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2.0 General Information

2.1 General description

2.1.1 General description TopGear

TopGear is the name for Johnson Pump's wide of new generation of positive displacement pumps based on the Internal Gear principle.

TopGear - a long way gone

In 1904 Jens Nielsen created the first internal gear pump to evacuate seepage water out of his stone quarry. The pump that Jens had in mind must do the job with little maintenance and with the pump installed at dry floor level. He found only the internal gear principle efficient and strong enough. Many manufacturers have built pumps on this principle.

The Swedish company Albin Pump developed the RB series and started production in 1936. Stork, a Dutch holding company, began to manufacture the RT series in 1946 under license from the Danish Myhrwold and Rasmussen company and in 1980 the SRT series became their own designed gear pump.

Johnson Pump is now the legal heir of these products (RB and SRT) and can be proud to look back at more than 60 years of experience of developing, manufacturing and distributing internal gear pumps. Johnson Pump will continue the efforts, they put into viscous liquid transport, with their new generation working horse TopGear pumps.

Internal Gear Principle

The internal gear principle is designed to be the working horse of positive displacement pumps for viscous liquid transport. The pump "gear within a gear" principle is really quite simple, compact and robust.

Two gears, different in size, the smallest gear placed excentrically inside the bigger gear, mesh at close tolerance to push liquid through under pressure. There are only two moving parts, and only one shaft has to be sealed. The liquid streams steadily through the pump with only low pulsations. The pump can be reversed in flow direction.

Applications

Thanks to the ingenious design a wide range of high or low viscous liquids can be handled. The TopGear pumps are self priming and are used in a variety of industrial fluid handling applications such as:

- Oil and oil additives
- Paints, printing inks, lacquers, resins and adhesives
- Bitumen, asphalt and coal tar
- Foodstuffs, chocolate and sugar syrups
- Animal feedstuffs, molasses and fats
- Soaps and detergents
- Pulp and paper additives
- Chemical liquid products
- Isocyanates and polyols

Market position of 3 ranges

The TopGear series consists of 3 ranges that are complementary to each other and focused on different market domains.

L-range

- Simple design with floating rotor and shaft designed for easy applications.
- Low budget priced.
- Covering the old RB series of the Albin pumps.

G-range

- More complicated design and options designed for general purpose heavy duty applications.
- Covering the cast iron pumps of Stork old SRT-and SRTM-series.

H-range

- High-end heavy duty design. Apply to API 676.
- Designed for high demanding applications within chemical, petrochemical and general industry with a variety of materials and options.
- Covering the old Stork SRTM-series except cast iron pumps.

2.1.2 General description TopGear/H-range

- 9 sizes offering up to 130 m³/h.
- Viscosity up to 80000 mPa.s.
- Pump casing materials: Stainless steel, carbon steel and ductile iron.
- Bare shaft pumps with in line port connections.
- Shaft trust on bush bearing inside and ball bearing outside the liquid.
- Heavy duty construction and extended modular design.

Strengths

Focused on high-end applications of chemical, petrochemical and high demanding industry.

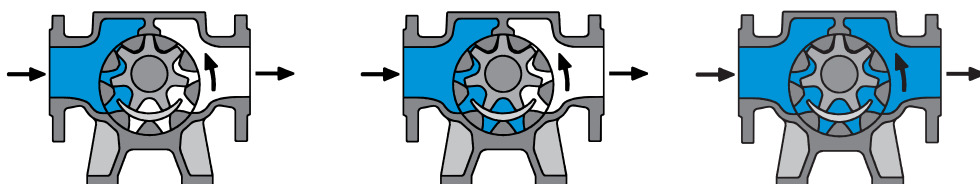
Multi optional design: Pumps are build and required on available features and options.

2.2 Operating principle

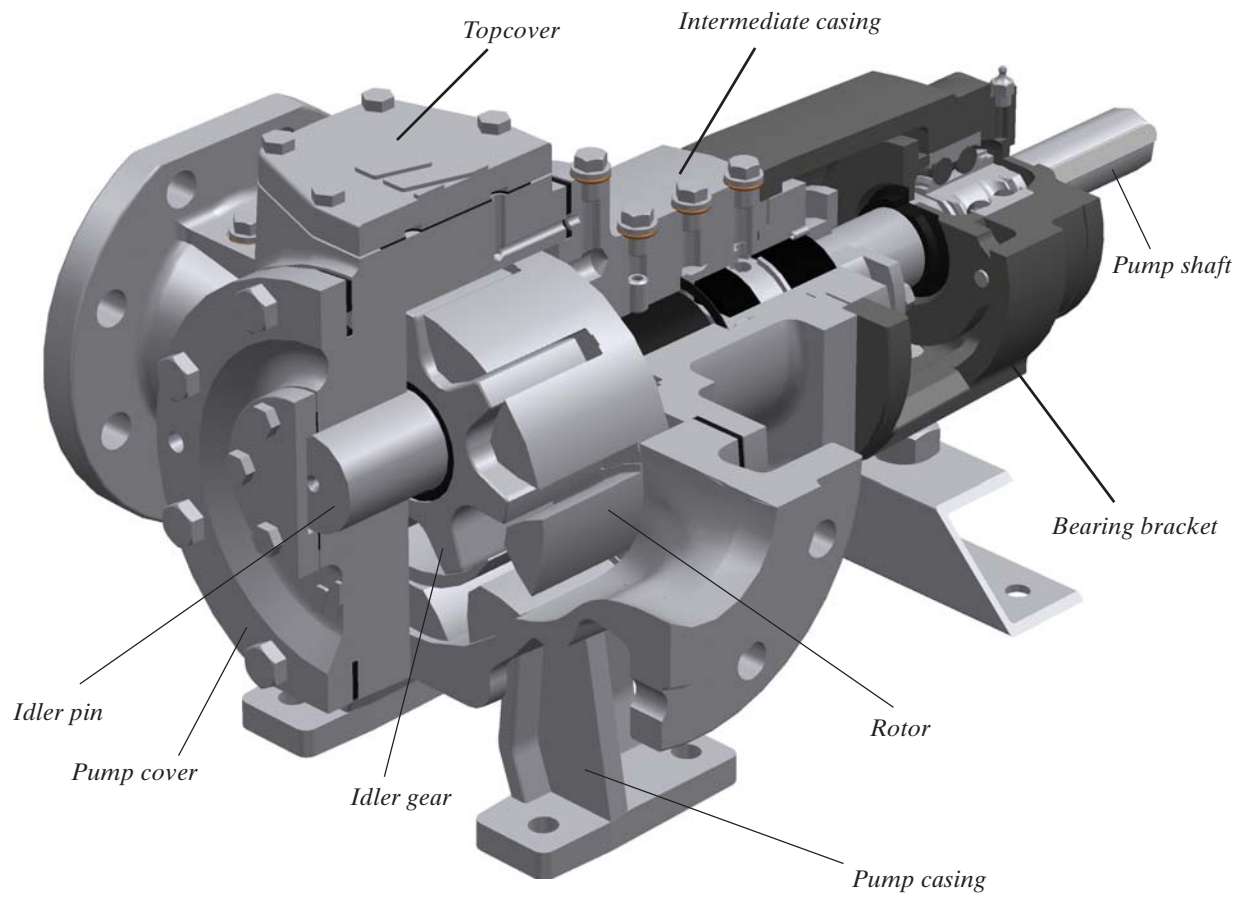
As the rotor and the idler gear unmesh, an underpressure is created and liquid enters the suction port. The liquid is transported in sealed pockets to the discharge side. The pump housing walls and the crescent create a seal which separates the suction side from the discharge side. The rotor and the idler gear mesh and the liquid is being discharged into the discharge line.

- When reversing the shaft rotation the flow will reverse through the pump as well.
- There are only two parts moving - the rotor and the idler gear.

Regarding the standard parts of the pump, see section 2.3.



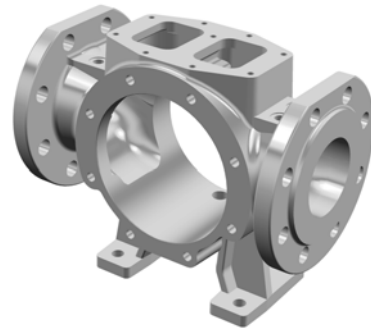
2.3 Pump standard parts



2.4 General pump programme in 4 modules

1. Pump casing with integral feet and in-line ports

Pump casing can remain installed in the pipe system during inspection and repair of rotors and shaft seal.



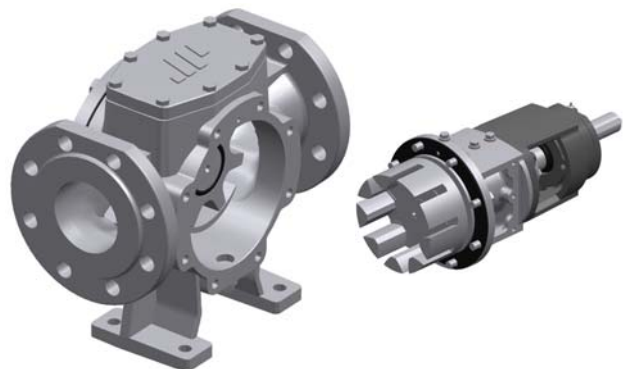
2. Front pull-out module

The total front, i.e. idler, cover and pin, can be removed for easy inspection of internal and for repair.



3. Back-pull out module

The total rotor with shaft, intermediate casing with rotor bearing, shaft seal and bearing bracket can be removed for easy inspection, repair and shaft seal replacement.

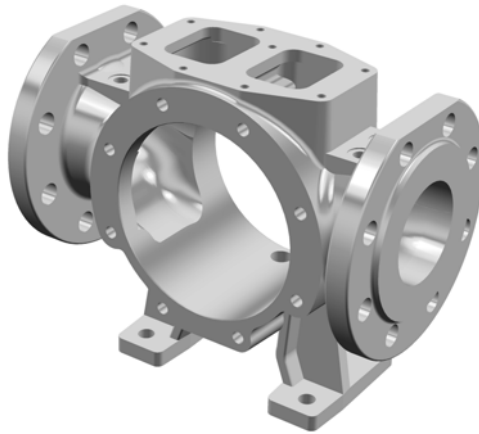


4. Top pull-off relief valve

The pre-assembled and pressure-set safety relief valve can be removed for inspection, repair, and if direction of rotation or pressure changes are required.



2.4.1 Pump casing



Features

Pump casing

- Horizontal in-line ports above centerline
- Integral feet under the pump casing
- Big ports
- Several PN flange connections available
- Manometer connections on both flanges
- Filling, venting and drain plugs provided
- Several material options

Benefits

- Liquid remains in the pump for next start-up
- Freely thermal expansion towards the rear
- Allows connection of wide pipe diameter size
- Lower pipe velocity and pressure losses
- Good NPSH performance possible
- Easy operational control and inspection

2.4.2 Front pull-out module



Features

Pump cover with pin

- Big cavities at in- and outlet
- Fixed pin by means of interference fit
- Several pin material options available

Benefits

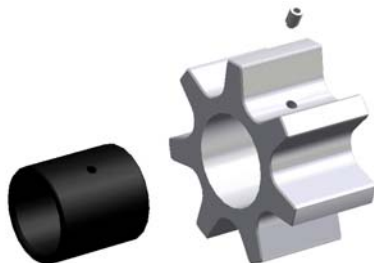
- Axial liquid entrance between displacement gears improves NPSHr
- Possibility to choose the right pin materials needed for the application



Idler with bushing

- Unique teeth profile
- Large pin and bush diameter
- Several material options

- Allows low and high viscous media
- Hydrodynamic lubrication by the pumped liquid possible to limit bush-pin wear
- Possibility to choose the right materials needed for the application



Features

Frontcover with heating jacket design

Add-on heating jacket front cover with several type of connection options:

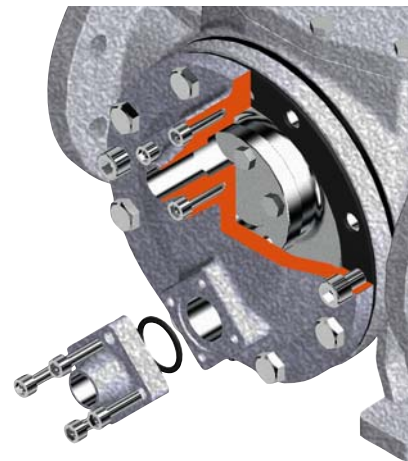
- Steam version with thread connections (S-jacket)
- Thermal oil version with flange connections and ductile materials meeting DIN4754 safety regulations (T-jacket)

Benefits

- Heats pump casing, internals and relief valve body
- Allows safe start-up and shut-down procedures
- Allows to bring the pump to the right temperature when the liquid solidifies or has too high viscosity at start-up, shut-down and emptying of the pump
- Possible to add the jacket cover later without changing the main pump parts when heating seems to be needed



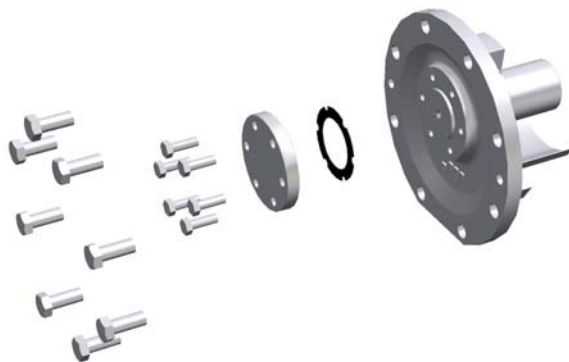
Front cover with S-jackets



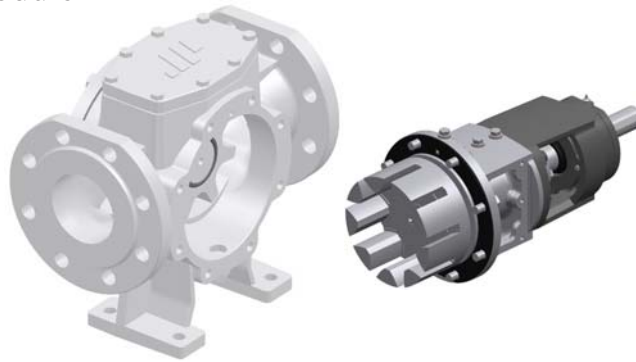
Front cover with T-jackets

Idler pin cover design

- Extra sealed pin cover
- High temperature design – strong bolting and wall thickness of cover
- Secure the tightness between pump internal and heating jacket at extreme temperature and pressure



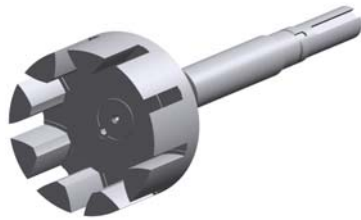
2.4.3 Back pull-out module



Features

Rotor and pump shaft

- Unique tooth profile and strong rotor teeth
- Strong rotor and shaft fixation by means of interference fit
- Strong shaft provided by diameter steps
- Several material options

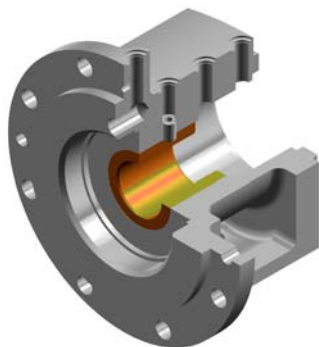


Benefits

- Allowing high viscous liquids
- High torque and radial force allowed even at high temperature and standard clearances
- Easy assembling of shaft seals without risk to damage elastomers
- V-belt drive possible
- Possibility to choose the right materials needed for the application

Intermediate casing with bush bearing

- Modular design of intermediate casing
- Several material, jacket and shaft sealing options
- Internal bush bearing close to the radial force of the rotor
- Big diameter of the bush inside the liquid
- Many plug openings provided
- Possibility to choose the right materials needed for the application
- Hydrodynamic lubrication by the pumped liquid possible to limit bush shaft wear
- Plug openings facilitate filling and venting and could be used for external liquid circulation and flushing



Features

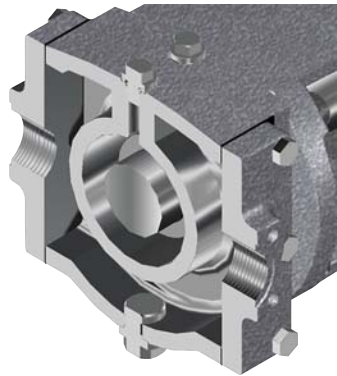
Benefits

Heating jackets around the shaft seal option

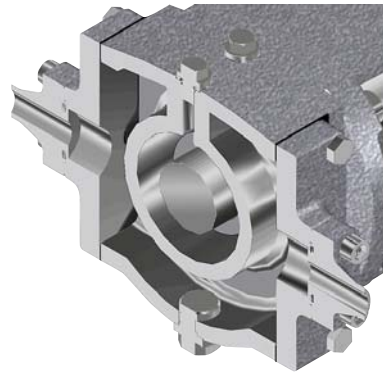
Add-on heating jacket cover with several type of connection options:

- Steam version with thread connections (S-jacket)
- Thermal oil version with flange connections and ductile materials meeting DIN4754 safety regulations (T-jacket)

- Heats internal of pump at rear, bush bearing and shaft seal
- Possible to create a temperature gradient towards the shaft seal (cooling or heating)
- Allows safe start-up and shut-down procedures
- Allows to bring the pump to the right temperature when the liquid solidifies or has too high viscosity at start-up, shut-down and emptying of the pump
- Possible to add the jacket covers later without changing the main pump parts when heating seems to be needed



Shaft seal with S-jackets

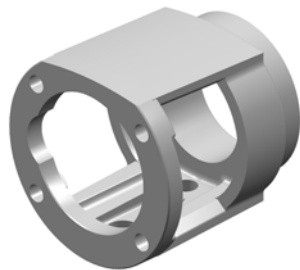


Shaft seal with T-jackets

Features

Bearing bracket with ball bearing and extra support

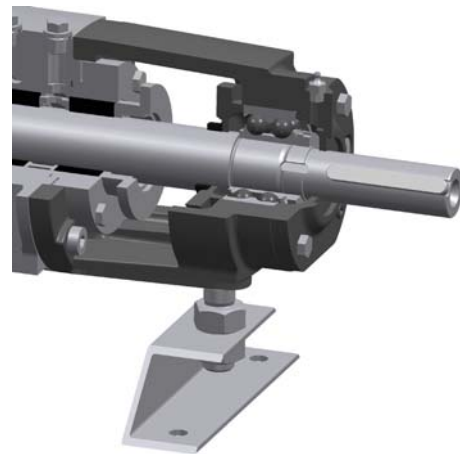
- Bracket provided by threaded drain opening
- Bracket support flexible in axial direction but radially stiff
- System to adjust axial internal pump clearance
- Strong double row ball bearing locks rotor axially
- Metal cage ball bearings at bigger pump sizes (for technical details, see Chapter 5.0)
- Regreasing nipples provided for bigger pump sizes
- Strong general design



Bearing bracket

Benefits

- Drain opening allows evacuation of shaft seal leakage fluid
- Extra support allows axial thermal expansion and V-belt driving
- Readjusting axial clearance and compensating axial wear possible
- High ball bearing life time cycle
- Easy maintenance and relubrication



Rolling bearing design on intermediate casing with bracket support

Modular shaft seal system (for available options see following Chapter 2.4.4)

- The wide opening in the intermediate casing allows several type of shaft seal
- Specific parts are of stainless steel and interchangeable within models
- Several auxiliary connections possible according to API-plan and ISO-code
- Wide application range
- High interchangeability between models and some sizes
- Short downtimes (combined with back-pull-out)
- Corrosion resistant
- Easy operational control and inspection

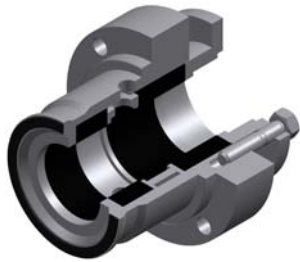


2.4.4 Shaft seal options

Features

Packed gland

- Pre-assembled cartridge
- Several packing ring material options
- Option with or without lantern ring
- Lantern ring connections via plug openings in intermediate casing



Benefits

- Easy maintenance and repair
- Packing rings can be replaced in place
- Choice of packing ring material in function of the application
- Easy access of lantern ring connections
- Single or double connection flushing over the lantern ring possible
- Pressure release over the lantern ring possible

Single mechanical seal

- Big housing diameter around the mechanical seal
- Conical shape of the seal cover
- Fully mounted inside the intermediate casing
- DIN 24960 short (KU) or long (NU)
- Circulation connections provided via intermediate casing close to the sliding faces

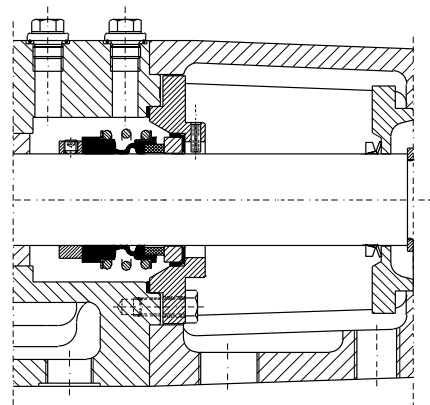


Single mechanical seal, MG12



Single mechanical seal, M7N

- Improved design for viscous media and media containing fine solids such as pigments
- Plenty of space around the seal is an opportunity for viscous liquids
- Solids are moved away from the sealing faces by the conical shape of the cover
- External circulation, if applied, improves performance and lubrication of the seal faces
- Can be cooled or heated by means of the jacket option at the intermediate casing
- Quick access for maintenance and service



Single mechanical seal, MG12, built-in

Features

Double mechanical seal

Short DIN24960 KU mechanical seals (2 seals assembled):

- In tandem arrangement – non-pressurised
- In back-to-back arrangement – pressurised

Cartridge mechanical seal

- The wide opening in the intermediate casing allows several type and make of cartridge mechanical seal
- Cartridge seals are pre-mounted and tested in advance

Cartridge seals offer advanced shaft seal options e.g.

- Balanced type mechanical seal (single and double)
- Dynamic loaded springs at static side outside pumped medium
- Steam or liquid quenched single cartridge seal
- Liquid or gas lubricated double seal for zero-emission operation
- Safe double seal with several features and operational functions:
 - non-pressurised acts as a tandem seal
 - pressurised acts as a back-pull-out seal
 - integrated pump design for circulation of quench fluid
- API-alike functions and design features

Benefits

- Double seals can improve shaft seal performance and security
- High viscosity and abrasive duty possible with back-to-back configuration
- Allows the right choice of shaft seal needed for the application
- Separately tested item ensured good shaft sealing operation
- Easy to assemble and to replace in situ
- Minimum time for maintenance and service
- Improves environment, failure and life cycle costs



Cartridge seal with trottle bush (TE3)



Cartridge seal with lipseal (QE3)



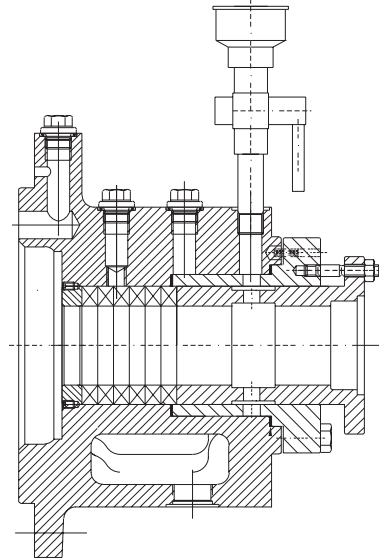
*Cartridge seal –
Double seal arrangement (DE3)*

Features

Benefits

Reverted packing version (chocolate execution)

- Combined gland bearing bush outside pumped medium
 - External grease lubrication of bearing bush
 - Often combined with extra internal clearances
- Special applications such as chocolate pumping



2.4.5 Safety relief valve – “Top pull-off” module



Features

Safety relief valve

- Mounted on top of the pump
- Horizontal or vertical according to pump size
- Double safety relief valve available (2 single valves mounted in opposite)
- Heated relief valve available (spring heated)

Benefits

- Protects the pump and installation against excessive overpressure
- Top mounting allows heating jacket on the pump casing at front (some competitors cannot)
- Double safety relief valve protects both flow directions through the pump



Single safety relief valve



Heated relief valve



Horizontal safety relief valve



Double safety relief valve

2.4.6 Gaskets

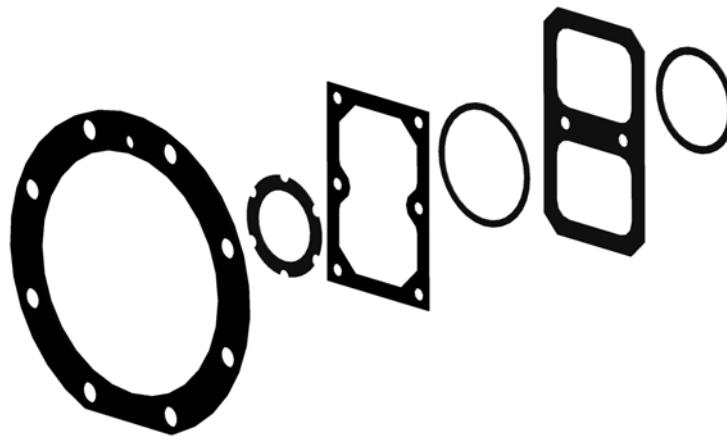
Features

Benefits

Graphite flat gasket

- On pump casing and relief valve
- On jackets (no more elastomer O-rings!)
- On shaft sealing covers

- Asbestos free
- Resistant to high temperature
- Good chemical resistant
- Remain excellent elasticity
- Not penetrant for thermal oil
- Excellent heat conductivity



Plugs with flat gasket

- All plugs often opened for maintenance
- Gaskets on stainless steel pumps are of reinforced PTFE (Gylon material)
- Gaskets on other than stainless steel pumps are of metal envelope with core of asbestos free elastic packing material

- Asbestos free
- Allows high temperature sealing
- Good corrosion resistance
- Less creep then pure PTFE (max. 250°C)
- Allowed for 300°C
- Metal envelope protects the elastic core mechanically against torsion



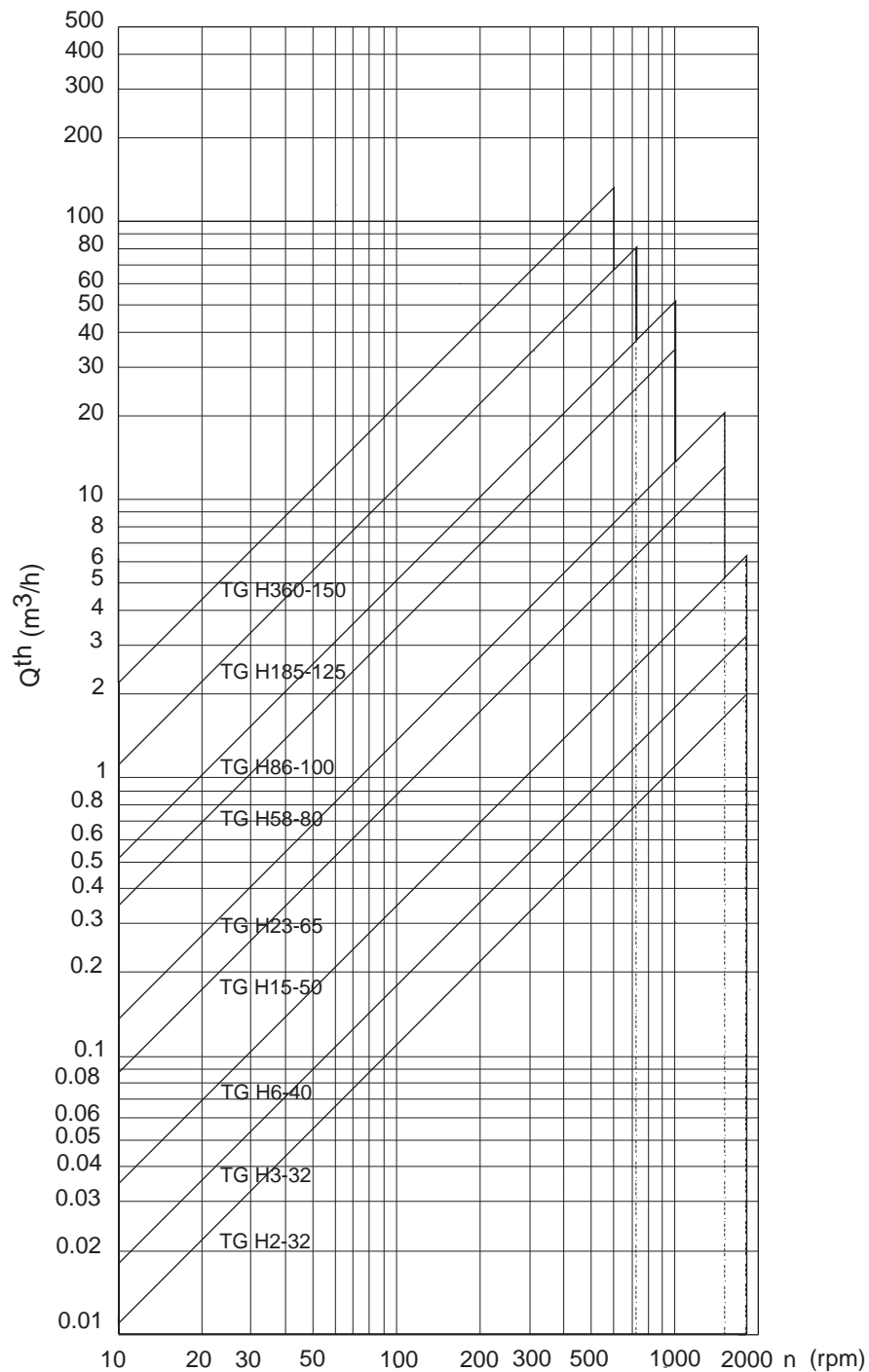
2.5 General Performance

2.5.1 Displacement and capacity

The pump range is divided in 9 sizes given capacity from 0.01 m³/h to 130 m³/h. The displacement volume pro 100 revolution is most characteristic for the pump size and makes part of the type name. The capacity of the pump without internal slip is equal to the displacement pro revolution times the shaft speed .

Following graph gives an overview of sizes and related capacity versus speed.

The peripheral velocity of the outside diameter of the rotor is a limiting factor for the shaft speed.



The peripheral velocity of the outside diameter of the rotor is a limiting factor for the shaft speed.

The main dimensions of the TopGear H-range are designed in such a way that most of the pumps can work on normal electric motor speed at 50 Hz frequency allowing direct drive.

Following table gives the most important pump characteristics with maximum shaft speed and maximum capacity and the capacity at normal electrical motor speed at 50 Hz frequency in case of direct drive.

Pump size	d (mm)	Vs-100 (dm ³)	n.max (min ⁻¹)	n.mot (min ⁻¹)	Q.th (l/s)	Q.th (m ³ /h)	v.u (m/s)	v.i (m/s)
TG H2-32	32	1.83	1800		0.5	2.0	6.1	0.7
				1450	0.4	1.6	4.9	0.5
TG H3-32	32	2.99	1800		0.9	3.2	6.1	1.1
				1450	0.7	2.6	4.9	0.9
TG H6-40	40	5.8	1800		1.7	6.3	7.5	1.4
				1450	1.4	5.0	6.1	1.1
TG H15-50	50	14.5	1500		3.6	13.1	7.9	1.8
				1450	3.5	12.6	7.6	1.8
TG H23-65	65	22.7	1500		5.7	20.4	9.0	1.7
				1450	5.5	19.7	8.7	1.7
TG H58-80	80	57.6	1050		10.1	36.3	8.8	2.0
				960	9.2	33.2	8.0	1.8
TG H86-100	100	85.8	960	960	13.7	49.4	8.8	1.7
TG H185-125	125	185	750		23	83	8.8	1.9
				725	22	80	8.5	1.8
TG H360-150	150	360	600		36	130	8.8	2.0

Legend

- d : port diameter (inlet and outlet port)
- Vs-100 : displaced volume pro 100 revolutions
- n.max : maximum allowable shaft speed in rpm
- n.mot : normal speed of direct drive electric motor (at 50Hz frequency)
- Q.th : theoretical capacity without slip at differential pressure = 0 bar
- v.u : peripheral velocity of rotor
- v.i : velocity of liquid in the ports at Qth (inlet and outlet port)

2.5.2 Pressure

For performance on pressure three kind of pressures must be considered i.e.

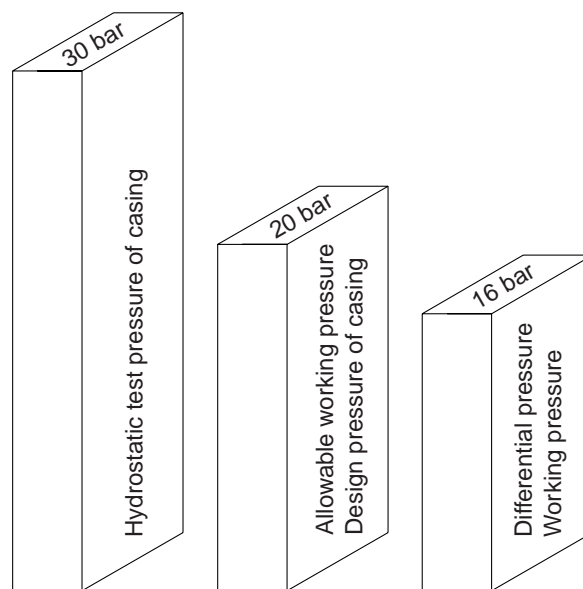
Differential pressure or working pressure (p) is the pressure on which the pump normally operates. The maximum differential pressure for all TopGear H-range pumps is 16 bar.

Maximum allowable working pressure (p.max) is the pressure on which the pump casing is designed and that can be achieved occasionally when the operating pressure raises over the normal operating pressure p.e. when the pump run with open relief valve.

In the TopGear H-range the design pressure is 20 bar i.e. 4 bar higher than the maximum differential pressure. It ensures higher safety such as is required in API676 for rotary positive displacement pumps.

The hydrostatic test pressure = 30 bar is the pressure on which the pump casing is tested. The test pressure is 1.5 times the design pressure.

Following figure give a graphical presentation of the several kind of pressures.



2.5.3 Viscosity

Maximum viscosity depends of the type of shaft sealing.

Shaft sealing type	Maximum viscosity (mPa.s) *)
Packed gland PO, PQ	80000
Double mechanical seal Back to back – GD and GCD pressurized	80000
Tandem – GG and GCD not pressurized	5000
Single mechanical seal GS with Burgmann MG12	3000
GS with Burgmann M7N	5000
GCQ and GCT cartridge	5000

*) Remark:

Figures are for Newtonian liquids at operating temperature. The maximum allowable viscosity between the sliding faces of the mechanical seal depends on nature of liquid (Newtonian, plastic etc.), the sliding speed of the seal faces and the mechanical seal construction.

2.5.4 Temperature

TopGear pumps H-range are designed for high temperature. Following table give the overall temperature.

Depending of shaft sealing type and used materials the temperature must be limited.

Pump size	Minimum allowable temperature (° C)			Maximum allowable temperature (° C)		
	Casing materials			Casing materials		
	R	S	N	R	S	N
TG H2-32	-40	-	-	+200	-	-
TG H3-32			-			
TG H6-40			-			
TG H15-50	-40	-30	-	+250	+300	+300
TG H23-65			-25			
TG H58-80			-25			
TG H86-100			-25			
TG H185-125			-25			
TG H360-150			-25			

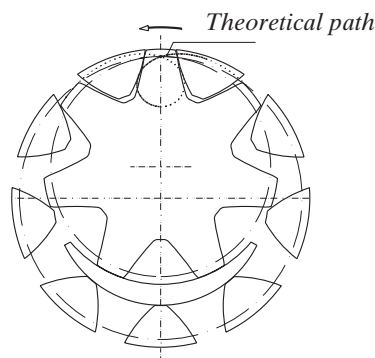
2.5.5 Hydraulic design

The hydraulic of the TopGear H-range has some typical design features that lead to excellent performance.

Strong design suitable for high viscous media i.e.

- Good NPSHr performance
- High allowable torque
- One class of clearance allowing good total efficiency
- Safety relief valve with big unobstructed passage

Principle of gearing



Special teeth shape lead to favorable bearing forces

