Agilent

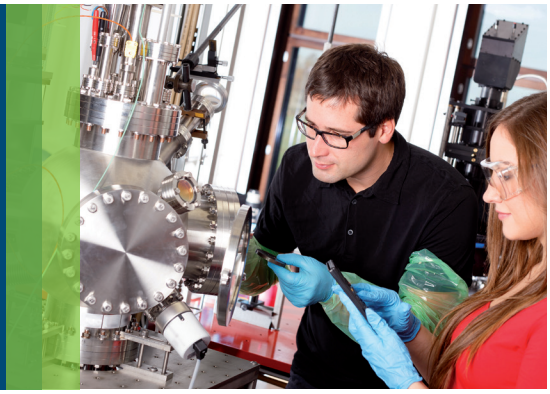
Trusted Answers

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

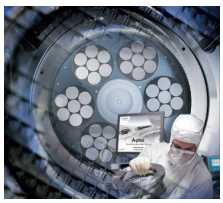
Unmatched vacuum performance in-class, with TwisTorr stages optimized for H_2 compression, make them ideal for demanding academic and research applications.

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

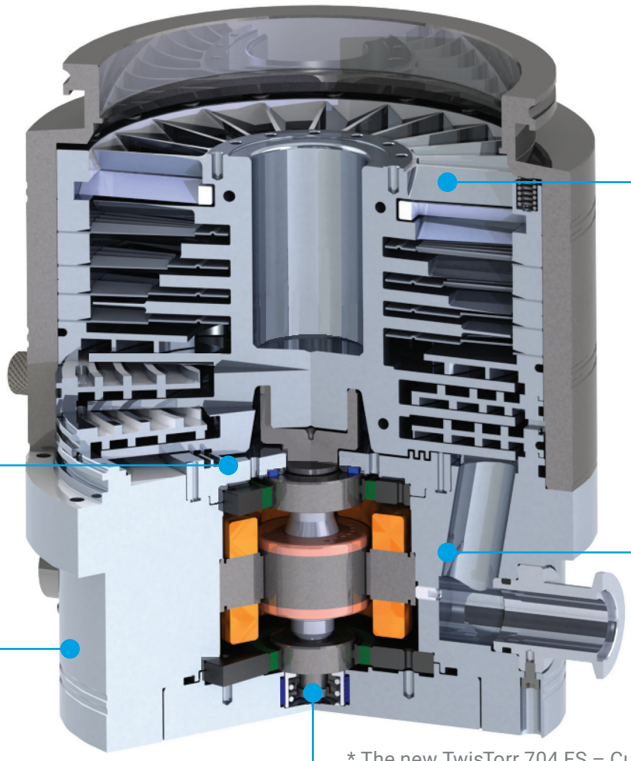
Your benefits

- 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



* The new TwisTorr 704 FS – Cutaway

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

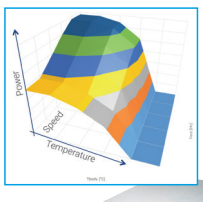
- Stable noise and vibration performance over time

TwisTorr FS family features

- Agilent Floating Suspension
- Stable/constant bearings and rotor positioning over time

How quiet is a Twistorr FS pump?

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



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

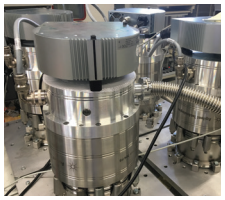
TwisTorr FS: Design Process, Quality, and Reliability Test Elements

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

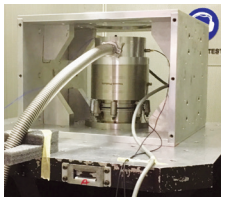
Agilent Warranty: Two year full coverage. Free-of-charge pump quick replacement in case of issues in the first 24 months.



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.

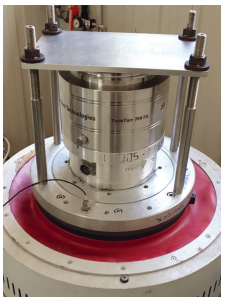
The test provides confidence in the pump's hassle-free operation for an average period of more than five years.



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.



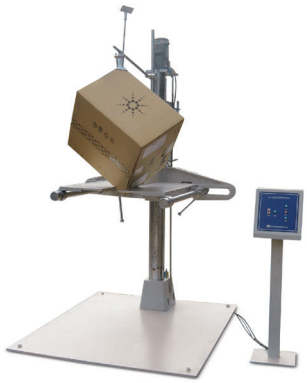
Vibration test – TwisTorr 404 FS, 704 FS, 804 FS*

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*

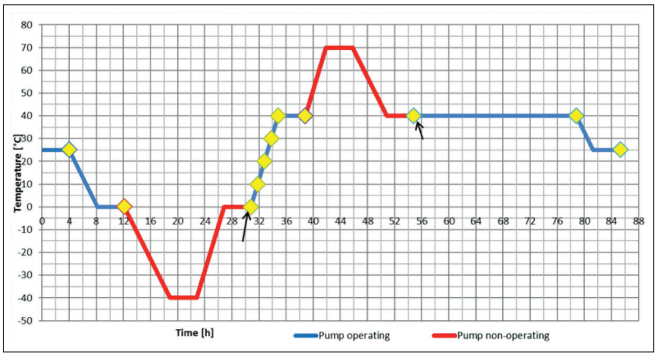
Packaging functionality was verified with packed pumps subjected to 18 drops from a height of 96 cm (37.8 inch). The test confirmed that packaging can limit the acceleration provided to the pump during typical transportation to 30 g. Shock tests have shown that 30 g is a level of acceleration fully compatible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



Stability over time

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

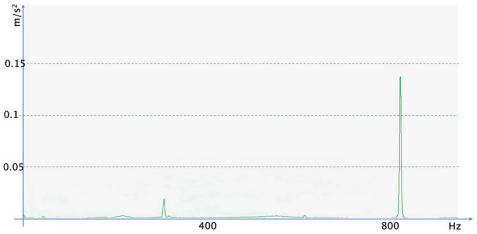
Pumps were exposed for 86 h to temperatures ranging from –40 °C to +70 °C (not operative) and from 0° C to 40 °C (operative). Pump unbalance and correct operation were verified 11 times on every pump with only minor variations, well below the acceptance threshold. Thermal test confirmed pump robustness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

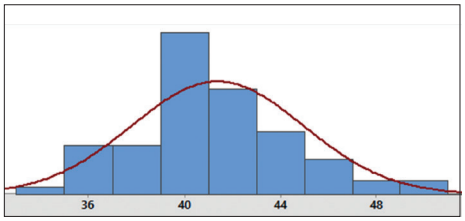
The pump vibration spectrum is verified on every pump during the manufacturing process, and before the pump ships as a final test of correct operation. The average maximum vibration level at full speed is 0.4 m/s^2.



FFT Analysis – TwisTorr 404 FS, 704 FS, 804 FS

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.



Noise distribution cart – TwisTorr 404, 704, 804 FS

*NOTE: *Test data provided are referred to TwisTorr 404 FS, 704 FS, 804 FS – similar data are available on request even for 84 FS and 304 FS.*

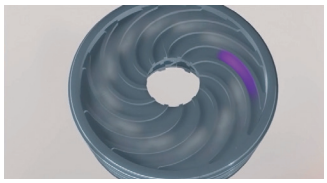
What Is TwisTorr?

The new molecular-drag technology, applied to the entire family from 84 FS to 804 FS

Agilent TwisTorr technology*

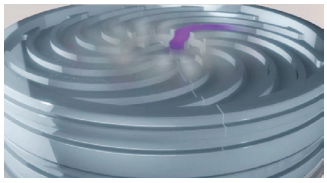
- Pumping effect is created by a spinning rotor disk, which transfers momentum to gas molecules.
- Gas molecules are forced to follow the spiral groove design on the stator. The specific design of the channel ensures constant local pumping speed and avoids reverse pressure gradients, minimizing power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

(*) US Patent applications 12/343961 and 12/343980, 24 Dec. 2008.

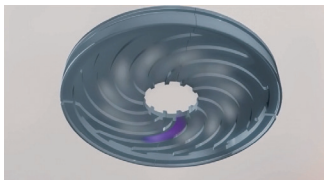


Centripetal pumping action

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

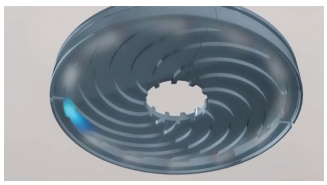


Spiral groove design on the upper section of the TwisTorr stator causes a **centripetal** pumping action).



Centrifugal pumping action

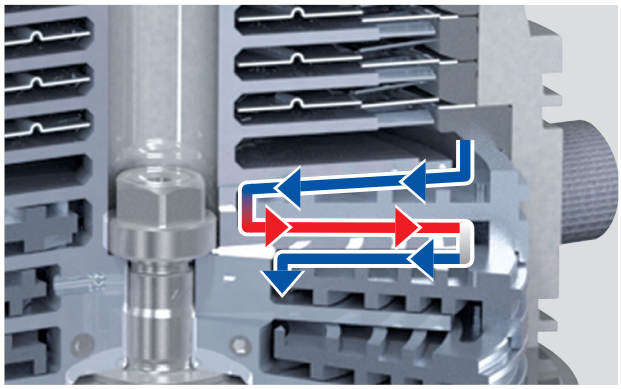
Upper surface area of rotating disk transfers momentum to gas molecules.



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

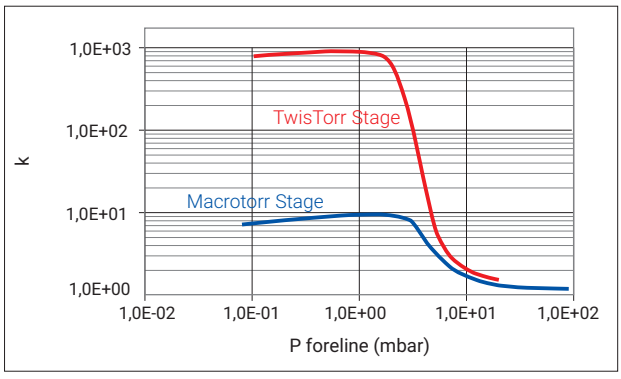
- TwisTorr pumps offer the highest pumping speed in their category for all gases.
- The state-of-the-art TwisTorr technology also achieves the highest compression ratios for light gases in a commercially available turbomolecular pump.
- While offering the highest performance, average power consumption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



Gas flow in centripetal and centrifugal direction through TwisTorr channels

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.

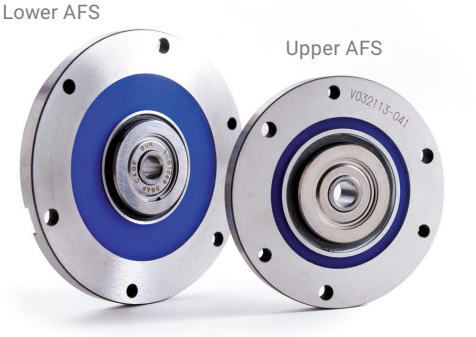


Compression ratio

- 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.

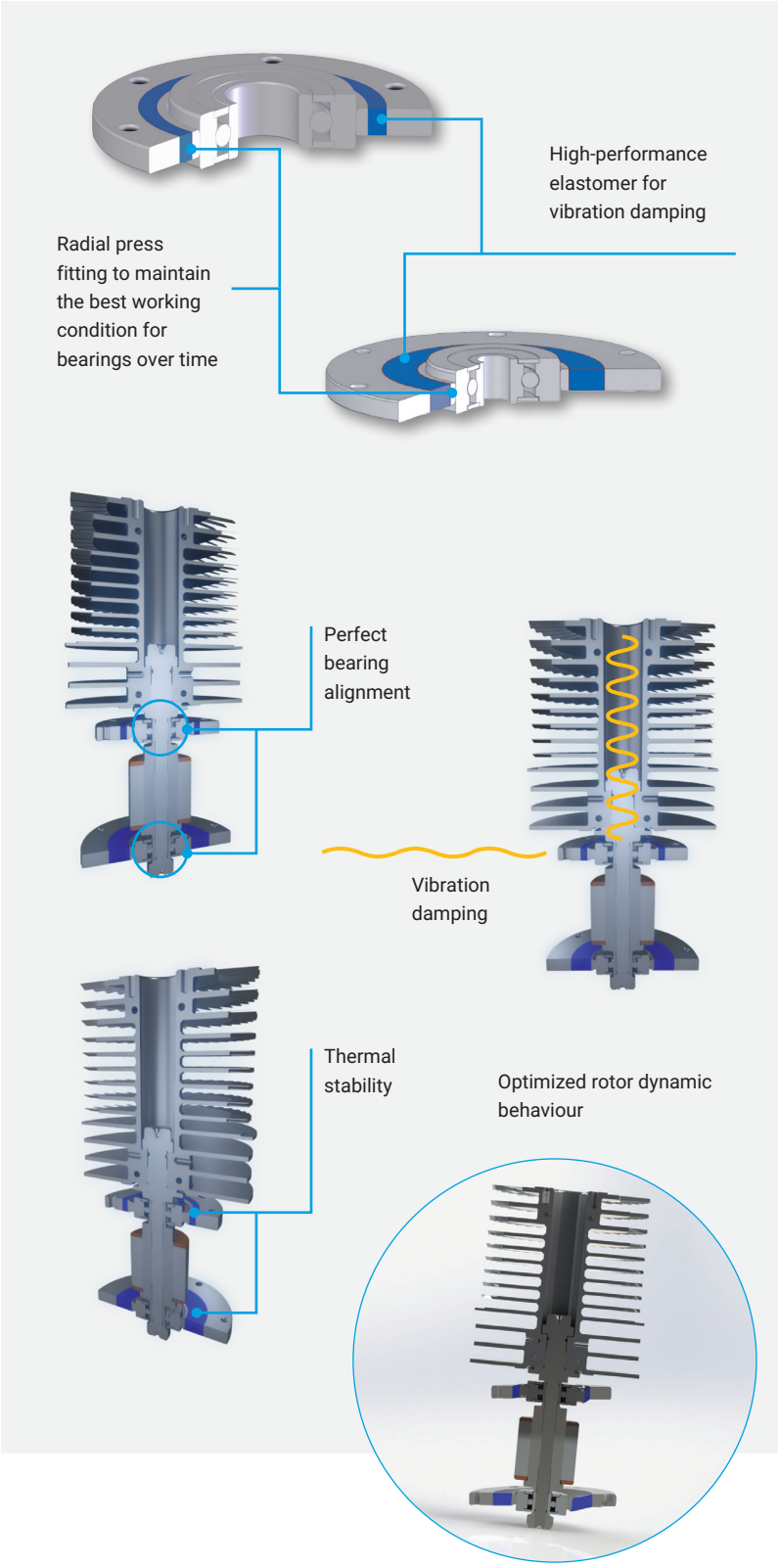
What Is Agilent Floating Suspension?

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

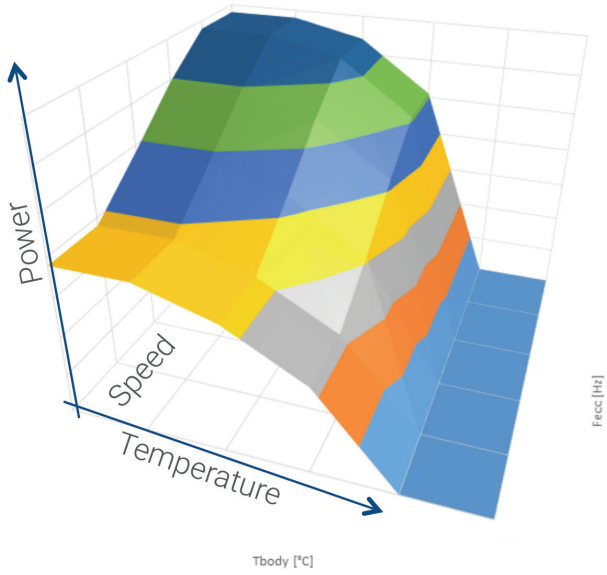
Rack or onboard, available for 404 FS, 704 FS, and 804 FS pumps with 3D firmware for performance optimization

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

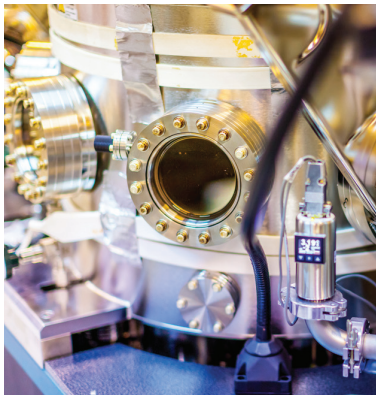
Dynamic speed and power tuning are optimized according to inlet pressure, gas load, and temperature, ensuring the best performance under all conditions.



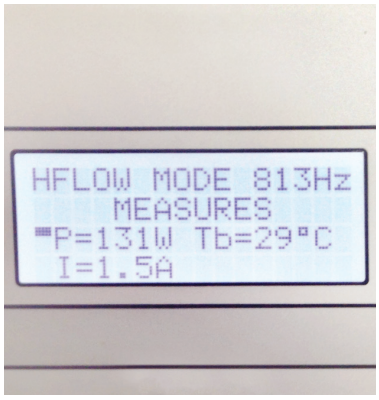
3D firmware benefits:

- 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

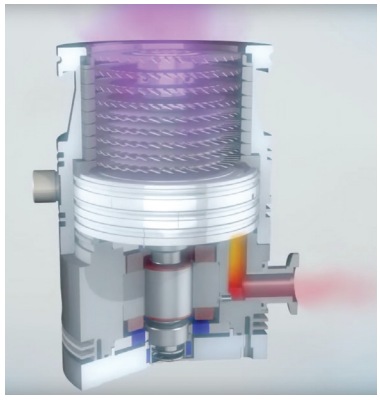
3D software drives the pump



Auto-detection of application requirements



Dynamic setting/tuning of pump parameters



TwisTorr technology output/performance

High gas flow	Rotational speed	High throughput
	Power	
High vacuum	Temperature	High compression

Vacuum Solutions for Better Service

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

Agilent TwisTorr 704 FS

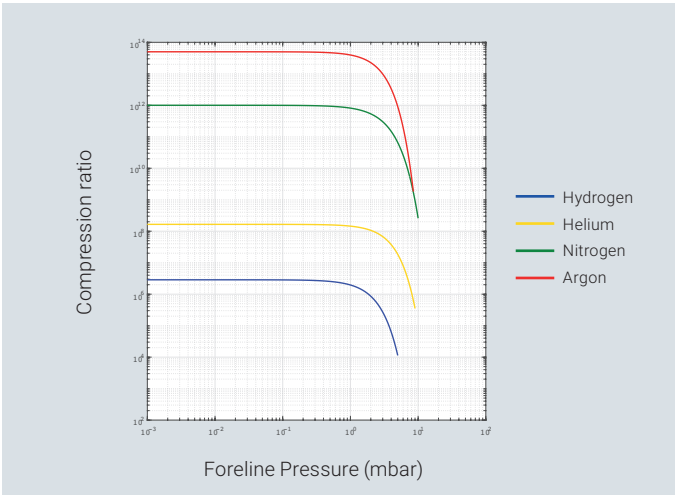
Technical Specifications

Technical Specifications		
Pumping speed	ISO 160 / CF 8"	
N_2 He H_2 Ar	660 L/s 640 L/s 480 L/s 625 L/s	
Max Gas Throughput (*)	Air Cooling (25°C ambient temperature)	Water Cooling (15°C water temp. / 25°C ambient temp.)
N_2	4.3 mbar L/s 255 SCCM	6.2 mbar L/s 367 SCCM
He	7.9 mbar L/s 467 SCCM	10.4 mbar L/s 615 SCCM
Ar	1.5 mbar L/s 89 SCCM	3.3 mbar L/s 195 SCCM
(*) Backing pump 11.6 m^3/hr		
Compression ratio and foreline tolerance (**)		
N_2 He H_2 Ar	> 1 x 10^{11} 2 x 10^8 3 x 10^6 > 1 x 10^{11}	10 mbar 10 mbar >4 mbar 8.5 mbar
(**) 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^{-10} Torr)	
Inlet flange	ISO 160K, ISO 160F, CFF 8"	
Foreline flange	NW25 (NW40 as option)	
Rotational speed	Auto setting from 40'800 RPM to 49'500 RPM	
Start-up time	< 5 minutes	

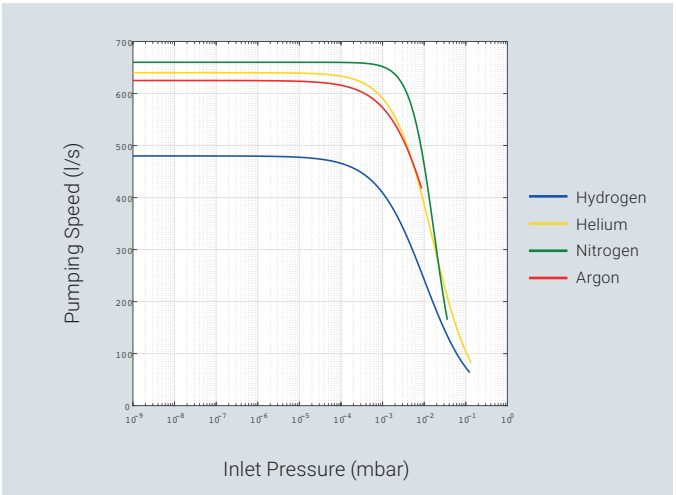
Technical Specifications		
Recommended forepump	Agilent DS302 Rotary Vane Pump Agilent IDP-10 Dry Scroll Pump Agilent IDP-15 Dry Scroll Pump	
Operating position	Any	
Oper. ambient temp.	+5 °C to +35 °C	
Rel. humidity of air	0 - 90 % (not condensing)	
Bakeout temp.	ISO pump: 80 °C at inlet flange CFF 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)	ISO160K ISO160F CFF 8"	20.6 kg (45.3) 22.6 kg (49.7) 22 kg (48.4)

Conformity to Norms	
EMC (Control Units)	61326-1
Safety (CE/CSA)	61010-1
Machinery Directive	DIR 2006/42/CE
Low Voltage Directive	DIR 2014/35/EU
EMC Directive (Control Units)	DIR 2014/30/EU
ROHS	DIR 2011/65/EU

Compression Ratio



Pumping Speed



Agilent TwisTorr 804 FS

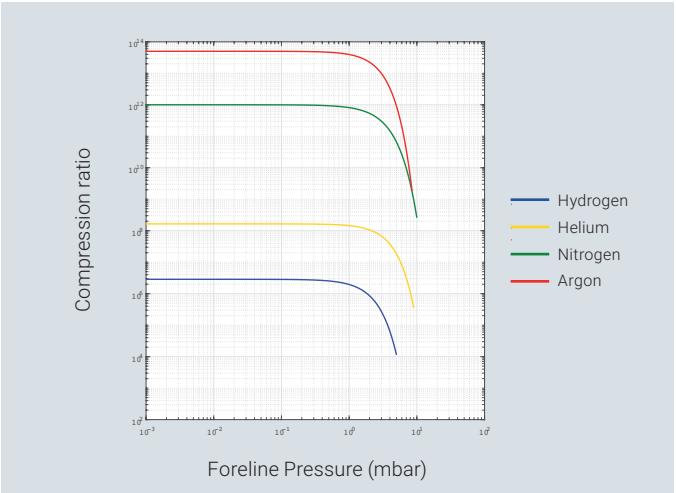
Technical Specifications

Technical Specifications			
Pumping speed	ISO200K-F	ISO250K-F	CFF10
N_2 He H_2 Ar	720 L/s 660 L/s 485 L/s 690 L/s		
Max Gas Throughput (*)	Air Cooling (25°C ambient temperature)	Water Cooling (15°C water temp. / 25°C ambient temp.)	
N_2	4.3 mbar L/s 255 SCCM	6.2 mbar L/s 367 SCCM	
He	7.9 mbar L/s 467 SCCM	10.4 mbar L/s 615 SCCM	
Ar	1.5 mbar L/s 89 SCCM	3.3 mbar L/s 195 SCCM	
(*) Backing pump 11.6 m^3/hr			
Compression ratio and foreline tolerance**			
N_2 He H_2 Ar	> 1 x 10^{11} 2 x 10^8 3 x 10^6 > 1 x 10^{11}	10 mbar 10 mbar >4 mbar 8.5 mbar	
(**) Foreline Tolerance defined as the pressure at which the turbopump still produces a compression of 100 and estimated in water cooling mode			
Base pressure with recomm. forepump	< 1 x 10^{-10} mbar (< 1 x 10^{-10} Torr)		
Inlet flange	ISO 200K, ISO 200F, ISO 250K, ISO 250F, CFF 10"		
Foreline flange	NW25 or NW40		
Rotational speed	Auto setting from 40'800 RPM to 49'500 RPM		
Start-up time	< 5 minutes		

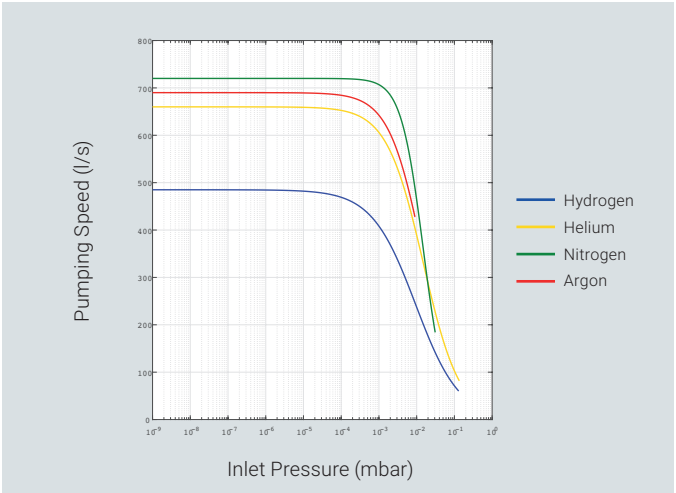
Technical Specifications		
Recommended forepump	Agilent DS302 Rotary Vane Pump Agilent IDP-10 Dry Scroll Pump Agilent IDP-15 Dry Scroll Pump	
Operating position	Any	
Oper. ambient temp.	+5 °C to +35 °C	
Rel. humidity of air	0 to 90% (not condensing)	
Bakeout temp.	ISO pump: 80°C at inlet flange CFF pump: 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 ISO200F ISO250K ISO250F CFF 10"	20.7 kg (45.5) 23.6 kg (51.9) 23.3 kg (51.2) 27.6 kg (60.9) 22.1 kg (48.6)

Conformity to Norms	
EMC (Control Units)	61326-1
Safety (CE/CSA)	61010-1
Machinery Directive	DIR 2006/42/CE
Low Voltage Directive	DIR 2014/35/EU
EMC Directive (Control Units)	DIR 2014/30/EU
ROHS	DIR 2011/65/EU

Compression Ratio



Pumping Speed



Agilent TwisTorr 404 FS

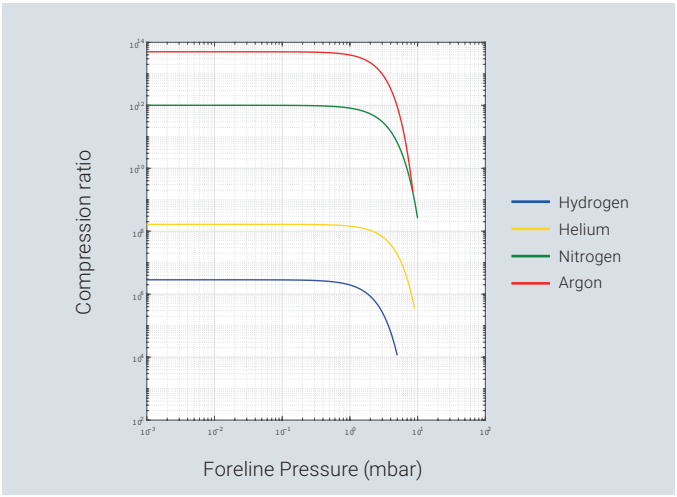
Technical Specifications

Technical Specifications		
Pumping speed	ISO 100K / ISO 100F / CFF 6"	
N_2 He H_2 Ar	380 L/s 505 L/s 415 L/s 340 L/s	
Max Gas Throughput (*)	Air Cooling (25°C ambient temperature)	Water Cooling (15°C water temp. / 25°C ambient temp.)
N_2	4.3 mbar L/s 255 SCCM	6.2 mbar L/s 367 SCCM
He	7.9 mbar L/s 467 SCCM	10.4 mbar L/s 615 SCCM
Ar	1.5 mbar L/s 89 SCCM	3.3 mbar L/s 195 SCCM
(*) Backing pump 11.6 m^3/h		
Compression ratio and foreline tolerance (**)		
N_2 He H_2 Ar	> 1 x 10^{11} 2 x 10^8 3 x 10^6 > 1 x 10^{11}	10 mbar 10 mbar > 4 mbar 8.5 mbar
(**) 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^{-10} Torr)	
Inlet flange	ISO 100K, ISO 100F, CFF 6"	
Foreline flange	NW25 (NW16 as optional accessory)	
Rotational speed	Auto setting from 40800 RPM to 49500 RPM	
Start-up time	< 5 minutes	

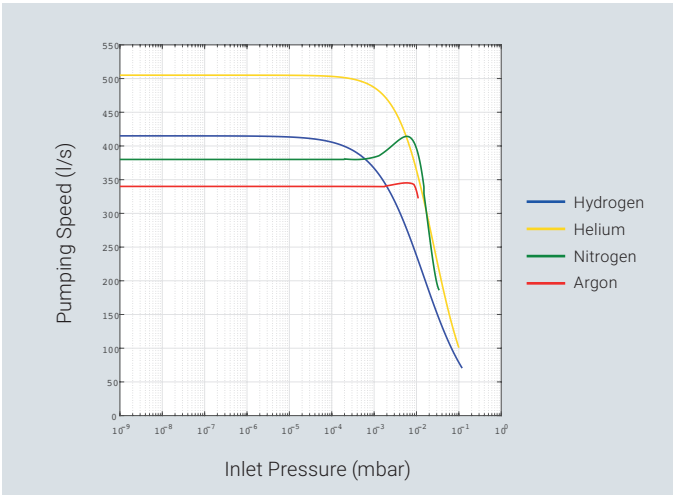
Technical Specifications		
Recommended forepump	Agilent DS302 Rotary Vane Pump Agilent IDP-10 Dry Scroll Pump Agilent IDP-15 Dry Scroll Pump	
Operating position	Any	
Oper. ambient temp.	+5 °C to +35 °C	
Rel. humidity of air	0 to 90% (not condensing)	
Bakeout temp.	ISO pump: 80°C at inlet flange CFF pump: 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)	ISO100K ISO100F CFF 6"	22.6 kg (49.8) 23.7 kg (52.3) 23.5 kg (51.8)

Conformity to Norms	
EMC (Control Units)	61326-1
Safety (CE/CSA)	61010-1
Machinery Directive	DIR 2006/42/CE
Low Voltage Directive	DIR 2014/35/EU
EMC Directive (Control Units)	DIR 2014/30/EU
ROHS	DIR 2011/65/EU

Compression Ratio



Pumping Speed



Agilent TwisTorr 304 FS

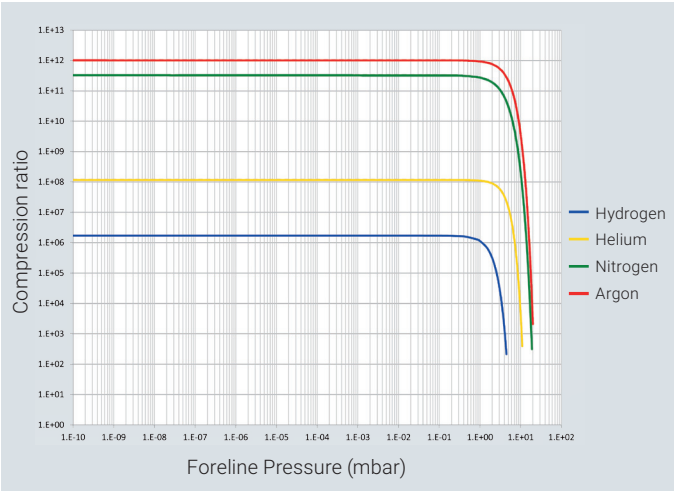
Technical Specifications

Technical Specifications		
Pumping speed	ISO 100 / CF 6”	ISO 160 / CF 8”
N_2 He H_2 Ar	250 L/s 255 L/s 220 L/s 250 L/s	250 L/s 255 L/s 220 L/s 250 L/s
Max Gas Throughput (*)	Air Cooling (25°C ambient temperature)	Water Cooling (15°C water temp. / 25°C ambient temp.)
N_2	170 SCCM	170 SCCM
Ar	110 SCCM	110 SCCM
(*) Backing pump 11.6 m^3/h		
Compression ratio and foreline tolerance (**)		
N_2 He H_2 Ar	> 1 x 10^{11} > 1 x 10^{8} 1.5 x 10^{6} > 1 x 10^{11}	>10 mbar >10 mbar >4 mbar >10 mbar
(**) 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^{-10} Torr)	
Inlet flange	ISO 100, CFF 6”, ISO 160, CFF 8”	
Foreline flange	KF16 NW (KF25 - optional)	
Rotational speed	60000 rpm (1010 Hz driving frequency)	
Start-up time	< 3 minutes	

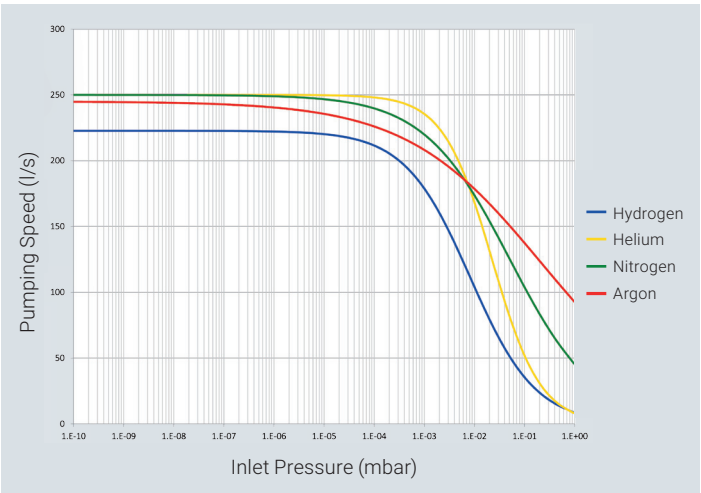
Technical Specifications		
Recommended forepump	Agilent DS102 Rotary Vane Pump Agilent IDP-7 Dry Scroll Pump	
Operating position	Any	
Oper. ambient temperature	+5 °C to +35 °C	
Rel. humidity of air	0 to 90 % (not condensing)	
Bakeout temp.	80 °C at inlet flange max (ISO flange) 120 °C at inlet flange max (CFF 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. 50 L/h	
Noise Pressure Level (at 1m at full speed)	< 50 dB(A)	
Storage temp.	-40°C to +70°C	
Max altitude	3000 m	
Weight kg (lbs)	ISO 100 CFF 6” ISO 160 CFF 8”	5.5 kg (12.3) 7.5 kg (16.5) 5.7 kg (12.6) 9.7 kg (20.9)

Conformity to Norms	
EMC (Control Units)	61326-1
Safety (CE/CSA)	DIR 2006/42/CE
ROHS	DIR 2011/65/EU

Compression Ratio



Pumping Speed



Agilent TwisTorr 84 FS

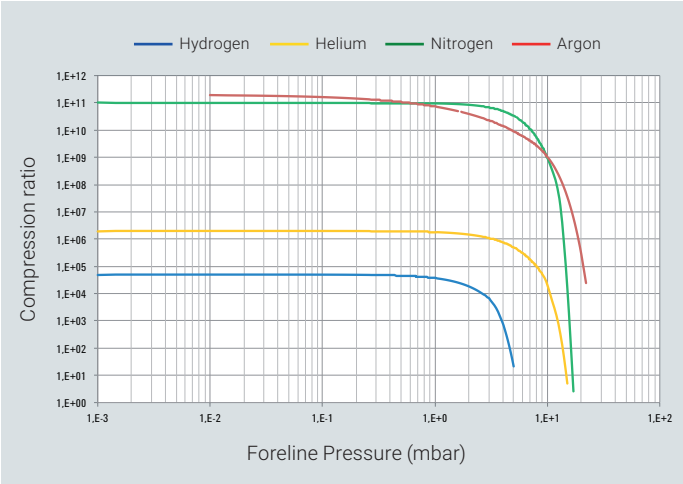
Technical Specifications

Technical Specifications				
Pumping speed	KF40	CFF 2.75"	ISO 63	CFF 4.5"
N_2	49 L/s	56 L/s	67 L/s	67 L/s
He	38 L/s	46 L/s	63 L/s	63 L/s
H_2	36 L/s	40 L/s	53 L/s	53 L/s
Ar	44 L/s	57 L/s	66 L/s	66 L/s
Max Gas Throughput (*)	Air Cooling (25°C ambient temperature)		Water Cooling (15°C water temp. / 25°C ambient temp.)	
N_2	100 SCCM		100 SCCM	
Ar	70 SCCM		70 SCCM	
(*) Backing pump 11.6 m^3/h				
Compression ratio and foreline tolerance (**)				
N_2	≥ 1.0 x 10^{11}		>14 mbar	
He	2.0 x 10^6		>12 mbar	
H_2	5.0 x 10^4		>4 mbar	
Ar	> 1.0 x 10^{11}		>14 mbar	
(**) 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	< 5 x 10^{-10} mbar (< 3.75 x 10^{-10} Torr)			
Inlet flange	KF 40, 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			

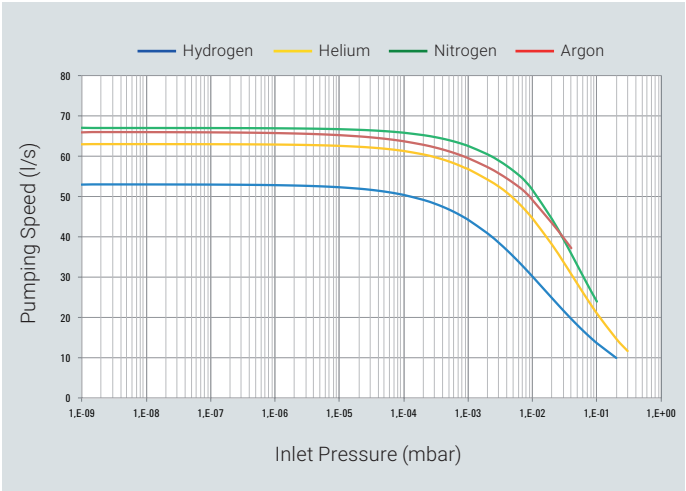
Technical Specifications		
Recommended forepump	Agilent DS 40M / DS 102 Rotary Vane Pump Agilent IDP-3/IDP-7 Dry Scroll Pump	
Operating position	Any	
Oper. ambient temp.	+5 °C to +35 °C	
Rel. humidity of air	0 - 90 % (not condensing)	
Bakeout temp.	80 °C for ISO (120 °C for CFF) at inlet flange	
Lubricant	Permanent lubrication	
Cooling requirements		
Air cooling	Forced air (5- 35 °C ambient temp.) Air flow temperature +5° C to +35 °C	
Water cooling	Water temperature from +15°C to +25°C Water flow min. 65m L/h	
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 CFF 4.5" CFF 2.75" KF 40	2.05 kg (4.5) 3.50 kg (7.7) 3.34 kg (7.35) 2.37 kg (5.22)

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

Compression Ratio



Pumping Speed



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