Stepless Reverse Flow Control

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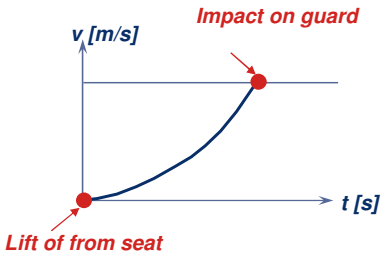
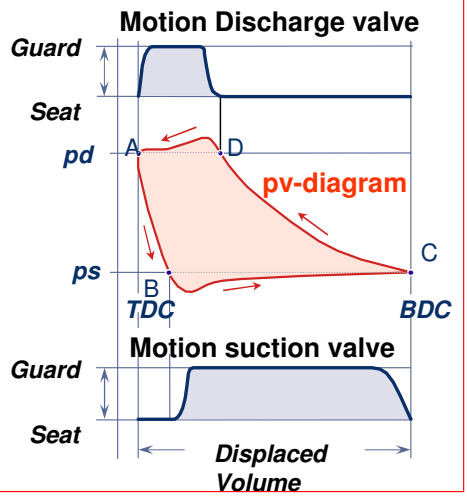
  - Rotary valves

Valve Motion at Full load

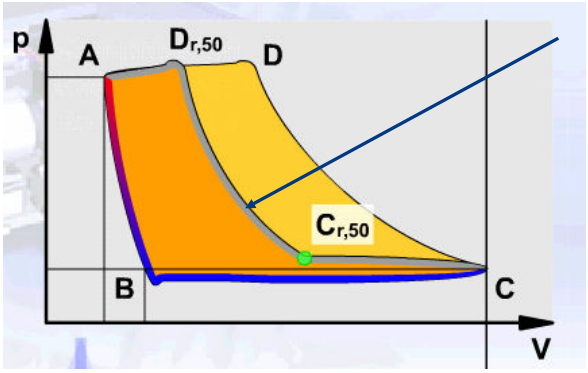
pV and lift diagram of valve sealing element:



v ... Velocity
t ... Time



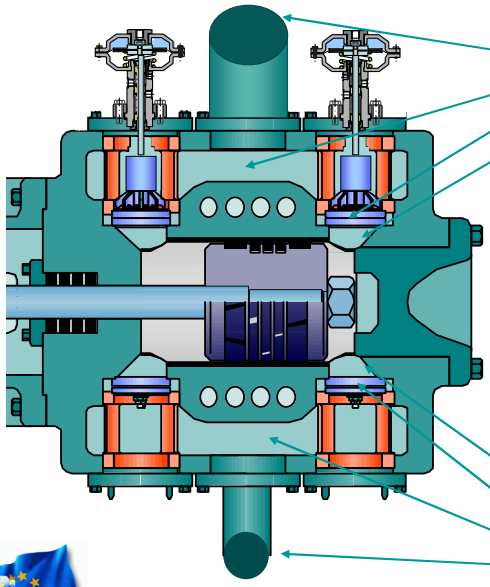
Reverse Flow Principle



The start of compression is delayed. Part of the gas sucked in during suction stroke is pushed back.

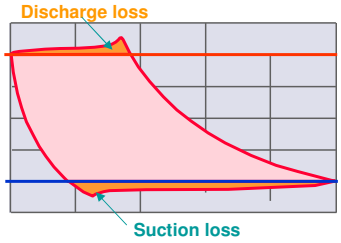
Area enclosed by pV graph is equivalent to the energy consumed.

Valve losses at full load



Suction losses caused by:

- *Piping*
- *Suction chamber*
- *Suction valve*
- *Valve nest*



Discharge losses caused by

- *Discharge valve nest*
- *Discharge valve loss*
- *Discharge chamber*
- *Piping*

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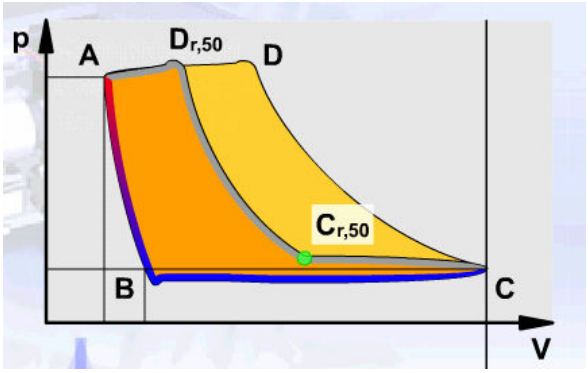
Valve losses at reverse flow

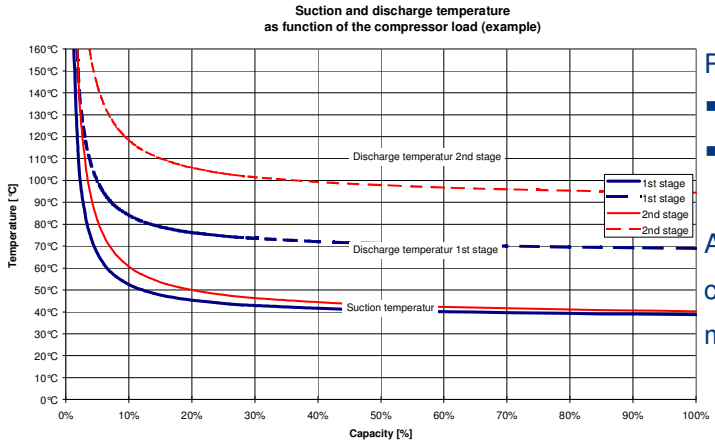


The losses at 50% part load are:

100% suction valve loss
50% reverse flow loss
50% discharge loss

Approx. same loss as at full load, but reduced capacity

Temp. increase at reverse flow



Power loss generates heat:

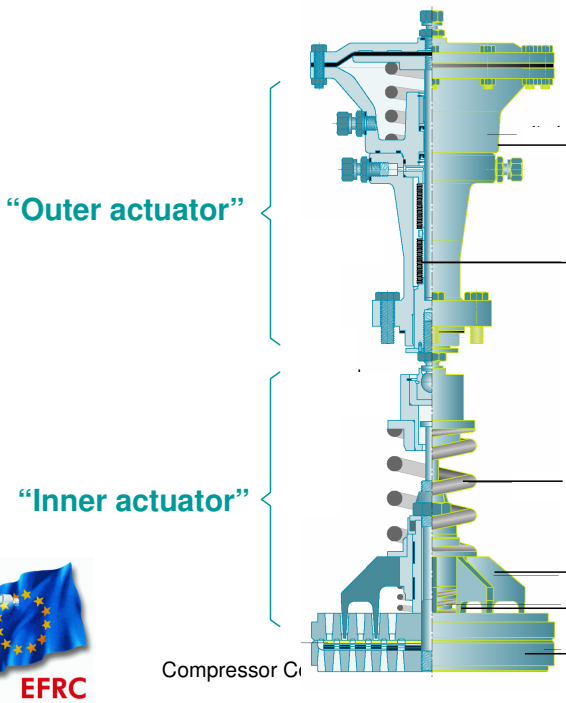
- Suction temp. increase
- Discharge temp. increase

At 0% load the compressor can be operated for 5 to 15 minutes.

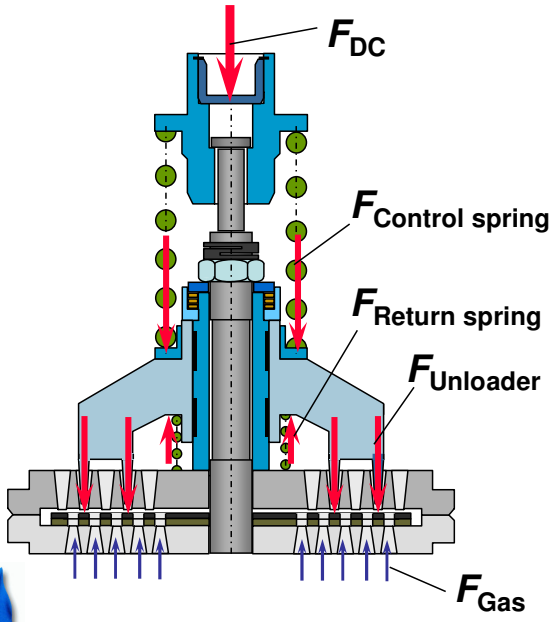
Systems based on reverse flow principle

- Pneumatic control systems

Components of a pneumatic actuator



Principle of Operation



- Unloading force acts via control spring to unloader fingers
- Suction valve plate is forced to remain open
- If reverse gas flow exceeds unloader force the valve closes

  $F_{Gas} > F_{Unloader}$
- The valve snaps open if unloader force exceeds the max. gas force

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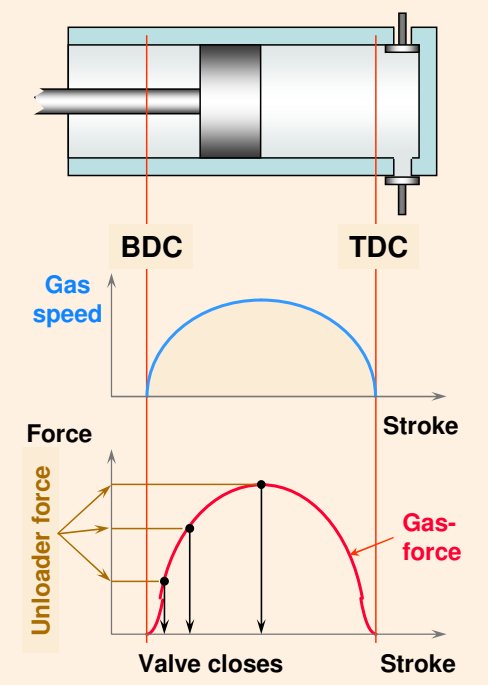
Theoretical Background



- Valve closes if

$$F_{Gas} > F_{Unloader}$$

- Gas force

$$F_{Gas} = \zeta \cdot \rho \cdot \frac{v_{Gas}^2}{2} \cdot A_O$$

Closing time of the valve plate depends on:

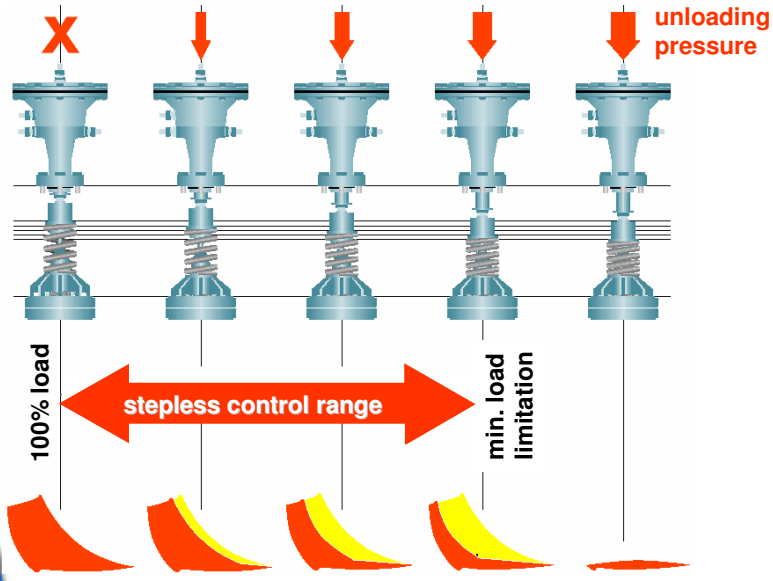
-- piston speed

$$v_{Gas} \sim v_{Piston}$$

-- gas density

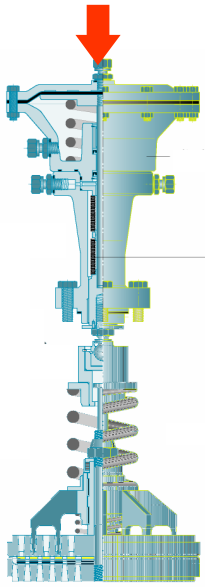
$$\rho = \frac{1}{R} \cdot \frac{p_{suct} \cdot M}{T_{suct}}$$

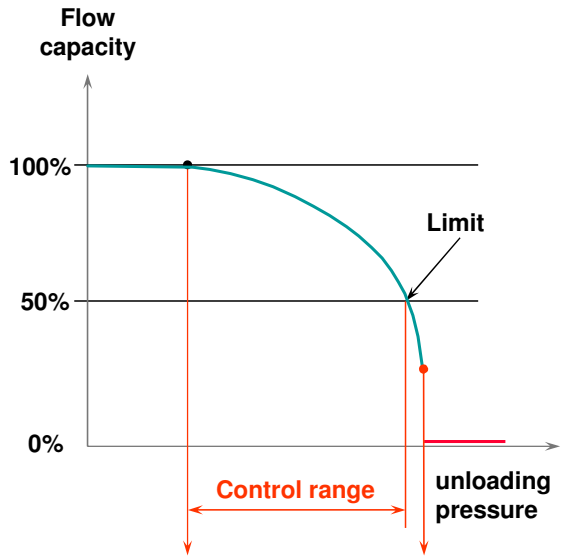
Unloading Pressure - Load



effects on pV-diagram

Unloading Pressure - Load





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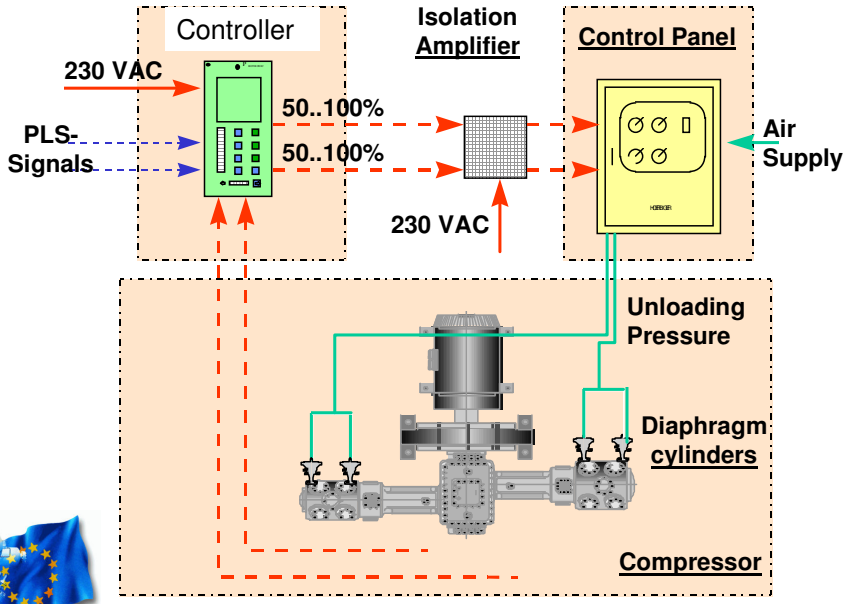
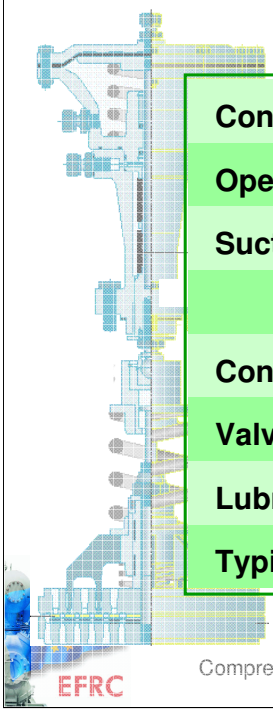
The Pneumatic System



Pneumatic System - Application Range

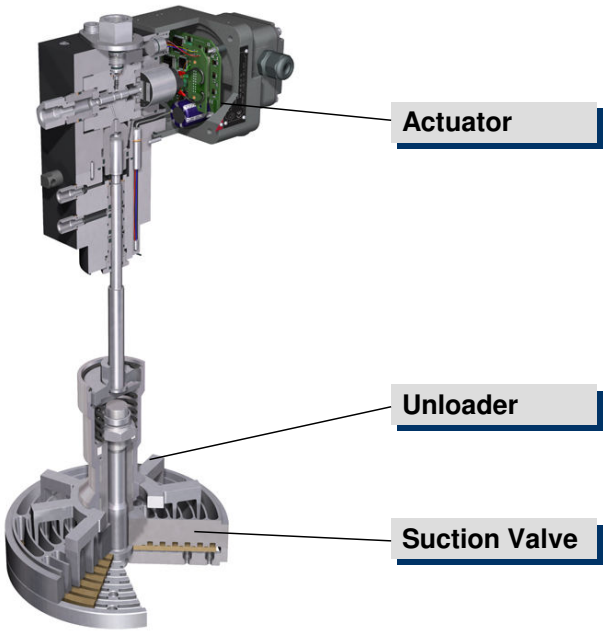


Control range	100% ... 50%
Operational conditions	constant
Suction pressure	up to 60 bar
Control	electronically
Valve plate material	Steel pref.
Lubrication	lube
Typical applications	Process industry

Systems based on reverse flow principle

- Hydraulic/Electronic systems

Components of HydroCOM Actuator



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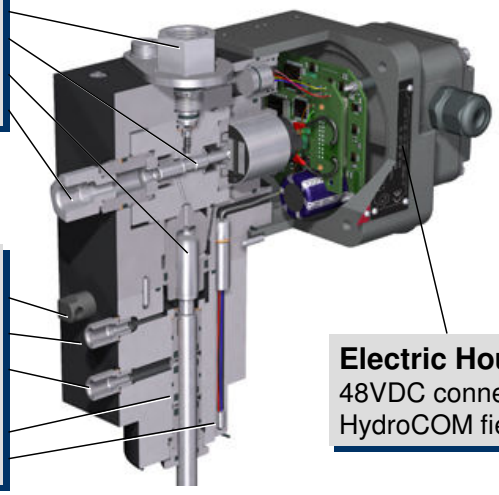
Components of HydroCOM Actuator

Valve Housing
Oil inlet
Solenoid valve
High pressure piston
Oil outlet

Seal Housing
Vent
Leakage oil
Flare line
Optional: Seal gas
Sealing elements
Temperature sensor



Electric Housing
48VDC connection
HydroCOM field bus

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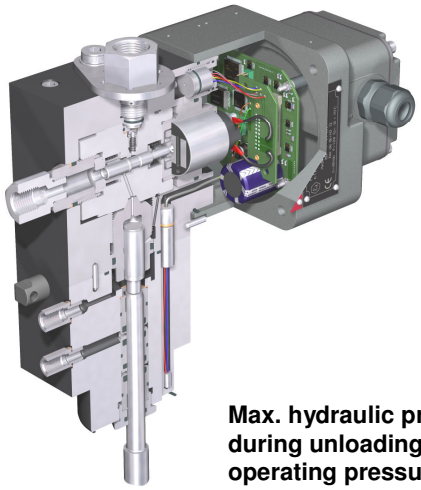
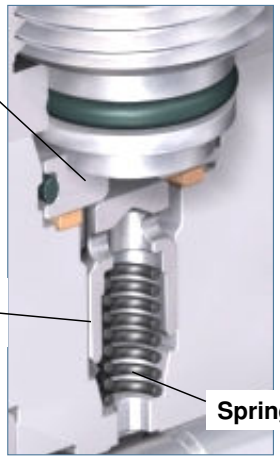
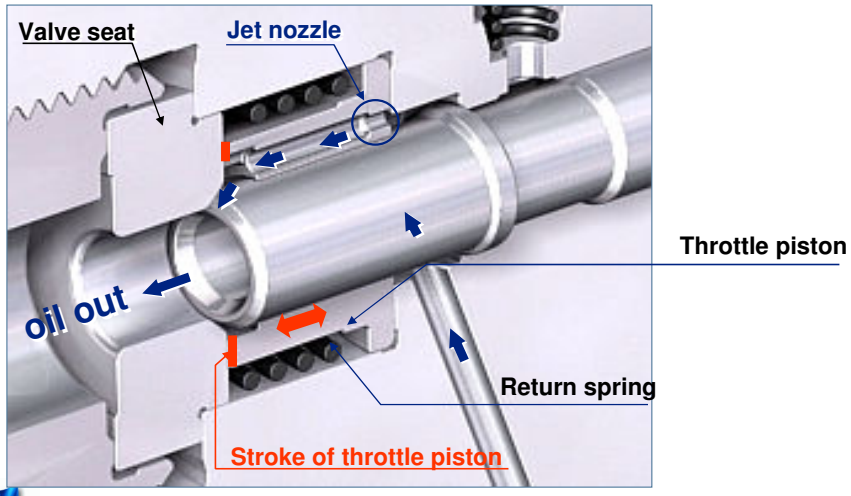
Valve housing – Check valve





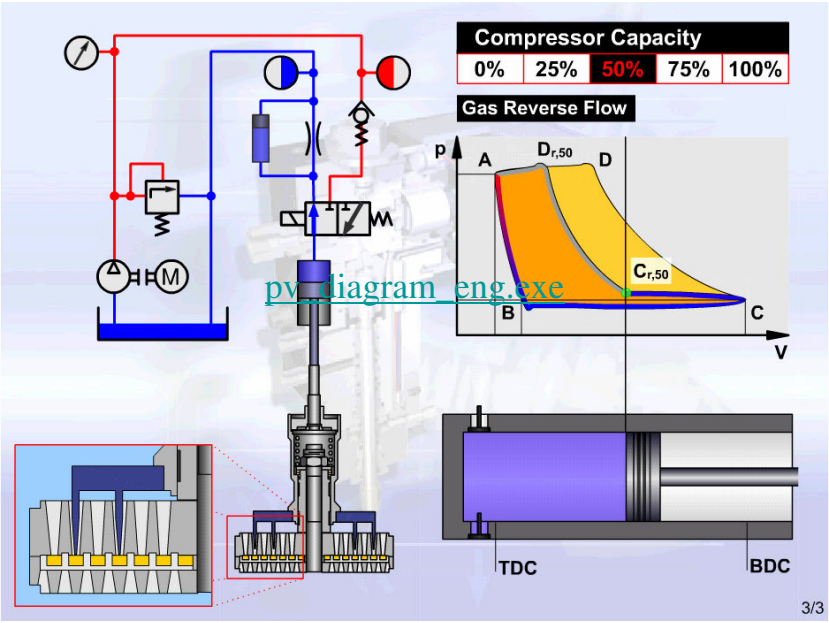
Max. hydraulic pressure in actuator during unloading > hydraulic unit operating pressure
=> Check valve integrated

Valve housing – Soft touch damper

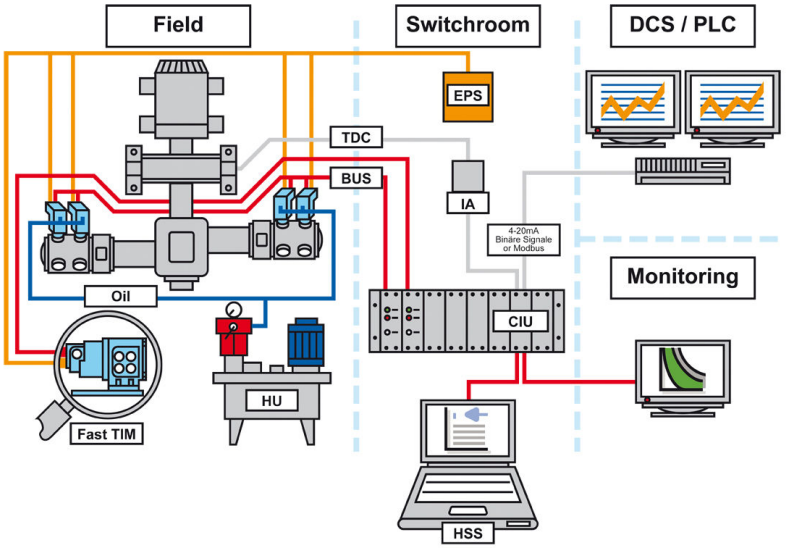


Components of HydroCOM Actuator

Working principle



HydroCOM System Layout



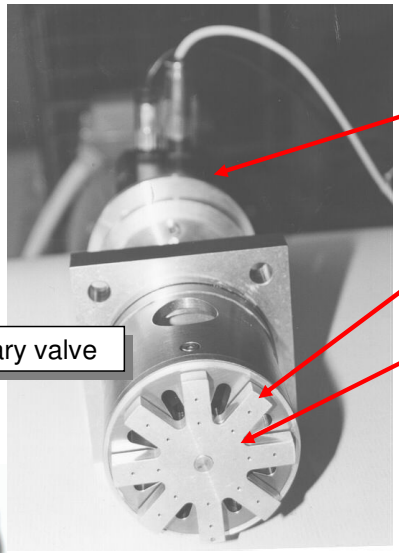
HydroCOM Application Range

Control range	(0..) 10*...100%
Max. suction pressure	160bar
Max. suction temperature	120°C
Max. compressor speed	1200 rpm
Non-lube, corrosive gases	yes
Suction valve sealing element	ring, plate
Gases	All, except O_2 + acethylen
Ex-certification ATEX, Japan	ExII 2G EEx de IIB + H2 T4
Ex-certification Canada (CSA)	Class I, Div.1, Gr. A, B, C, D
Ex-certification US (FM)	Class I, Div.1, Gr. B, C, D, T4 AEx d,e IIB + H2 T4

Systems based on reverse flow principle

- Rotary valve

Rotary Valve



Rotary valve

Electronic driver

Valve seat

Valve guard => rotor + sealing element

Rotary valve requires active valve control;