Agilent TwisTorr FS Turbo Pump Family

New generation turbo pumps with TwisTorr drag technology and Agilent Floating Suspension
A New Category of Turbomolecular Pumps

Meet the TwisTorr FS family: compact, reliable, energy efficient, best-in-class turbo drag packages with innovative technology, for outstanding performance.

**Agilent TwisTorr FS pump applications**

The new TwisTorr FS technology represents a unique blend of performance and features that is perfectly suited for a wide range of applications.

- **Academia, government, and research**
  Unmatched vacuum performance in-class, with TwisTorr stages optimized for H₂ compression, make them ideal for demanding academic and research applications.

- **Surface analysis**
  Thanks to low vibration, low noise, and high stability, TwisTorr FS turbo pumps meet the specific demands of electron microscopes.

- **Analytical instrumentation**
  High throughput and optimized performance for light gases in routine applications are perfectly suited for use in analytical instruments.

- **Industrial and semiconductors**
  TwisTorr FS turbo pumps offer dry, clean vacuum for demanding industrial and semiconductor applications.

**Agilent quality and reliability**

**Your benefits**
- Reduced cost of ownership and system downtime
- Proven robustness and reliability
- Agilent quality standards

**TwisTorr FS family features**
- Agilent Floating Suspension (AFS)
- Optimized thermal design
- Precise positioning of bearings and rotor

**Easy system integration**

**Your benefits**
- Compact design
- Plug and play
- Easy pump driving and monitoring
- Operation in any position
- Oil-free solution

**TwisTorr FS family features**
- Ceramic ball bearings with permanent lubrication
- PCB, onboard, rack control units with serial and Profibus communication
- Retrofittable to any pump
Your Solution for High Performance, Quality, and Reliability

Superior performance
Your benefits
- Low ultimate pressure
- Fast pumpdown
- Smaller/less expensive backing pump
- Suitable for high gas load applications
- Lower power consumption

TwisTorr FS family features
TwisTorr drag stages allow for:
- Superior compression ratio
- High foreline pressure tolerance
- Best-in-class pumping speed

Quiet and low vibration
Your benefits
- Excellent vibration level (damping effect)
- Quiet pump during operation

TwisTorr FS family features
- Agilent Floating Suspension

Stability over time
Your benefits
- Stable noise and vibration performance over time

TwisTorr FS family features
- Agilent Floating Suspension
- Stable/constant bearings and rotor positioning over time

How quiet is a Twistorr FS pump?

<table>
<thead>
<tr>
<th>Noise</th>
<th>dBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motorcycle (8 m away)</td>
<td>90</td>
</tr>
<tr>
<td>Freight train (25 m); food blender</td>
<td>80</td>
</tr>
<tr>
<td>Cars on freeway; vacuum cleaner</td>
<td>70</td>
</tr>
<tr>
<td>Air conditioner (30 m); office noise</td>
<td>60</td>
</tr>
<tr>
<td>Rotary vane pump</td>
<td>55</td>
</tr>
<tr>
<td>Agilent IDP-15 scroll pump/conversation at home</td>
<td>50</td>
</tr>
<tr>
<td>Competitors’ medium TMP</td>
<td>50</td>
</tr>
<tr>
<td>Agilent medium TwisTorr pumps</td>
<td>43</td>
</tr>
<tr>
<td>Competitors’ small TMP</td>
<td>48</td>
</tr>
<tr>
<td>Agilent small TwisTorr pumps</td>
<td>40</td>
</tr>
</tbody>
</table>

Now featuring
New 3D Software for pump control
- Optimized performance, maximum flexibility and extended reliability
- Dynamic speed and power tuning according to inlet pressure, gas load, and temperature
- Constantly the best pump performance in every application condition
- Learn more, see pages 8-9
TwisTorr FS: Design Process, Quality, and Reliability Test Elements

The Product Life Cycle method drives and tracks the design process through the six steps of proposal, investigation, lab prototype, production prototype, pilot run, and ramp to volume. Reiterated controls and tracking ensure full confidence in performance, quality, and regulatory data published for users.

*Agilent quality and reliability*

**2-Year warranty - TwisTorr 404 FS, 704 FS, 804 FS**

Agilent Warranty: Two year full coverage. Free-of-charge pump quick replacement in case of issues in the first 24 months.

**Life test – TwisTorr 404 FS, 704 FS, 804 FS**

Pump reliability is proven through an accelerated life test on a significant number of pumps, exposed for extended time to accelerating factors.

The test provides confidence in the pump’s hassle-free operation for an average period of more than five years.

**Shock test – TwisTorr 404 FS, 704 FS, 804 FS**

Pump resistance to shocks is proven by tests on a batch of pumps in both operative and inoperative conditions. Every pump is exposed to a 30 to 120 g acceleration (equivalent to a drop from 82 cm/32” – not operative pump, and 15 cm/6” – operative pump). Pumps are shock-tested six times in vertical, horizontal, and upside-down orientations.

No issues occurred with the tested pumps after 24 drops (no rotor mechanical contacts, no change to pump operation). Pump unbalance, verified after every drop, showed minor variations, well below acceptance threshold; the shock test confirmed pump robustness and reliability.

**Vibration test – TwisTorr 404 FS, 704 FS, 804 FS**

Compatibility with vibrations generated by external sources was demonstrated through a set of tests on a batch of pumps both in operative and inoperative conditions. Each pump was exposed to energy levels from 0.5 to 2 g during 105 minute vibration cycles in vertical, horizontal, and upside-down orientations at full rotational speed and not operative.

The test confirmed pump robustness and full compatibility with vibrations, as no rotor mechanical contacts or changes to pump operation were highlighted, and the pump unbalance remained well below the acceptance threshold.
**Packaging test – TwisTorr 404 FS, 704 FS, 804 FS**

Packaging functionality was verified with packed pumps subjected to 18 drops from a height of 96 cm (37.8 inch). The test confirmed that packaging can limit the acceleration provided to the pump during typical transportation to 30 g. Shock tests have shown that 30 g is a level of acceleration fully compatible with TwisTorr pump design.

**Stability over time**

**Thermal test – TwisTorr 404 FS, 704 FS, 804 FS**

Pumps were exposed for 86 h to temperatures ranging from –40 °C to +70 °C (not operative) and from 0° C to 40 °C (operative). Pump unbalance and correct operation were verified 11 times on every pump with only minor variations, well below the acceptance threshold. Thermal test confirmed pump robustness and full compatibility with all expected operative and non-operative temperature conditions.

**Quiet and low vibration**

**Fourier analysis – TwisTorr 404 FS, 704 FS, 804 FS**

The pump vibration spectrum is verified on every pump during the manufacturing process, and before the pump ships as a final test of correct operation. The average maximum vibration level at full speed is 0.4 m/s².

**Noise test – TwisTorr 404 FS, 704 FS, 804 FS**

Pump noise was verified through tests on a batch of pumps in 12 different operative statuses and orientations, including vertical, horizontal, and upside-down positions, with and without gasload; high temperature and low temperature; and full speed and low speed. The average pump noise resulting from the 168 measurements was 43 dB(A) +/-3σ in normal operation.
What Is TwisTorr?
The new molecular-drag technology, applied to the entire family from 84 FS to 804 FS

Agilent TwisTorr technology*

- Pumping effect is created by a spinning rotor disk, which transfers momentum to gas molecules.
- Gas molecules are forced to follow the spiral groove design on the stator. The specific design of the channel ensures constant local pumping speed and avoids reverse pressure gradients, minimizing power consumption.


Centripetal pumping action
Lower surface area of rotating disk transfers momentum to gas molecules.

Spiral groove design on the upper section of the TwisTorr stator causes a centripetal pumping action).

Centrifugal pumping action
Upper surface area of rotating disk transfers momentum to gas molecules.

Spiral groove design on the lower section of the TwisTorr stator causes a centrifugal pumping action. The pumping effect is repeated for each of the pump’s TwisTorr stages.

Leading-edge performance

- TwisTorr pumps offer the highest pumping speed in their category for all gases.
- The state-of-the-art TwisTorr technology also achieves the highest compression ratios for light gases in a commercially available turbomolecular pump.
- While offering the highest performance, average power consumption by the new drag section design is reduced by a factor of four, compared to previous designs.

Space saving design

- Our rotor is based on the proven Agilent monolithic rotor design, which positions the TwisTorr stator between two smooth spinning disks, thereby exploiting the pumping action by both disk surfaces in series.
- The double-sided spiral groove design on the TwisTorr stators combines centripetal and centrifugal pumping action in series, greatly reducing the size of the drag section.

Compression ratio

- Compression ratio for \( N_2 \) of a single TwisTorr stage can increase up to a factor of 100 with respect to a MacroTorr stage of the same space and rotor speed, without reducing foreline tolerance and pumping speed.
What Is Agilent Floating Suspension?
Innovative solutions for low vibration and stability over time

- Low vibration and acoustical noise
- Optimal working conditions for the bearings, extended operating life
- Exceptional stability for very demanding SEM application.

- High geometrical precision for perfect bearing alignment
- Designed radial and axial stiffness, optimized rotor dynamic behavior, and acoustic noise
- Axial spring effect of lower AFS for bearing preload and axial rotor positioning
- Excellent thermal stability
The New TwisTorr Medium TMP Controllers

Rack or onboard, available for 404 FS, 704 FS, and 804 FS pumps with 3D firmware for performance optimization

A significant move toward greater flexibility, speed of execution, and simplicity, TwisTorr 404 FS, 704 FS, and 804 FS introduce a new Agilent innovation: 3D pump control software. The innovative pump driving function provides maximum flexibility, speed, and simplicity, providing the best possible throughput performance according to the pump operative conditions.

A unique vacuum system quickly and automatically meets the entire spectrum of application needs, from UHV to high gas-load, from a single turbo pump. An automated routine manages pump rotational frequency and power according to the required inlet pressure and gas-load, at the temperature point required by the specific application.

**Maximum flexibility, speed, and simplicity, thanks to a unique smart vacuum system**

Dynamic speed and power tuning are optimized according to inlet pressure, gas load, and temperature, ensuring the best performance under all conditions.
3D firmware benefits:

- Immediate auto-detection of changing requirements in the application
- Dynamic TMP performance adapts to application conditions for process stabilization and speed
- Always the best tuning for TMP pumping technology, taking complete advantage of TwisTorr technology potential
- Minimized stress on pump components through continuous TMP parameter tuning for extended reliability

3D software drives the pump

Auto-detection of application requirements
- High gas flow
- High vacuum

Dynamic setting/tuning of pump parameters
- Rotational speed
- Power
- Temperature

TwisTorr technology output/performance
- High throughput
- High compression
The power of over 60 years of expertise in vacuum service has been applied to our most innovative turbo pump family. Learn about our TwisTorr turbo pump support strategy.

Exchange

Advance Exchange – In a fast moving world we keep your business ahead. Our Premium Advance Exchange Program maximizes your uptime and enables you to focus on what you do best — your business.

- Quick and hassle-free turnaround
- Refurbished to “As New” specifications
- Full one-year warranty

Quality Repair

When uncompromised quality at the right price is essence, you need a trusted partner to deliver it. Specialized Repair Centers around the globe bring Agilent quality standards closer to you.

When your TwisTorr turbo pump needs attention, we have the right know-how and experience to deal with it.

- Certified process and workmanship
- Genuine Agilent parts

Dedicated Solutions

Your work is important to us. Our technology refresh programs and tailored service plans are designed to protect and secure your investment. Customized service contracts and a comprehensive upgrade program are designed around your business needs and make us the natural choice as your vacuum service partner.

- Stay up to date
- Close to your business
- Personalized coverage
Technical Specifications

<table>
<thead>
<tr>
<th>Technical Specifications</th>
<th>Technical Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pumping speed ISO 160 / CF 8&quot;</td>
<td>Recommended forepump Agilent DS302 Rotary Vane Pump</td>
</tr>
<tr>
<td>N₂ 660 L/s</td>
<td>Agilent IDP-10 Dry Scroll Pump</td>
</tr>
<tr>
<td>He 640 L/s</td>
<td>Agilent IDP-15 Dry Scroll Pump</td>
</tr>
<tr>
<td>H₂ 480 L/s</td>
<td>Operating position Any</td>
</tr>
<tr>
<td>Ar 625 L/s</td>
<td>Oper. ambient temp. +5 °C to +35 °C</td>
</tr>
<tr>
<td>Max Gas Throughput (*)</td>
<td>Rel. humidity of air 0 - 90 % (not condensing)</td>
</tr>
<tr>
<td>N₂ 4.3 mbar L/s (25°C ambient temperature) 255 SCCM</td>
<td>Bakeout temp. ISO pump: 80 °C at inlet flange</td>
</tr>
<tr>
<td>He 7.9 mbar L/s (30°C ambient temperature) 467 SCCM</td>
<td>CFF pump: 120 °C at inlet flange</td>
</tr>
<tr>
<td>H₂ 10.4 mbar L/s (25°C ambient temperature) 367 SCCM</td>
<td>Lubricant Permanent lubrication</td>
</tr>
<tr>
<td>Ar 1.5 mbar L/s (25°C ambient temperature) 89 SCCM</td>
<td>Cooling requirements Air cooling Air temperature from +5°C to 35°C</td>
</tr>
<tr>
<td>(*) Backing pump 11.6 m³/hr</td>
<td>Water cooling Water temperature from +15°C to +25°C</td>
</tr>
<tr>
<td>Compression ratio and foreline tolerance (**)</td>
<td>Water flow min. 100 L/h</td>
</tr>
<tr>
<td>N₂ &gt; 1 x 10⁻¹¹ 10 mbar</td>
<td>Noise Pressure Level (at 1m at full speed) 43dB(A)</td>
</tr>
<tr>
<td>He 2 x 10⁻⁹ 10 mbar</td>
<td>Storage temp. -40°C to +70°C</td>
</tr>
<tr>
<td>H₂ 3 x 10⁻⁷ &gt;4 mbar</td>
<td>Max altitude 3000 m</td>
</tr>
<tr>
<td>Ar &gt; 1 x 10⁻¹¹ 8.5 mbar</td>
<td>Weight kg (lbs) ISO160K 20.6 kg (45.3)</td>
</tr>
<tr>
<td>Base pressure with recom. forepump &lt; 1 x 10⁻¹⁰ mbar (&lt; 1 x 10⁻¹⁴ Torr)</td>
<td>ISO160F 22.6 kg (49.7)</td>
</tr>
<tr>
<td>Inlet flange ISO 160K, ISO 160F, CFF 8” CFF 8” 22 kg (48.4)</td>
<td>Conformity to Norms EMC (Control Units) 61326-1</td>
</tr>
<tr>
<td>Foreline flange NW25 (NW40 as option)</td>
<td>Safety (CE/CSA) 61010-1</td>
</tr>
<tr>
<td>Rotational speed Auto setting from 40’800 RPM to 49’500 RPM</td>
<td>Machinery Directive DIR 2006/42/CE</td>
</tr>
<tr>
<td>Start-up time &lt; 5 minutes</td>
<td>Low Voltage Directive DIR 2014/35/EU</td>
</tr>
<tr>
<td></td>
<td>EMC Directive (Control Units) DIR 2014/30/EU</td>
</tr>
<tr>
<td></td>
<td>ROHS DIR 2011/65/EU</td>
</tr>
</tbody>
</table>

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Compression Ratio

Pumping Speed

![Graph](image-url)
Technical Specifications

<table>
<thead>
<tr>
<th>Technical Specifications</th>
<th>ISO200K-F</th>
<th>ISO250K-F</th>
<th>CFF10</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pumping speed</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N₂</td>
<td>720 L/s</td>
<td>660 L/s</td>
<td>690 L/s</td>
</tr>
<tr>
<td>He</td>
<td>485 L/s</td>
<td>485 L/s</td>
<td>690 L/s</td>
</tr>
<tr>
<td>H₂</td>
<td>720 L/s</td>
<td>660 L/s</td>
<td>690 L/s</td>
</tr>
<tr>
<td>Ar</td>
<td>485 L/s</td>
<td>485 L/s</td>
<td>690 L/s</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Max Gas Throughput (*)</th>
<th>Air Cooling (25°C ambient temperature)</th>
<th>Water Cooling (15°C water temp. / 25°C ambient temp.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N₂</td>
<td>4.3 mbar L/s 255 SCCM</td>
<td>6.2 mbar L/s 367 SCCM</td>
</tr>
<tr>
<td>He</td>
<td>7.9 mbar L/s 467 SCCM</td>
<td>10.4 mbar L/s 615 SCCM</td>
</tr>
<tr>
<td>Ar</td>
<td>1.5 mbar L/s 89 SCCM</td>
<td>3.3 mbar L/s 195 SCCM</td>
</tr>
</tbody>
</table>

(*) Backing pump 11.6 m³/hr

<table>
<thead>
<tr>
<th>Compression ratio and foreline tolerance**</th>
</tr>
</thead>
<tbody>
<tr>
<td>N₂</td>
</tr>
<tr>
<td>He</td>
</tr>
<tr>
<td>H₂</td>
</tr>
<tr>
<td>Ar</td>
</tr>
</tbody>
</table>

(**) Foreline Tolerance defined as the pressure at which the turbopump still produces a compression of 100 and estimated in water cooling mode.

<table>
<thead>
<tr>
<th>Base pressure with recomm. forepump</th>
<th>&lt; 1 x 10⁻¹⁰ mbar ( &lt; 1 x 10⁻¹⁰ Torr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreline flange</td>
<td>NW 25 or NW 40</td>
</tr>
<tr>
<td>Rotational speed</td>
<td>Auto setting from 40'800 RPM to 49'500 RPM</td>
</tr>
<tr>
<td>Start-up time</td>
<td>&lt; 5 minutes</td>
</tr>
</tbody>
</table>

Recommended forepump:
- Agilent DS302 Rotary Vane Pump
- Agilent IDP-10 Dry Scroll Pump
- Agilent IDP-15 Dry Scroll Pump

Operating position: Any

Oper. ambient temp.: +5 °C to +35 °C

Rel. humidity of air: 0 to 90% (not condensing)

Bakeout temp.:
- ISO pump: 80°C at inlet flange
- CFF pump: 120°C at inlet flange

Lubricant: Permanent lubrication

Cooling requirements
- Air cooling: Air temperature from +5°C to 35°C
- Water cooling: Water temperature from +15°C to +25°C

Water flow min. 100L/h

Noise Pressure Level (at 1m at full speed): 43dB(A)

Storage temp.: -40 °C to +70 °C

Max altitude: 3000 m

Weight kg (lbs):
- ISO200K: 20.7 kg (45.5)
- ISO200F: 23.6 kg (51.9)
- ISO250K: 23.3 kg (51.2)
- ISO250F: 27.6 kg (60.9)
- CFF 10⁰: 22.1 kg (48.6)

Conformity to Norms
- EMC (Control Units): 61326-1, 61010-1
- Safety (CE/CSA): DIR 2006/42/CE, DIR 2014/35/EU
- EMC Directive (Control Units): DIR 2011/65/EU
- ROHS: 2011/65/EU
Technical Specifications

### Agilent TwisTorr 404 FS

#### Technical Specifications

<table>
<thead>
<tr>
<th>Pumping speed</th>
<th>Technical Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>N₂</td>
<td>380 L/s</td>
</tr>
<tr>
<td>He</td>
<td>505 L/s</td>
</tr>
<tr>
<td>H₂</td>
<td>415 L/s</td>
</tr>
<tr>
<td>Ar</td>
<td>340 L/s</td>
</tr>
</tbody>
</table>

#### Max Gas Throughput (*)

<table>
<thead>
<tr>
<th>Gas</th>
<th>Air Cooling (25°C ambient temperature)</th>
<th>Water Cooling (15°C water temp. / 25°C ambient temp.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N₂</td>
<td>4.3 mbar L/s 255 SCCM</td>
<td>6.2 mbar L/s 367 SCCM</td>
</tr>
<tr>
<td>He</td>
<td>7.9 mbar L/s 467 SCCM</td>
<td>10.4 mbar L/s 615 SCCM</td>
</tr>
<tr>
<td>Ar</td>
<td>1.5 mbar L/s 89 SSCM</td>
<td>3.3 mbar L/s 195 SCCM</td>
</tr>
</tbody>
</table>

(*) Backing pump 11.6 m³/h

#### Compression ratio and foreline tolerance (**) |

<table>
<thead>
<tr>
<th>Gas</th>
<th>Compression ratio</th>
<th>Foreline pressure (mbar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N₂</td>
<td>&gt; 1 x 10⁻¹¹</td>
<td>10 mbar</td>
</tr>
<tr>
<td>He</td>
<td>2 x 10⁻¹⁰</td>
<td>10 mbar</td>
</tr>
<tr>
<td>H₂</td>
<td>3 x 10⁻⁹</td>
<td>&gt; 4 mbar</td>
</tr>
<tr>
<td>Ar</td>
<td>&gt; 1 x 10⁻¹¹</td>
<td>8.5 mbar</td>
</tr>
</tbody>
</table>

(**) Foreline Tolerance defined as the pressure at which the turbopump still produce a compression of 100 and estimated in water cooling mode

#### Base pressure with recomm. forepump

< 1 x 10⁻¹⁰ mbar

(= 1 x 10⁻⁹ Torr)

#### Operator settings

- Inlet flange: ISO 100K, ISO 100F, CFF 6" (as optional accessory)
- Foreline flange: NW25 (NW16 as optional accessory)
- Rotational speed: Auto setting from 40800 RPM to 49500 RPM
- Start-up time: < 5 minutes

#### Recommended forepump

- Agilent DS302 Rotary Vane Pump
- Agilent IDP-10 Dry Scroll Pump
- Agilent IDP-15 Dry Scroll Pump

#### Operating position

- Any

#### Oper. ambient temp.

- +5 °C to +35 °C

#### Rel. humidity of air

- 0 to 90% (not condensing)

#### Bakeout temp.

- ISO pump: 80°C at inlet flange
- CFF pump: 120°C at inlet flange

#### Lubricant

- Permanent lubrication

### Coolant requirements

- Air cooling
  - Air temperature from +5°C to 35°C
- Water cooling
  - Water temperature from +15°C to +25°C
  - Water flow min. 100L/h
  - Water temperature from +15°C to +25°C
  - Water flow min. 100L/h

#### Noise Pressure Level (at 1m at full speed)

- 43dB(A)

#### Storage temp.

- -40 °C to +70 °C

#### Weight (kg/lbs)

<table>
<thead>
<tr>
<th>ISO100K</th>
<th>ISO100F</th>
<th>CFF 6&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.6 kg (49.8)</td>
<td>23.7 kg (52.3)</td>
<td>23.5 kg (51.8)</td>
</tr>
</tbody>
</table>

#### Conformity to Norms

- EMC (Control Units): 61326-1, 61010-1
- Machinery Directive: DIR 2006/42/CE
- ROHS: 61326-1, 61010-1

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**Compression Ratio**

<table>
<thead>
<tr>
<th>Inlet Pressure (mbar)</th>
<th>Foreline Pressure (mbar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen</td>
<td>Helium</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>Argon</td>
</tr>
</tbody>
</table>

**Pumping Speed**

<table>
<thead>
<tr>
<th>Inlet Pressure (mbar)</th>
<th>Pumping Speed (l/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen</td>
<td>Helium</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>Argon</td>
</tr>
</tbody>
</table>
Agilent TwisTorr 304 FS

### Technical Specifications

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<tr>
<td><strong>Pumping speed</strong></td>
<td><strong>Recommended forepump</strong></td>
</tr>
<tr>
<td>ISO 100 / CF 6”</td>
<td>Agilent DS102 Rotary Vane Pump</td>
</tr>
<tr>
<td>ISO 160 / CF 8”</td>
<td>Agilent IDP-7 Dry Scroll Pump</td>
</tr>
<tr>
<td><strong>Max Gas Throughput (*)</strong></td>
<td><strong>Operating position</strong></td>
</tr>
<tr>
<td>N₂</td>
<td>Any</td>
</tr>
<tr>
<td>250 L/s</td>
<td>+5 °C to +25 °C</td>
</tr>
<tr>
<td>He</td>
<td>0 to 90 % (not condensing)</td>
</tr>
<tr>
<td>255 L/s</td>
<td>Bakeout temp.</td>
</tr>
<tr>
<td>H₂</td>
<td>80 °C at inlet flange max (ISO flange)</td>
</tr>
<tr>
<td>220 L/s</td>
<td>120 °C at inlet flange max (CFF flange)</td>
</tr>
<tr>
<td>Ar</td>
<td>Lubricant</td>
</tr>
<tr>
<td>250 L/s</td>
<td>Permanent lubrication</td>
</tr>
<tr>
<td>Air Cooling</td>
<td><strong>Cooling requirements</strong></td>
</tr>
<tr>
<td>Water Cooling</td>
<td>Air cooling</td>
</tr>
<tr>
<td>(25°C ambient temperature)</td>
<td>Air temperature from +5°C to 35°C</td>
</tr>
<tr>
<td>Water Cooling</td>
<td>Water cooling</td>
</tr>
<tr>
<td>(15°C water temp. / 25°C ambient temp.)</td>
<td>Water temperature from +15°C to +25°C</td>
</tr>
<tr>
<td><strong>Base pressure</strong></td>
<td>Water flow min. 50 L/h</td>
</tr>
<tr>
<td>with recomm. forepump</td>
<td>Noise Pressure Level (at 1m at full speed)</td>
</tr>
<tr>
<td>&lt; 1 x 10^-15 mbar</td>
<td>&lt; 50 dB(A)</td>
</tr>
<tr>
<td>&lt; 1 x 10^-8 Torr</td>
<td>Storage temp.</td>
</tr>
<tr>
<td>Inlet flange</td>
<td>-40°C to +70°C</td>
</tr>
<tr>
<td>ISO 100, CF 6”, ISO 160, CFF 8”</td>
<td><strong>Max altitude</strong></td>
</tr>
<tr>
<td>Foreline flange</td>
<td>3000 m</td>
</tr>
<tr>
<td>KF16 NW (KF25 - optional)</td>
<td><strong>Weight kg (lbs)</strong></td>
</tr>
<tr>
<td>Rotational speed</td>
<td>ISO 100</td>
</tr>
<tr>
<td>60000 rpm</td>
<td>5.5 kg (12.3)</td>
</tr>
<tr>
<td>(1010 Hz driving frequency)</td>
<td>CFF 6”</td>
</tr>
<tr>
<td>Start-up time</td>
<td>7.5 kg (16.5)</td>
</tr>
<tr>
<td>&lt; 3 minutes</td>
<td>ISO 160</td>
</tr>
<tr>
<td></td>
<td>5.7 kg (12.6)</td>
</tr>
<tr>
<td></td>
<td>CFF 8”</td>
</tr>
<tr>
<td></td>
<td>9.7 kg (20.9)</td>
</tr>
</tbody>
</table>

### Graphs

- **Compression Ratio**
  - Northern Hydrogen
  - Silver Helium
  - Black Nitrogen
  - Red Argon

- **Pumping Speed**
  - Northern Hydrogen
  - Silver Helium
  - Black Nitrogen
  - Red Argon
### Technical Specifications

#### Pumping Speed

- **Nitrogen (N₂)**: 49 L/s (KF40), 56 L/s (CFF 2.75”), 67 L/s (ISO 63), 67 L/s (CFF 4.5”)
- **Helium (He)**: 38 L/s (KF40), 46 L/s (CFF 2.75”), 63 L/s (ISO 63), 63 L/s (CFF 4.5”)
- **Hydrogen (H₂)**: 36 L/s (KF40), 40 L/s (CFF 2.75”), 53 L/s (ISO 63), 53 L/s (CFF 4.5”)
- **Argon (Ar)**: 44 L/s (KF40), 57 L/s (CFF 2.75”), 66 L/s (ISO 63), 66 L/s (CFF 4.5”)

#### Max Gas Throughput (*)

- **Nitrogen (N₂)**: 100 SCCM
- **Argon (Ar)**: 70 SCCM

(* Backing pump 11.6 m³/h

#### Compression ratio and foreline tolerance (**)  

- **Nitrogen (N₂)**: $\geq 1.0 \times 10^{-11}$ mbar
- **Helium (He)**: $2.0 \times 10^{-11}$ mbar
- **Hydrogen (H₂)**: $5.0 \times 10^{-11}$ mbar
- **Argon (Ar)**: $> 1.0 \times 10^{-11}$ mbar

(**) Foreline Tolerance defined as the pressure at which the turbopump still provide a compression of 100 and estimated in water cooling mode

#### Base pressure with recom. forepump

- $< 5 \times 10^{-10}$ mbar
- ($< 3.75 \times 10^{-10}$ Torr)

#### Inlet flange

- KF40, ISO 63, CFF 4.5”, CFF 2.75”

#### Foreline flange

- KF16 NW

#### Rotational speed

- 81000 rpm (1350 Hz driving frequency)

#### Start-up time

- < 2 minutes

---

### Cooling requirements

- **Air cooling**: Forced air (5-35 °C ambient temp.)
- **Water cooling**: Water temperature from +15°C to +25°C

#### Noise Pressure level (at 1 mt at full speed)

- 40 dB(A)

#### Storage temp.

- -40 °C to +70 °C

#### Max altitude

- 3000 m

#### Weight kg (lbs)

- ISO 63: 2.05 kg (4.5 lbs)
- CFF 4.5”: 3.50 kg (7.7 lbs)
- CFF 2.75”: 3.34 kg (7.35 lbs)
- KF40: 2.37 kg (5.22 lbs)

### Conformity to Norms

- CE, C-CSA-US, RoHS compliant as per 2011/65/UE

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#### Graphs

- **Compression Ratio**
  - Hydrogen
  - Helium
  - Nitrogen
  - Argon

- **Pumping Speed**
  - Hydrogen
  - Helium
  - Nitrogen
  - Argon

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