

A rough guide turbo pump selection

Making sense of the spaghetti of technical
data and specifications

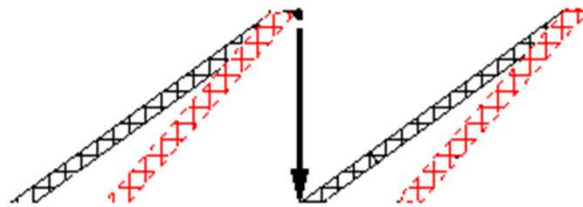
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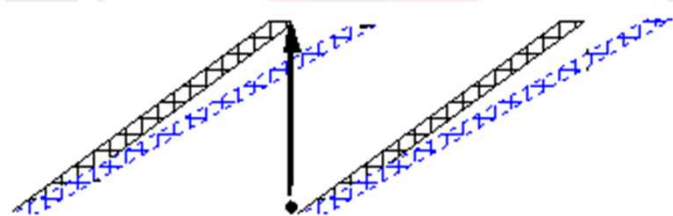
A rough guide turbo pump selection

- brief description of how a turbo works
- typical published data
- specifying a turbo for a system
- audience examples and discussion

How does a turbo pump work?



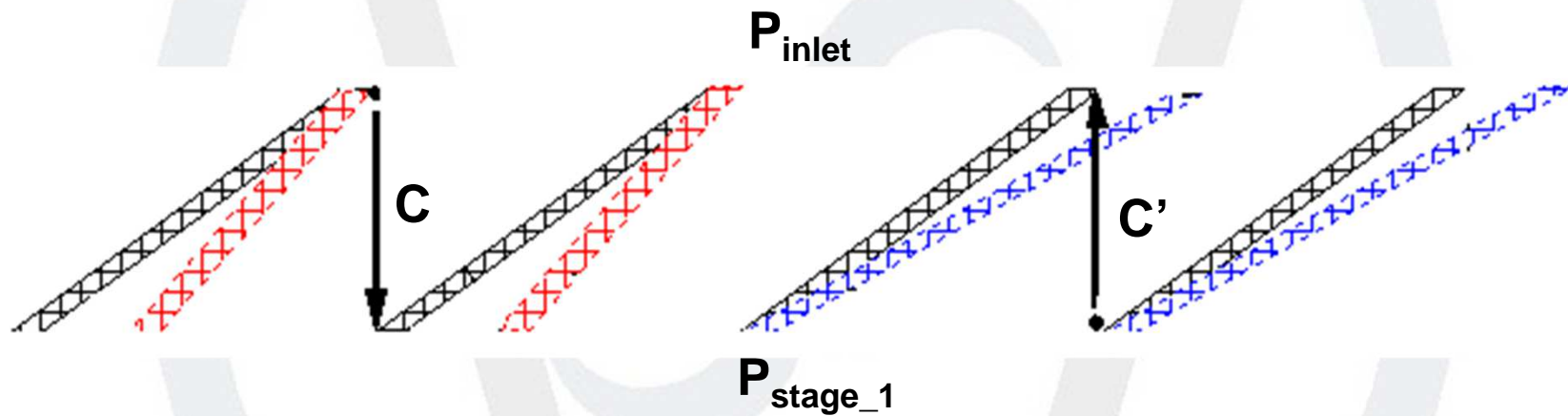
- Conductance for molecules entering pump is increased



- Conductance for molecules in contra-flow is decreased

How does a turbo work?

$$S \equiv \frac{Q}{P}$$



$$Q = P_{inlet} C - P_{stage_1} C'$$

Pumping Speed

$$Q = P_0 C_1 - P_1 C_1'$$

$$P_0 = \frac{(Q + P_1 C_1')}{C_1}$$

$$S = C_1 - C_1' \frac{P_1}{P_0}$$

many stages – (cf 9): P_1 from P_2 ; P_2 from P_3 etc; P_{last} from P_{back}

each stage has an incremental effect

Compression ratio, R

$$R \equiv \frac{P_{back}}{P_{inlet}}, Q = 0$$

$$P_0 = \frac{C_1'}{C_1} P_1$$

$$P_n = \frac{C_{n+1}'}{C_{n+1}} P_{n+1}$$

Total compression ratio is the product of all the stages

Comments on S and R

lighter gases move faster so “Mach” angle of blades is reduced:

- reduced pumping speed
- reduced compression ratio

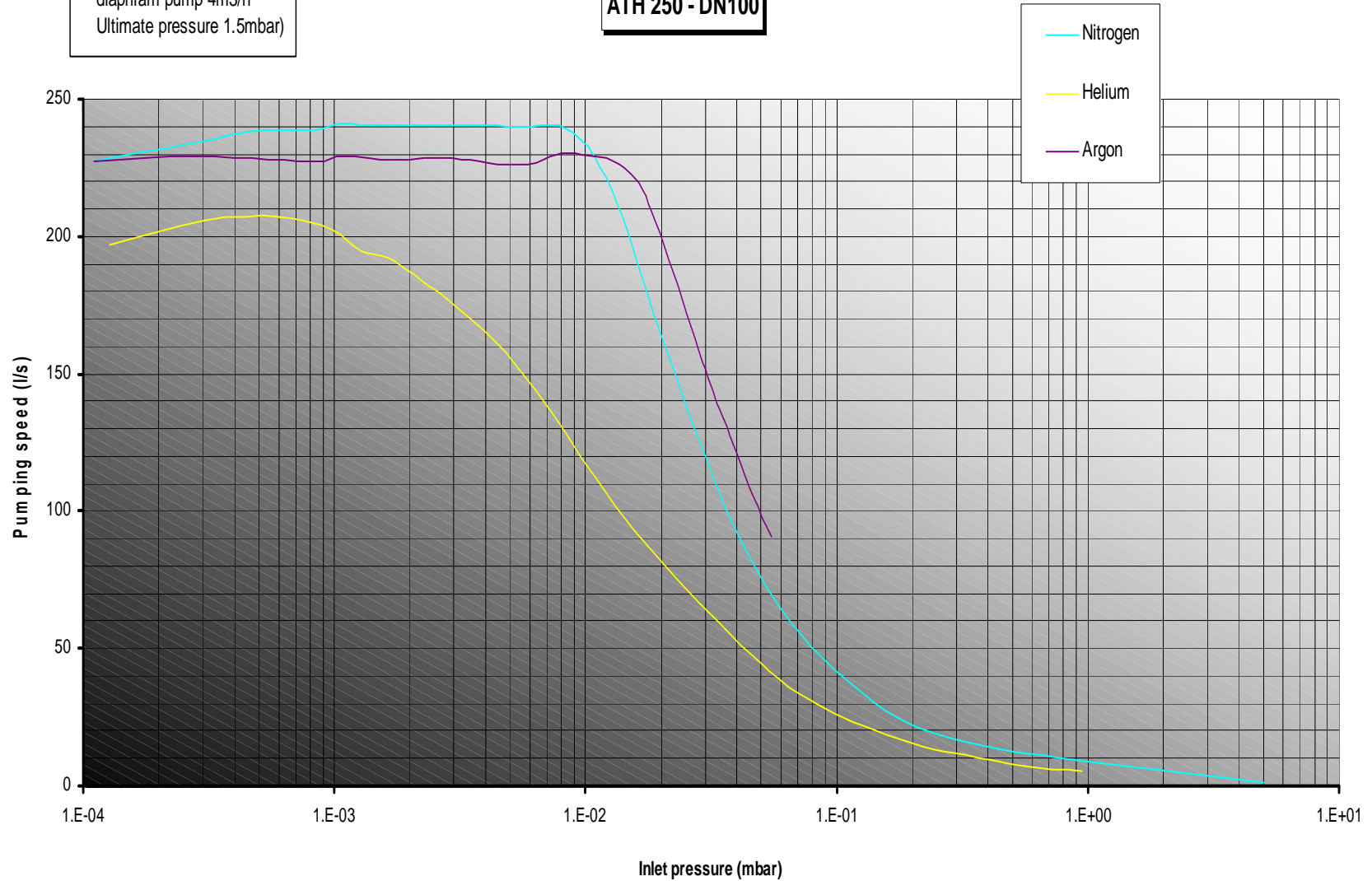
heavier gases are less mobile so slower to pump:

- reduces pumping speed

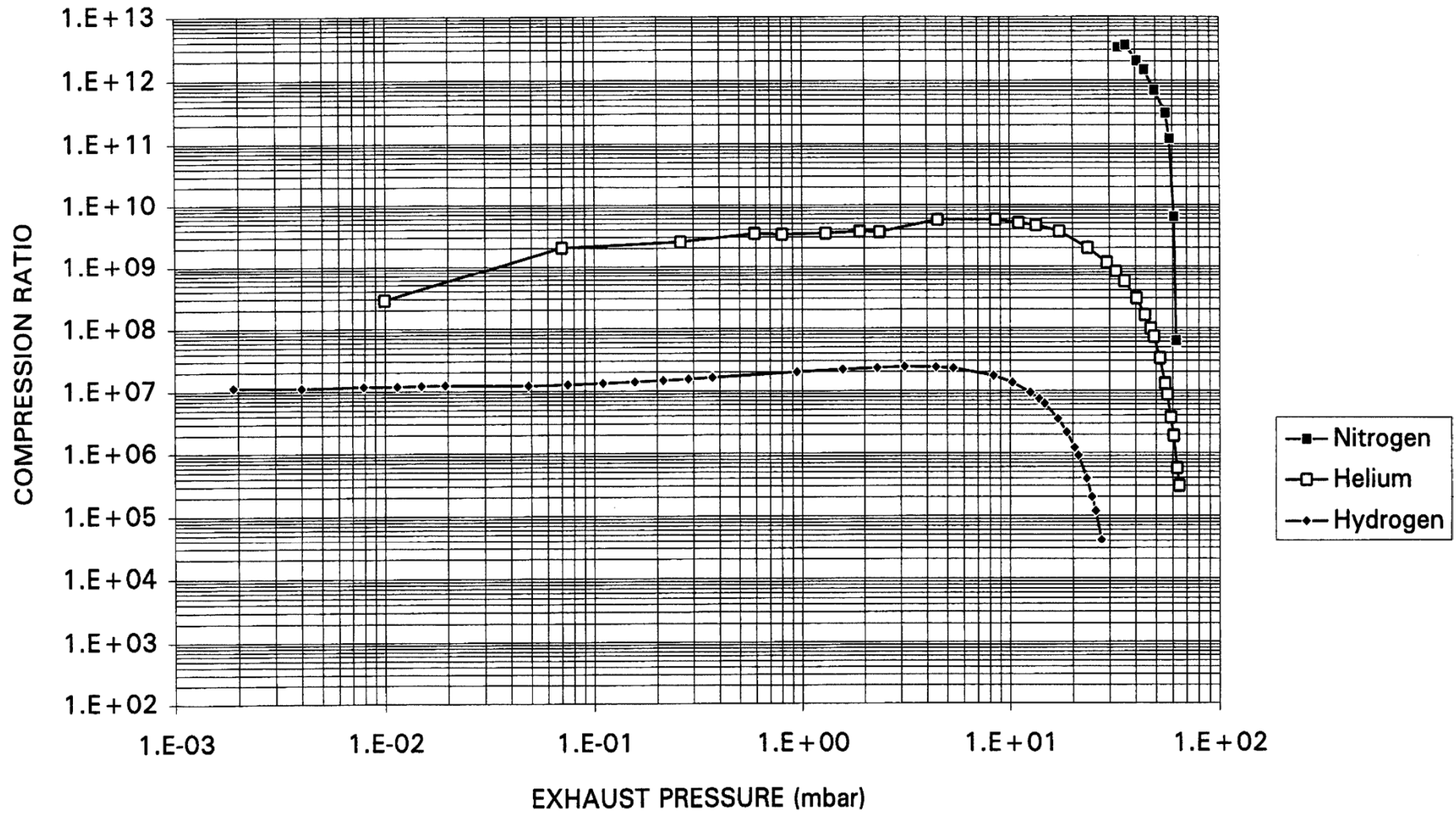
Pumping speed

Primary pump: MD4
diaphragm pump 4m³/h
Ultimate pressure 1.5mbar)

Pumping speed
ATH 250 - DN100



Compression ratio



Technical Specifications

Characteristics	Unit	ATH 300	ATH 300 Ci
Inlet flange	DN	100 ISO-K / 100 CF-F 160 ISO-K / 160 CF-F	
Rotation speed	rpm	42,000	
Pumping speed at inlet	N2 He	l/s	250 (DN 100) 300 (DN 160) 215 (DN 100) 240 (DN 160)
Pumping speed*** at intermediate port	N2 He	l/s	- 2-5 - 3-5
Compression rate at inlet	N2 He		1 x 10 ⁹ 1 x 10 ⁵
Compression rate at intermediate port	N2 He		- 7 x 10 ⁴ - 2 x 10 ²
Ultimate pressure* at inlet	mbar	< 1 x 10 ⁹	
Ultimate pressure* at intermediate port	mbar	-	1 x 10 ⁶
Maximum pressure at inlet** in continuous operation	mbar	1 x 10 ¹	
Maximum pressure at exhaust** in continuous operation	mbar	10	
Noise level	dB(A)	< 53	
Weight	kg	6.5 (ISO-K)	10.5 (CF-F)
Recommended primary pump		RVP, ACP 28, AMD	
Vibration level	mm/s	< 0.3	
Starting power	VA	250	
Nominal power	W	300	
Start-up time (0 to 42000 rpm)	min	< 3.5	
Cooling		Standard: natural convection Forced air: option Water: option	
Mounting orientation		any	
Intermediate port flange	DN	-	16 ISO-KF
Exhaust flange	DN	25 ISO-KF	

* Measured according to Pneurop Standard with CFF flange and RVP, after 48h in vacuum oven.

**The two maximum pressures cannot occur at the same time.

*** According to the intermediate port pressure.

Technical Specifications

Technical Data

Turbomolecular Pump	TURBOVAC	SL 80		SL 300		SL 700	
		63 ISO-K	63 CF	100 ISO-K	100 CF	160 ISO-K	160 CF
Inlet flange	DN	63 ISO-K	63 CF	100 ISO-K	100 CF	160 ISO-K	160 CF
Pumping speed							
N ₂	l/s	65		270		690	
Ar	l/s	60		260		630	
H ₂	l/s	49		190		580	
He	l/s	55		255		360	
Max. gas throughput with water cooling device							
N ₂	mbar l/s	2.0		2.9		5.6	
Ultimate pressure*							
with dual-stage oil-sealed rotary vane pump	mbar	< 2 x 10 ⁻¹⁰		< 1 x 10 ⁻¹⁰		< 10 ⁻⁹	
Max. foreline pressure for N ₂ , water-cooled version	mbar	< 20		< 8		< 15	
Recommended fore vacuum pump							
dual-stage oil-sealed rotary vane pump		TRIVAC 2.5 E		TRIVAC NT 5		TRIVAC NT 10	
		TRIVAC NT 5		TRIVAC NT 10		TRIVAC NT 16	
scroll vacuum pump		SCROLLVAC SC 5 D		SCROLLVAC SC 5 D		SCROLLVAC SC 15 D	
				SCROLLVAC SC 15 D		SCROLLVAC SC 30 D	
diaphragm pump		DIVAC 2.5 VT		DIVAC 2.5 VT		-	
Run-up time	min	1.5		4		5	
Power consumption at ultimate pressure	W	17		18		60	
Noise level	dB(A)	< 46		< 49		< 47	
Weight with TURBO.DRIVE	kg	2.5	3.7	5.8	8.0	14.8	18.1

* CF flange configuration

Specifying a turbo pump

- Pumping Speed:

- volumetric pumping: $t = -\frac{V}{S} \ln \frac{P_t}{P_0}$; about 2.3V/S sec/decade

- but surface degassing: $\frac{dP}{dt} = \frac{1}{V} \{-SP + Q(t)_{desorb} + Q_{leak}\}$

- ultimate pressure only linear with pumping speed
- vacuum is logarithmic!
- big turbos don't guarantee UHV!

Specifying a turbo pump

- Compression Ratio:

- compression ratio limit contribution to high vacuum pressure:

- $P_{comp} = P_{back}/R$

- so $P_{hv} = Q/S + P_{back}/R$

- backing pressure can have an impact on high vacuum pressure, especially when pumping light gases:
- high throughput turbos for high gas load applications;
- high compression turbos for UHV applications
- hybrid turbos have built in HV backing pump!

Specifying a turbo pump

- Cooling and motor power:
 - in high load applications look out for max continuous inlet pressure
 - can depend on type of cooling
 - for high throughput lookout for ramp up time and motor power

Summary

- Gas load applications:
 - eg. sputtering -
 - look for high throughput turbo
 - match application to flow vs inlet pressure curves
- High throughput applications:
 - fast cycle times -
 - look for high motor power and rapid ramp up
- UHV applications:
 - look for high compression esp. in H₂
 - high speed in H₂