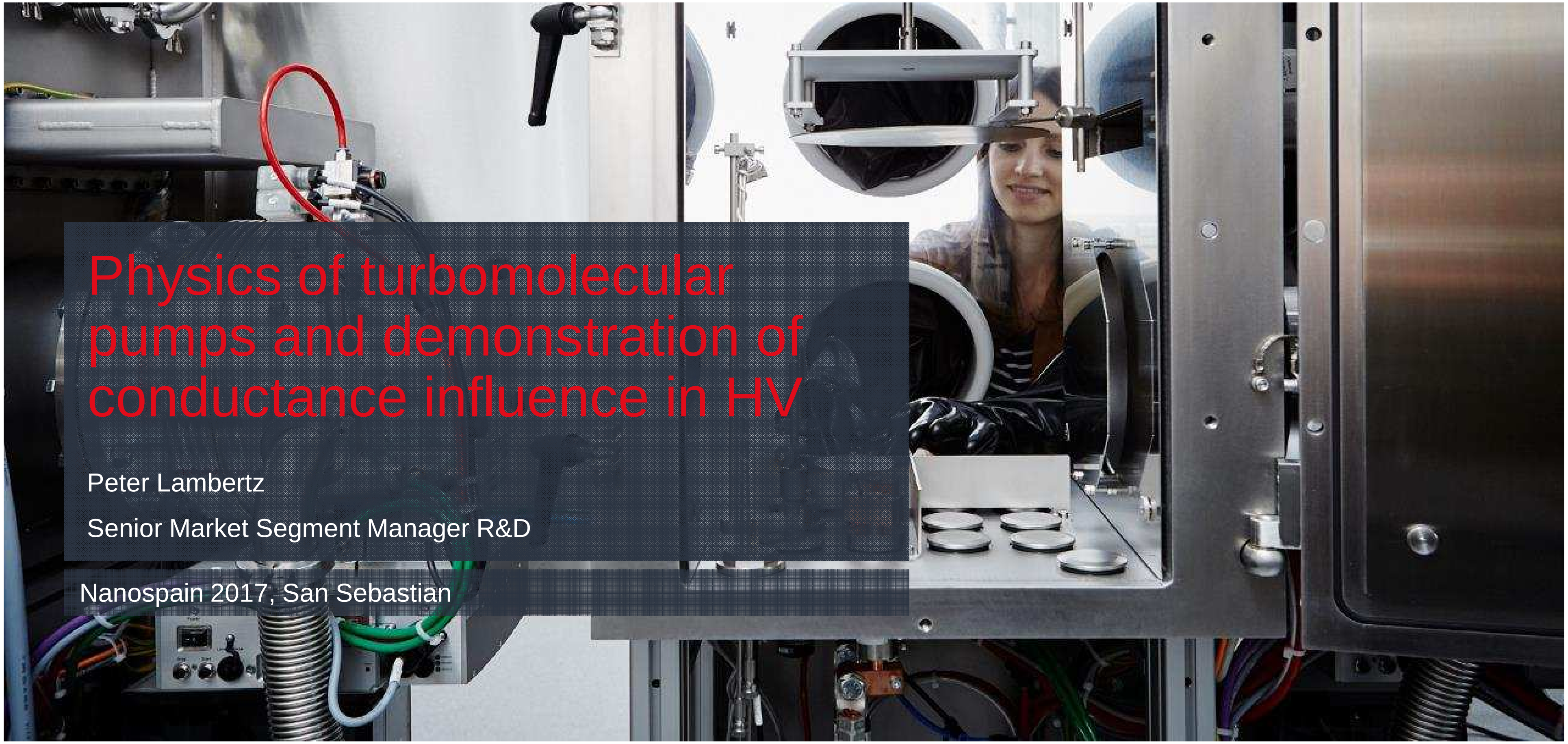

Physics of turbomolecular pumps and demonstration of conductance influence in HV

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Agenda

1	Basics of turbomolecular pumps
2	Key parameters of turbomolecular pumps
3	The operational diagram: The turbo's "ID card"
4	Conductance influence in HV
5	Summary

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Basics of turbomolecular pumps

Basics of turbomolecular pumps

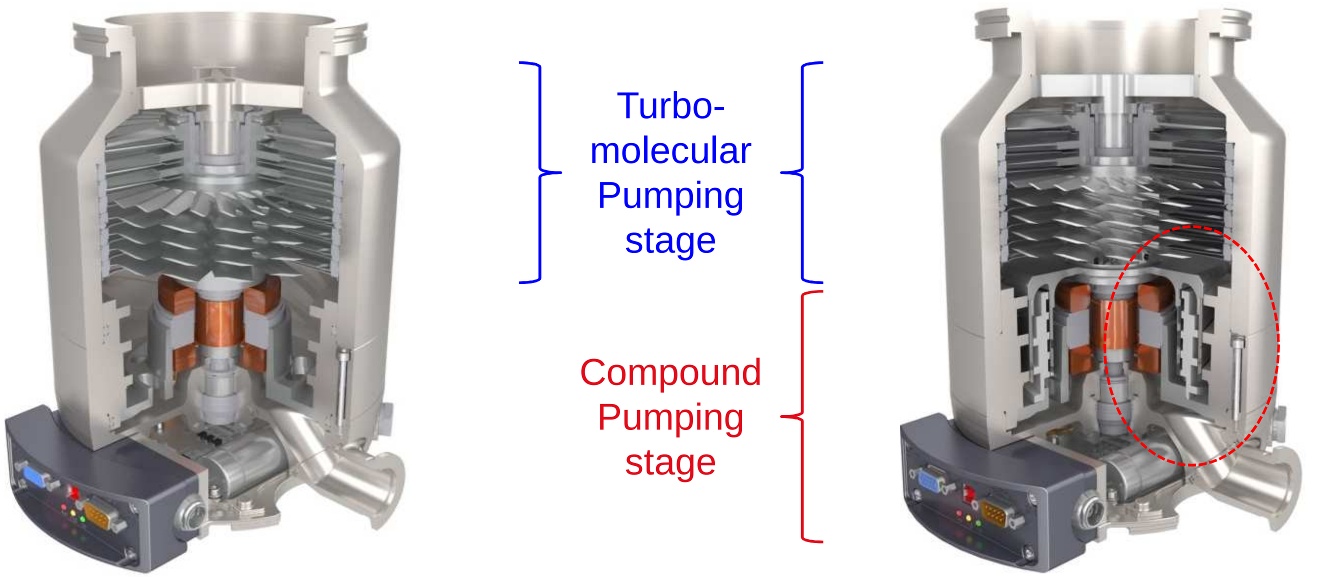
Turbomolecular Pump

- Kinetic vacuum pump
- High vacuum pump w/ typical operating pressures between 10^{-3} and 10^{-11} mbar
- Cannot compress against atmospheric pressure, i.e. a “backing pump” to further compress the gas to 1000 mbar
- Typical pumping speed sizes between 10 l/s and ~ 4000 l/s
- Main pumping principle: fast spinning rotor transfers momentum to gas particles in a molecular flow regime
- Typical rotor speeds: 500 – 1500 Hz (24000 – 90000 rpm)
- Technical challenges: rotor design, bearing concept (mechanical, magnetic, hybrid), safety

Basics of turbomolecular pumps

"Classic" turbo pumps and "Wide-range" turbo pumps

"Classic" Turbomolecular Pump	"Wide Range"



Pump containing only a Turbomolecular pumping stage

Pump containing a Turbomolecular pumping stage & Compound pumping stage

Agenda

Key parameters of turbomolecular pumps

TECHNICAL FEATURES

MAGiNTEGRA Magnetically levitated turbomolecular pumps		1600 iP(L) Booster	1700 iP(L)
Mounting orientation		any	
Inlet flange	DN	250 ISO-F / CF	
Pumping speed [l/s] (1)	N_2	1600	1650
Max. compression ratio (2)	N_2	10^7	10^8
Max. throughput [mbar l/s] (3)	N_2	60	40
Max. FV pressure [mbar] (4)	N_2	0,9	4

	Key Performance Indicators	
1	**Pumping Speed**	Maximum pumping speed at low backing pressures
2	**Maximum Compression Ratio**	Maximum compression (Inlet pressure/Outlet pressure) under no flow conditions (zero pumping speed).
3	**Maximum Throughput**	Maximum gas flow before the pumping speed starts to degrade by more than 10%
4	**Maximum Fore Vacuum (FV) Pressure**	Maximum exhaust pressure before pumping speed starts to degrade by more than 10%.

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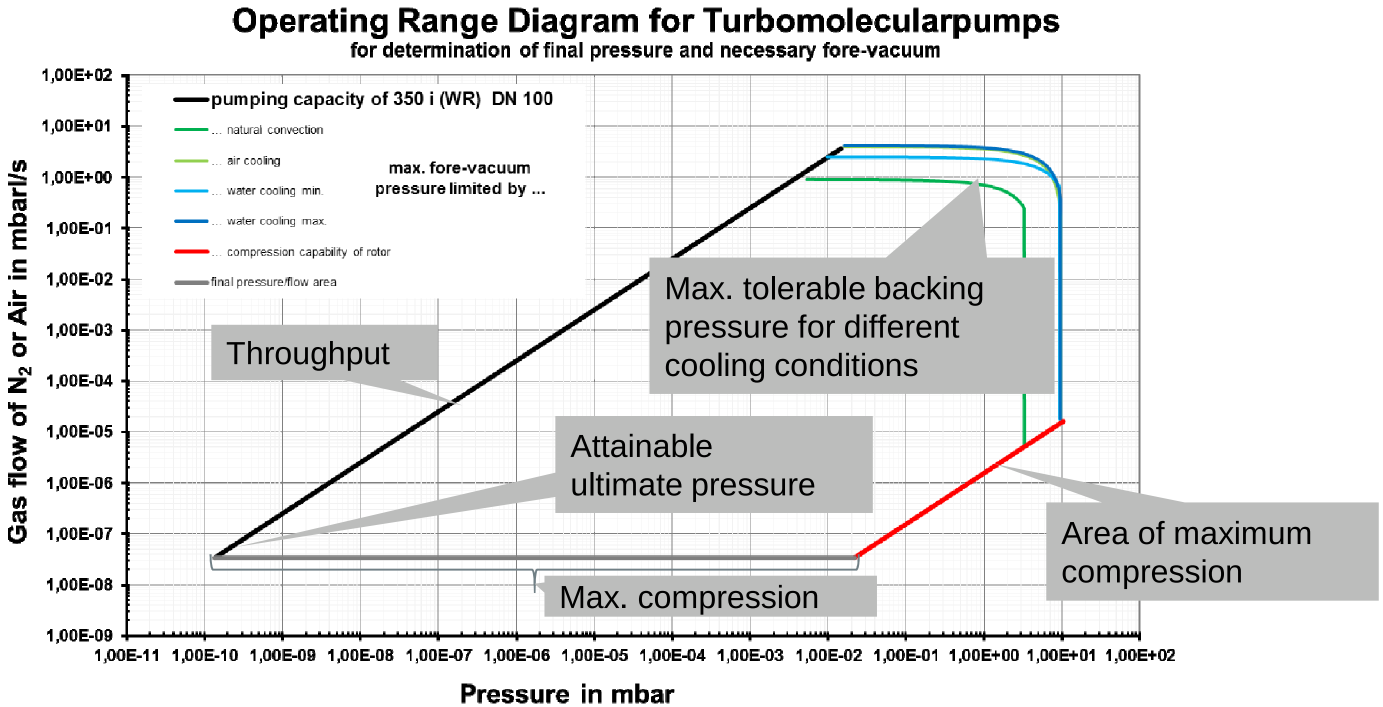
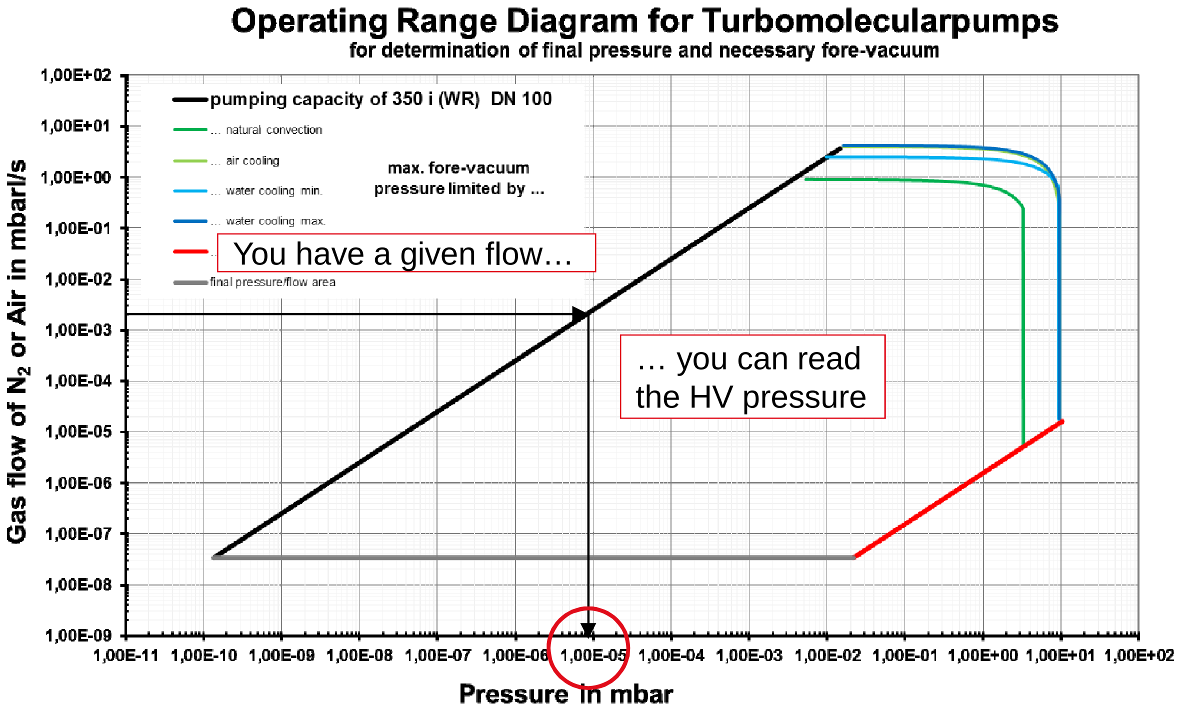
The operational diagram: The turbo's "ID card"

The Qp diagram cannot only show the throughput, but also other useful bits of information!



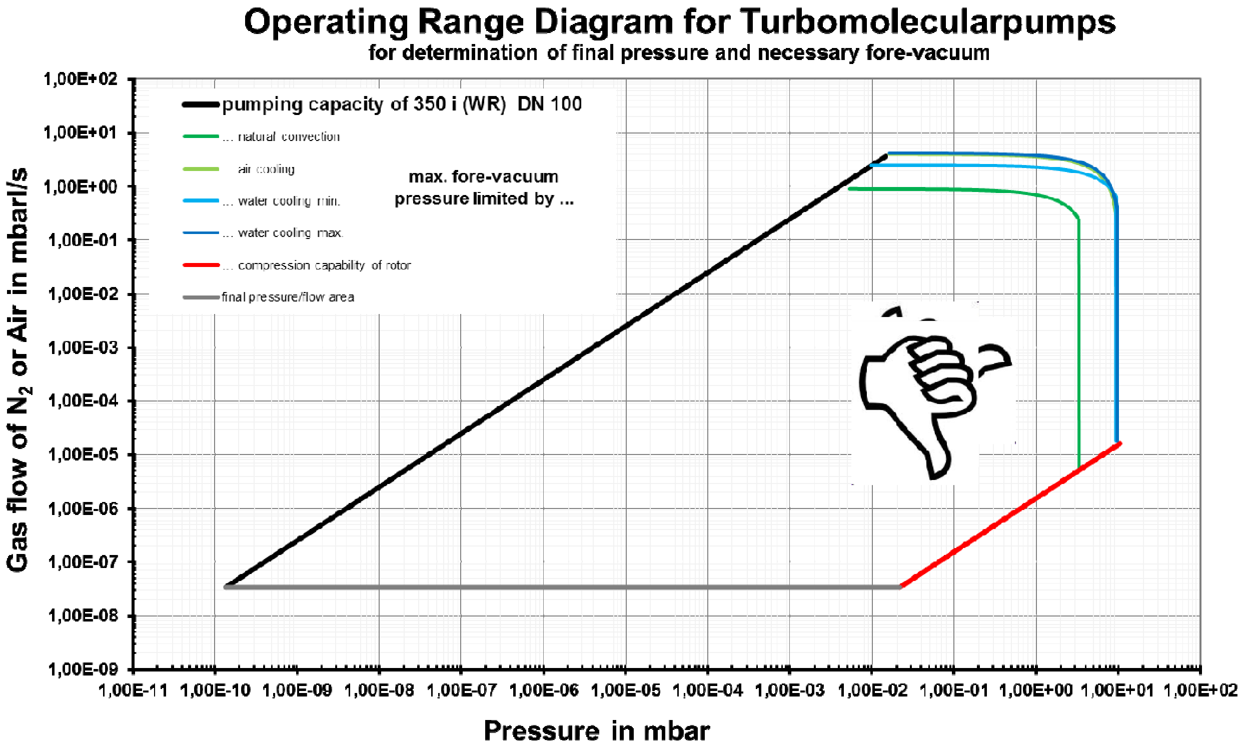
The operational diagram: The turbo's "ID card"

How to read and derive information from the Qp diagram



The operational diagram: The turbo's "ID card"

You learn if a certain backing pump is a suitable candidate



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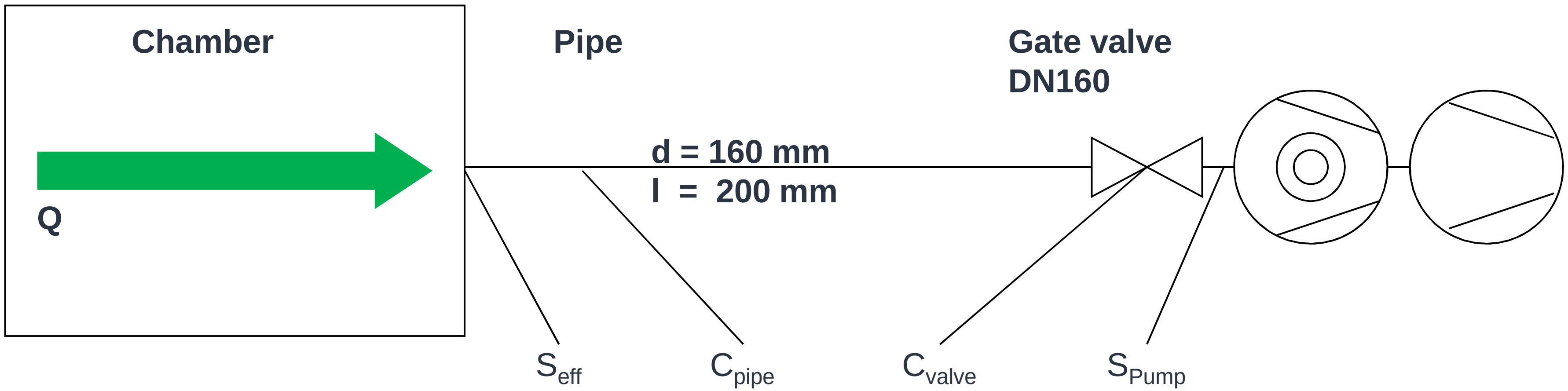
Conductance in HV- example calculation

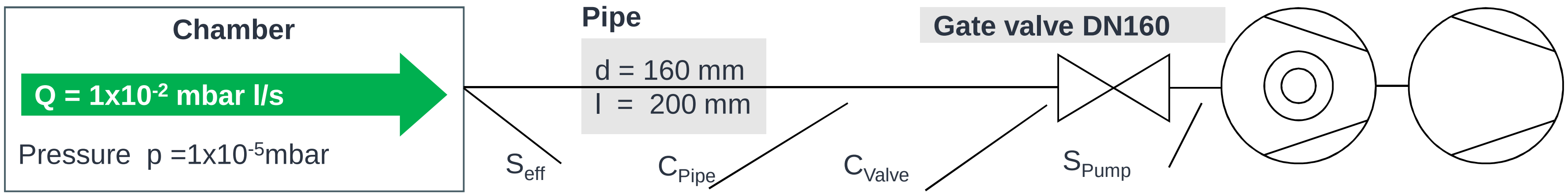
Influence of the suction pipe/Conductance



$$\frac{1}{S_{eff}} = \frac{1}{S_{pump}} + \frac{1}{C_{Pipe}} + \frac{1}{C_{Value}}$$

Conductance in HV – Example calculation

Example: Consideration of Conductance **(DN160)**



$$S_{eff} = \frac{Q(mbar\,l/s)}{p(mbar)} = \frac{1x10^{-2}\,mbar\,l/S}{1x10^{-5}\,mbar} = 10^{3}[l/s]$$

Conductance

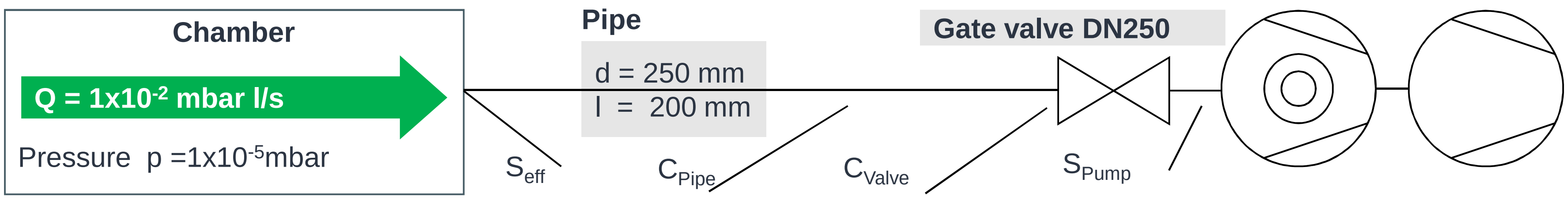
Pipe	DN160; 0,2m	C_{Pipe}	= 1768 l/s
Gate valve	DN160	C_{Valve}	= 6000 l/s

$$\frac{1}{S_{eff}} = \frac{1}{S_{pump}} + \frac{1}{C_{Pipe}} + \frac{1}{C_{Valve}}$$

$$S_{pump} = \frac{1}{\frac{1}{S_{eff}} - \frac{1}{C_{pipe}} - \frac{1}{C_{valve}}} = \frac{1}{\frac{1}{1.000} - \frac{1}{1.768} - \frac{1}{6.000}} = 3.735\,l/s$$

Conductance in HV – Example calculation

Example: Consideration of Conductance **(DN250)**



$$S_{eff} = \frac{Q(mbarI/s)}{p(mbar)} = \frac{1x10^{-2} mbarI/s}{1x10^{-5} mbar} = 10^{3}[I/s]$$

Conductance

Pipe	DN250; 0,2m	C_{Pipe}	= 5.278 l/s
Gate valve	DN250	C_{Valve}	= 22.000 l/s

$$\frac{1}{S_{eff}} = \frac{1}{S_{pump}} + \frac{1}{C_{Pipe}} + \frac{1}{C_{Valve}}$$

$$S_{pump} = \frac{1}{\frac{1}{S_{eff}} - \frac{1}{C_{pipe}} - \frac{1}{C_{valve}}} = \frac{1}{\frac{1}{1.000} - \frac{1}{5.278} - \frac{1}{22.000}} = 1.307 I/s$$

Agenda

Summary – Rules for working in HV conditions

Basic rules to obtain low pressures and fast pump down times

- Minimize surface area inside chamber
- Use materials with low desorption rates
- suitable pre treatment of materials (e.g. electro polishing)
- no internal gaps or trapped volumes
- heating or cooling of chamber surfaces
- reduction of sealings, feedthroughs etc.
- Sufficiently high installed pumping speed with high connection conductance:
  - Minimise pipe length
  - Maximise diameters
  - Avoid valves, ellbows, reducers etc
  - Use components with smooth (ínner surfaces)

Thank you for your attention!