.
◆ EMDEX® is a porous material that absorbs fluids, allowing chewable formulation development and manufacture using liquid APIs.
◆ The porous structure of the sparay-dried EMDEX® particles enables excellent content uniformity even for low dose, micronised APIs.
◆ Oily APIs are readily absorbed by the sponge-like structure of EMDEX®.
◆ Highly suited for veterinary products, due to its pleasant taste.

Comparison of powder characteristics of EMDEX® and spray dried lactose [3]:

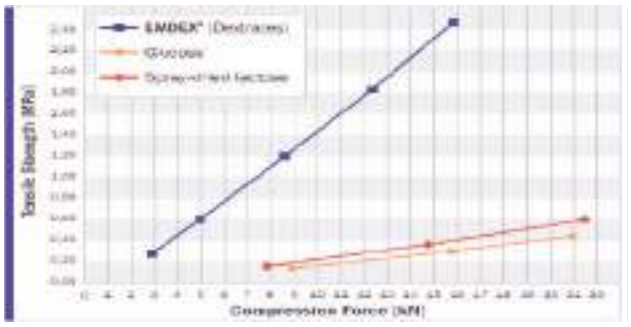
A comparision of EMDEX® and spray dried lactose with regard to their powder characterstics demonstrated the similarility of the two materials. Both are water-soluble, crystallised powders with a porous structure and a spherical particle shape. The particle shape, in combination with the high bulk

Parameter	EMDEX®	Spray-Dried Lactose
Particle Size d50 (µm)	190-220	130-160
Bulk Density (g/L)	600-700	600-700
Tapped Density (g/L)	700-800	700-800
Flodex Index (mm)	4	4
Water Solubility (g/L)	1000	220

Powder Characteristics of EMDEX® and spray dried lactose.

Compactability

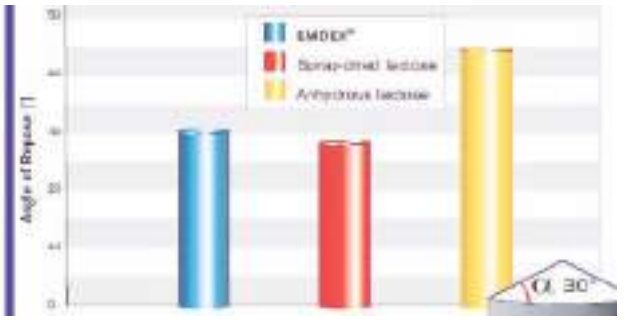
In this study, the effect of different soluble binder on tablet hardness was evaluated.



Observation: The kind of diluent used had a significant influence on the hardness of the tablets. While tablet manufactured with EMDEX® resulted in the highest compactability, those made from glucose and spray-dried lactose exhibited the lowest compactability. Spray drying of EMDEX® as well as the presence of oligosaccharides leads to massive increase in tablet strength.

Flowability

In this study, the flowability of different soluble binders was evaluated.

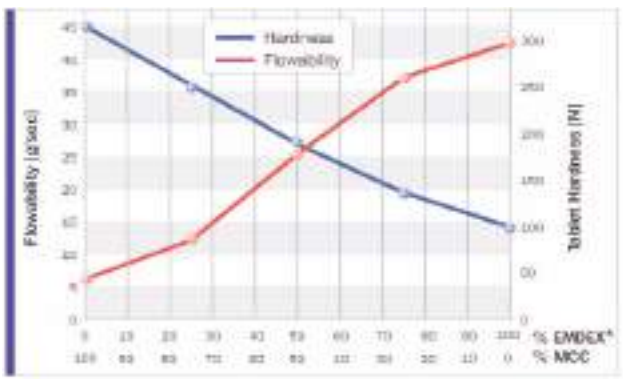


Observation: Due to its high bulk density and spherical particle shape, EMDEX® exhibits excellent flowability. This functional advantage can be utilised in pre-form or for flow enhancement in tableting blends and stickpacks. Angle of repose found to be a 300.

density, leads to excellent powder flow of EMDEX® and spray-dried lactose. Furthermore, both excipients are appropriate for direct compression applications and deform mainly by brittle fracture.

Hardness vs flowability:

In this study, the effect on hardness and flowability was evaluated.



Observation: The flowability of DC-grade micro-crystalline cellulose (VIVAPUR® 102) can be further improved by adding increasing amounts of EMDEX®

EMDEX® is a promising substitute for spray dried lactose as it has similar powder and tableting properties. Spray-dried lactose is widely used as filler and binder in the pharma industry, but many adults are not able to digest lactose. Lactose is absorbed from the gastrointestinal tract once it is hydrolyzed by the enzyme "lactase" into glucose and galactose. Hence, children deficient in "lactase," are unable to absorb lactose (due to congenital defect or lack of the enzyme) and develop flatulence, diarrhoea, gastrointestinal bloating following ingestion of milk due to the build-up of lactic acid, hydrogen and carbon dioxide. Lactose intolerance in infants and children can lead to prolonged episodes of bloating, diarrhoea, dehydration and metabolic acidosis. Therefore, it is indispensable to provide alternatives to lactose-containing drugs in order to make them suitable for lactose-intolerant patients[1][2].

Conclusion:

◆ EMDEX® is a water –soluble filler binder with brittle fracture as the main binding mechansim.

◆ EMDEX® and spray dried lactose show great similarity in terms of particle morphology, bulk density and flowability. EMDEX® was, therefore, ideally suited as a substitute for spray dried lactose in order to make them suitable for lactose-intolerant people.

◆ EMDEX® is well-suited for chewable tablets, effervescent tablets, oro-dispersible tablets, multi-layer tablets and sachet kind of formulation.

References:

1. Mattar, R. et al. (2012) Lactose intolerance: diagnosis, genetic, and clinical factors. Clinical and experimental Gastroenterology, 2012:5 113-121.

2. Pawar S, Kumar A (2002) Issues in the formulation of drugs for oral use in children. Pediatric Drugs 4(6):371–379

3. JRS Pharma The Use of EMDEX® in a Lactose-free Reformulation of Cetirizine Tablets- JRS Pharma https://www.jrspharma.com/pharma_en/technical-info/brochures/technical-info/EMDEX.php

4. JRS Pharma EMDEX® Brochure- JRS Pharma

5. Rowe, R.C., Sheskey, P.J.; Quinn, M.E. (2009) Handbook of Pharmaceutical Excipients. 6th Edition, Pharmaceutical Press, 218-220.

6. Leon Lachman, Herbert A. Lieberman, Joseph L. Kanig. The theory and Practice of Industrial Pharmacy, Varghese publication house, 3rd edition, 1990, 327-330.

QR Code:

Scan the QR code for more details regarding EMDEX® from JRS Pharma.

Author:
Prashant Bhangdiya
Technical Manager-Pharma
Rettenmaier India
Prashant.bhangdiya@jrsindia.com

CONTRIBUTOR'S CHECKLIST

❒ Express Pharma accepts editorial material for regular columns and from pre-approved contributors / columnists.
❒ Express Pharma has a strict non-tolerance policy of plagiarism and will blacklist all authors found to have used/refered to previously published material in any form, without giving due credit in the industry-accepted format. All authors have to declare that the article/column is an original piece of work and if not, they will bear the onus of taking permission for re-publishing in Express Pharma.
❒ Express Pharma's prime audience is senior management and pharma professionals in the industry. Editorial material addressing this audience would be given preference.
❒ The articles should cover technology and policy trends and business related discussions.
❒ Articles for columns should talk about concepts or trends without being too company or product specific.
❒ Article length for regular columns: Between 1200 - 1500 words. These should be accompanied by diagrams, illustrations, tables and photographs, wherever relevant.
❒ We welcome information on new products and services introduced by your organisation for our various sections: Pharma Ally (News, Products, Value Add), Pharma Packaging and Pharma Technology Review sections. Related photographs and brochures must accompany the information.
❒ Besides the regular columns, each issue will have a special focus on a specific topic of relevance to the Indian market.
❒ In e-mail communications, avoid large document attachments (above 1MB) as far as possible.
❒ Articles may be edited for brevity, style, and relevance.
❒ Do specify name, designation, company name, department and e-mail address for feedback, in the article.
❒ We encourage authors to send their photograph. Preferably in colour, postcard size and with a good contrast.

Email your contribution to:
The Editor,
Express Pharma,
Business Publications Division, The Indian Express (P) Ltd,
Mafatlal Centre, 7th floor, Ramnath Goenka Marg,
Nariman Point, Mumbai 400021
viveka.r@expressindia.com
viveka.roy3@gmail.com

COREL PHARMA CHEM

the next generation polymer technologist...

One stop solution to your formulation needs

ACRYCOAT®
Methacrylic Acid Copolymer
Gastrointestinal Targeting | Immediate Release
Controlled Release

COLORCOAT®
Ready to use Coating Material
Film Coating | Enteric Coating
Moisture Protection Coating | Transparent Coating

KYRON® T-314
Polacrilin Potassium
Superfast Disintegration and Dissolution Improver

KYRON®
Taste Masking of Bitter Drug
Suspensions | Dry Syrup | Mouth Dissolving Tablet
Dispersible Tablet | Chewable Tablet

ACRYPOL®
Carbomer / Acrylates Copolymer
Controlled Release | Rheology Modifier
Oral Care | Emulsifier | Suspending Agent

ACRYSOL®
Castor Oil Derivative
Solubiliser | Emulsifier | Dissolution Improver

ACRYFLOW®
Hydrogenated Castor Oil
Lubricant | Sustained Release | Emulsifier

Corel House, Opp. Bhagwat Petrol Pump, S.G. Highway, Gota, Ahmedabad - 382481 Gujarat, India
Tel: +91 8000980011/ 22/ 33 | E-mail: corel@corelpharmachem.com | marketing@corelpharmachem.com
Website: www.corelpharmachem.com

• ACRYPOL® • ACRYSET® • ACRYSOL® • ACRYFILM® • ACRYM®

REGD.WITH RNI NO. MAHENG/2005/21398, POSTAL REGD. NO. MCS/164/2025 – 27, PUBLISHED ON 5TH EVERY MONTH,
POSTED ON 9TH, 10TH, AND 11TH EVERY MONTH POSTED AT MUMBAI PATRIKA CHANNEL SORTING OFFICE, MUMBAI – 400001