User Guide

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Venting Procedure for Agilent Turbomolecular Pumps

Introduction

This user guide provides a detailed procedure for safely stopping and venting Agilent turbomolecular pumps (TMP). The process is divided into two main phases: switching off the TMP and decelerating the rotor. Proper adherence to these procedures ensures the longevity and efficiency of the pumps.

Procedure

Phase 1: Switch off the TMP

Switching off a TMP involves a sequence of standard actions. Two equivalent methods can be followed:

Method A

1. Isolate the system.

   To isolate the TMP from the rest of the system, close the forevacuum valve.

2. Switch off the primary pump.

   Switch off the primary pump immediately after isolating the system.

3. Switch off the TMP.

Method B

1. Switch off the TMP.

   Begin by switching off the TMP.

2. Isolate the system.

   To isolate the TMP, immediately close the forevacuum valve.

3. Switch off the primary pump.

These methods ensure the fastest venting time to atmospheric pressure. After completing this phase, the rotor deceleration procedure can be applied.

Note: If the pump is water-cooled, it is recommended to turn off the cooling water supply to prevent the possible condensation of water vapor.

Special considerations

Presence of aggressive gases

- Delay switching off the primary pump until the TMP reaches 100 Hz rotational speed. This practice leads to a longer venting time but helps in cleaning the TMP and removing contamination or aggressive process gases during the venting process.
- If the TMP has been used for pumping corrosive or aggressive gases, keep the purge flow on during the entire venting phase to ensure that the motor chamber maintains a higher pressure than the inlet section, up to full atmospheric pressure.

Phase 2: TMP rotor deceleration

Properly decelerating a TMP rotor is crucial for maintaining pump longevity and efficiency. The deceleration process involves controlled venting and, sometimes, active braking.

Venting

Determining optimal venting points

- **Inlet (vacuum chamber area): Recommended** when no isolation valve is installed between the pump inlet and the chamber. Venting from the TMP inlet port side is effective and straightforward.
- **Automatic vent valve: Recommended** for precise control of the venting sequence. Agilent offers automatic vent valves that connect to the turbo controllers, allowing users to tailor the venting sequence for their application.

  Options include:

  - 0.5 or 1.2 mm orifice
  - Normally open or normally closed versions
  - Various connector types (Molex/USB)
  - Integrated vent/purge valve (used on Turbo-V 2K-G Pump)

  "Pulsed/Controlled" venting is the most effective and safest way to decelerate a TMP rotor, as it allows proper deceleration over time automatically. This function is available in the rack controller series.
- **Manual vent screw: Recommended with restrictions**. All turbo pumps are supplied with a manual vent screw that can be opened by hand to slow the rotor by allowing atmospheric air into the pump. The vent screw has a precision-drilled orifice that limits gas flow. Open the screw by 1/4 turn to allow gas flow, repeating the action every 10 to 15 seconds until the rotor speed is under 50% of its nominal value, then fully open the screw.
- **Purge port: Recommended** processes with contaminants. Use a continuous flow of nitrogen (purging valves with flow rates of 10 or 20 sccm are available) to decelerate the rotor safely.
- **Foreline: Not recommended** due to the risk of migrating particulates from the primary pump (oil vapor or dust particles) into the TMP and vacuum chamber through the foreline port.

When to vent:

- Always vent the TMP after switching it off to avoid backstreaming of hydrocarbons or other contaminants from the forevacuum side.
- The pump can be vented immediately after switching off (when the rotational speed is between full-speed and 50% of nominal speed). In this case some additional care must be taken with the maximum vent flow used (see the following section).
- If, for any reason, the pump needs to be vented after a delay time, always be sure to vent it before the rotational speed drops below 50% of its nominal speed (under 50% of the rotational speed, the compression ratio is no longer sufficient to suppress the backstreaming of hydrocarbon oil from the backing pump).

Determining the appropriate gas flow rate: At full speed or above 50% of nominal speed, use a flow that ensures a deceleration time equivalent to the run-up time. For example, if a turbo pump takes five minutes to reach full speed, allow the same amount of time for venting.

Below 50% speed, any additional venting flow can be used.

Table 1. Agilent pumps and their recommended venting parameters.

Agilent Pump Model	Rotational Frequency (Hz)	Recommended Deceleration (Hz/s)	Recommended Time (min)
TwisTorr 74 FS	1,167	9	2
TwisTorr 84 FS	1,350	10	2
TwisTorr 304 FS/305	1,010	8	3
Turbo-V 551/701	714	5	5
TwisTorr 404 FS/ 704 FS/804 FS	825	6	5
Turbo-V 1001	633	3	4
Turbo-V 1K-G	759	3	5
Turbo-V 2K-G	555	2	6
Turbo-V 2300	550	2	6

Recommended venting gas: Always use dry gas (dry air or nitrogen) to avoid contamination. This prevents water vapor and other condensable gases from depositing on the vessel walls, which would extend the subsequent time to reach ultrahigh vacuum.

Active braking: Active braking is an electric braking feature available in the newest generation of Agilent rack controllers. It should be used when normal venting causes a rapid pressure increase inside the TMP leading to rotor deceleration beyond the recommended maximum rate. This typically occurs when the chamber volume is minimal or when a gate valve is positioned above the TMP inlet and closed on pump shutdown.

- **When to use:** Use active braking in applications where the pump/system cannot be vented (for example, nuclear applications) or if the vacuum level inside the chamber needs to be maintained below atmospheric pressure for the next analysis.
- **How to use:** Only AG rack controller series and Agilent TwissTorr Medium-TMP onboard controller (TwisTorr 704 family) are equipped with a specific resistor to dissipate the energy generated during rotor deceleration.

Please refer to Table 2 for a comprehensive list of turbomolecular pump control units featuring regenerative active breaking.

Free spin down under vacuum (not recommended): Free deceleration under vacuum is generally not recommended. However, it can be considered for pumps with modal balancing features (TwisTorr pumps 74 FS, 84 FS, and 305 FS).

Emergency procedures

In emergencies, quickly open the vent valve to decelerate the rotor in the shortest possible time. Note that this may reduce the service life of the bearings due to heavy overload.

Conclusion

Following these best practices ensures the safe and efficient venting of Agilent turbomolecular pumps, maintaining their longevity and performance. Proper venting and deceleration practices are crucial for the optimal operation of TMPs in various applications.

Want to see the procedure in action and explore more details? Watch the video for a step-by-step demonstration and further information.

Table 2. Turbo control unit series with active braking by model and family.

Product Family	Part Number	Description
2K-G	9698980	Turbo-V 2K-G base controller
2K-G	9698981	Turbo-V 2K-G controller with monitor
2K-G	9698982	Turbo-V 2K-G controller base and Profibus
2K-G	9698983	Turbo-V 2K-G controller base and monitor and Profibus
2K-G	366440901	TV 2K-G controller Profibus and monitor
2K-G	9698981M002	Turbo-V 2K-G controller with monitor
304 FS	X3506-64130	TwisTorr 304 FS AG rack RS232/485
304 FS	X3506-64003	TwisTorr 304 FS AG rack Profibus
304 FS	X3506-64022	Controller 304 FS AG rack
304 FS	X3506-64042	304 FS rack C/U with short cable
304 FS	X3506-64052	Twistorr 304 FS rack hardened
305 FS	X3506-64130	TwisTorr 305 remote controller 232-485
305 FS	X3506-64131	TwisTorr 305 remote controller Profibus
305 FS	X3506-64133	Remote controller 305 with short pump cable
305 FS	X3506-69132	Special turbo 305 FS remote controlled 232-485
704 FS	9698977M003	TV 704 FS C/U
704 FS	X3501-64006	TwisTorr Medium-TMP OS rack controller
704 FS	X3501-64016	Twistorr Medium-TMP rack controller
704 FS	X3501-64026	Twistorr Medium-TMP OS rack controller
704 FS	X3501-64056	Twistorr Medium-TMP-Cryo rack controller
704 FS	X3501-64096	Medium rack with retrofit interface
704 FS	X3512-64006	TwisTorr Medium-TMP OS onboard controller
704 FS	X3512-64016	Twistorr Medium-TMP onboard controller
74 FS	X3508-64022	TwisTorr 74 FS AG rack controller Profibus
74 FS	X3508-64301	TwisTorr 74 FS AG rack controller RS232/4
74 FS	X3508-64311	TwisTorr 74 FS AG rack controller RS232/485
74 FS	X3508-64321	TV 74 FS rack AG with retrofit interface
74 FS	X3508-64331	TT 74 FS AG rack controller RS232/485 cable 0.8 m
804 FS OS	X3501-64036	804 FS-OS rack TV 700 I/O
804 FS OS	X3501-64046	804 FS-OS rack for NC vent valve
84 FS	X3508-64002	TwisTorr 84 FS AG c/u rack Profibus
84 FS	X3508-64012	TwisTorr 84 FS-OS AG rack c/u Profibus
84 FS	X3508-64031	TwisTorr 84 FS AG 1/4 rack controller 100 to 240V
84 FS	X3508-64041	TwisTorr 84 FS AG 1/4 rack controller 100 to 240V
84 FS	X3508-64051	TwisTorr 84 FS AG 1/4 rack controller 100 to 240V
84 FS	X3508-64061	TwisTorr 84 FS AG rack c/u RS232/485
84 FS	X3508-64071	Controller 84 FS AG rack
84 FS	X3508-64081	TwisTorr 84 FS AG rack C/U
84 FS	X3508-64091	84 FS rack C/U 90 °C TMP connector
84 FS	X3508-64101	TwisTorr 84 FS-OS AG rack c/u RS232/485
84 FS	X3508-64201	TwisTorr 84 FS-OS AG 1/4 rack C/U 100 to 24 V
Other	X3501-64023	Rack controller 1001 with short pump cable
TV 301	9698992	TV 301 AG 1/4 rack controller 100 to 240 V RS232/485
TV 301	9698993	TV 301 AG 1/4 rack controller 100 to 240 V and Profibus
TV 301	9698991M001	Turbo-V 301 AG 1/4 rack controller 100 to 240 V
TV 301	9698991M002	Turbo-V 301 AG 1/4 rack controller 100 to 240 V
TV 301	9698991M004	Turbo-V 301 AG 1/4 rack controller 100 to 240 V
TV 301	9698992M001	TV 301 AG 1/4 rack controller 100 to 240 V RS232/485
TV 301	9698992M002	TV 301 AG 1/4 rack controller 100 to 240 V RS232/485
TV 301	9699524S002	Special controller, Turbo-V 300 HT, 120 V
TV 301	9699537S003	Special controller, Turbo-V 300 HT, 120 V
TV 301	X3506-64012	Turbo-V 301 AG rack CU with RS-232/485
TV 750	9699525	TV 750/850-AG rack controller
TV 750	9699526	Turbo-V 750/850-AG rack controller Profibus
TV 750	9699525M001	TV 750/850-AG rack controller
TV 750	9699525M002	TV 750 AG rack controller
TV 750	9699525M003	TV 750 AG rack controller
TV 750	X3501-64000	Turbo 750 rack controller
TV 81	9698988M001	Turbo-V 81 AG 1/4 rack controller 100 to 240 V
TV 81	9698988M002	Turbo-V 81 AG 1/4 rack controller
TV 81	9698988M004	Turbo-V 81 AG 1/4 rack controller 100 to 240 V
TV 81	9698988M006	TV 81 AG rack C/U 70 KRPM
TV 81	9698989M001	TV 81 AG 1/4 rack controller 100 to 240 V RS232/485
TV 81	9698989M002	TV 81 AG 1/4 rack controller 100 to 240 V - MAGNEX
TV 81	9698989M003	TV 81 AG 1/4 rack controller 100 to 240 V RS232/485
TV 81	9698989M005	Turbo-V 81 AG 1/4 rack controller 100 to 240 V

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