



Advantages of rotary lobe pumps

Like progressing cavity pumps, rotary lobe pumps belong to the pump type known as positive displacement pumps. Due to its compact design, a rotary lobe pump can be advantageously used for high discharge rates. In the following the special benefits of rotary pumps are described in comparison to progressing cavity pumps, also named eccentric screw pumps.

Small overall dimensions

Fig. 1 clearly shows a rotary lobe pump in a size range of about 30m³/hr requires much less space than a PC pump of comparable capacity. This is not only valid for this particular size: Especially for larger pumps beyond 2 gal/rev the difference in length increases extremely. Large PC-pumps waste up to 50% more space than rotary lobe pumps.



Fig 1: Comparison PC/Rotary Lobe

Fig. 2 shows an overall comparison in total length – including electric geared motor - between Vogelsang-pumps and PC pumps of a well known manufacturer. Over the whole range you will find that PC-pumps are 30 to 50% longer than a rotary lobe pump of the same size. The size here is read in terms of displacement volume (gal per revolution).

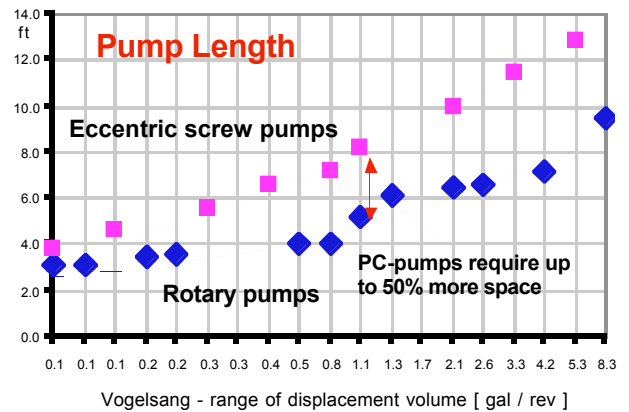


Fig 2: Space requirement (length including motor)

High Capacities

Looking at the capacity, the difference becomes much more significant: The flow rate of rotary lobe pumps can be increased up to 2.4 times of the PC-pump's flow rates (**Fig. 3**). This is due to the fact that rotary lobe pumps do not face the same speed limitations as the PC design.

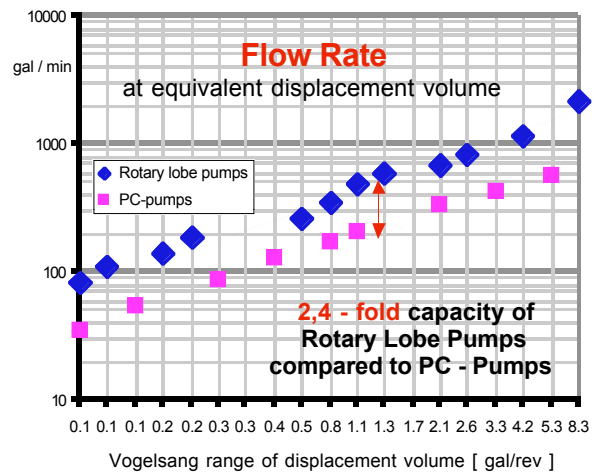


Fig. 3 Flow rate of rotary pumps compared to PC-pumps

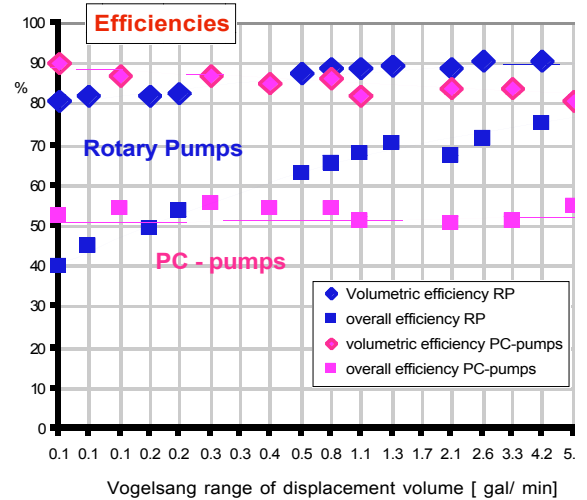
Both, rotary lobe pumps and PC pumps are used for pumping abrasive slurries. To assure maximum efficiency, both pump types rely on the least possible amount of clearance between the rotating displacement elements and the surrounding housing. To minimize wear, these pumps apply the principle of “soft against hard”, where the pressurizing element of the pump is coated with a wear resistant elastomer. In eccentric screw pumps, the stator is made of the “soft” material and in a rotary lobe pump the rotating lobes are rubber-lined. But there is one essential difference: Due to its two bearings per shaft, the rotary lobe pump is always



operating with clearances between housing and lobes, whereas PC-pumps work with close contact between metal rotor and rubber stator. This means the spiral shaped rotor is always pinched inside the undersized stator. On the one hand zero clearances result in low internal backflow but on the other hand the friction creates high starting and running torque. How these design differences affect the efficiency is shown in Fig 4.

High efficiency

Focusing on the efficiency one must separate in volumetric and overall efficiency. The volumetric efficiency characterizes the pump’s tightness. Small PC-pumps (with small displacement volume) normally have a higher volumetric efficiency than small rotary lobe pumps. Looking at larger pumps (high displacement volume), a rotary lobe pump has a better volumetric and a better overall efficiency. The overall efficiency sums up both, internal leakage and the torque created from internal friction. It is obvious from the diagram that the tightness of a PC-pump is paid for with high torque. The diagram is based on values measured while pumping water at 70 F with 58 PSI differential pressure. One has to have in mind that the running torque of PC-pumps increases with rising fluid temperature because of the rubber expansion.



Pulsation free lobe design

Most important is the different kind of bearing arrangement for the rotating elements. In a PC-pump the rotating screw is supported only inside the elastic stator. No extra bearings support the screw which is rotating eccentrically with the center of gravity moving up and down. The rotating elements of a rotary pump are supported by bearings on either both sides of the lobes or overhung. There is no eccentric movement and therefore no inertia forces that would limit the rotational speed. In addition to that helically twisted HiFlo lobes are standard in every Vogelsang pump (Fig. 5). This means also no vibration or pulsation caused by the geometry of the lobes. The displacement per revolution is absolute equal to the conventional straight lobes. There is no vibration-caused speed limit for a Vogelsang pump. This is also valid when the internal clearances are growing due to wear. Not so for PC-pumps: The bearing arrangement results in continuous zero clearance operation. Because of the high friction between steel and rubber, the stator will heat up immediately when no cooling and lubrication is provided by the pumped liquid – the PC pump can not run dry.



Fig. 5: HiFlo – lobes



Less friction

Unlike the PC pump a rotary lobe pump is working with clearances and the rotors only slightly touches the housing. Therefore it needs only a minimum of coolant and the temperature is increasing moderately at idle operating conditions. **Fig. 6** is showing the temperature rise in a PC pump and a rotary lobe pump under idle conditions.

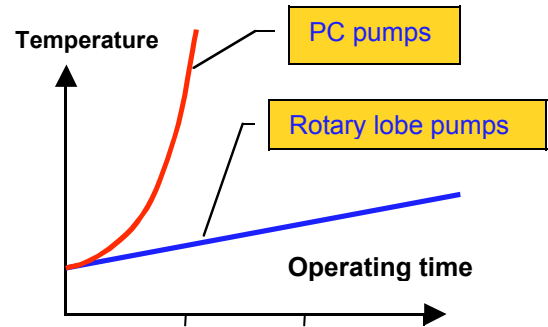


Fig. 6: Temperature increase running dry at idle operation

Easy lobe change

Both PC pumps and lobe pumps most of the time are working under abrasive conditions. So maintenance is a good criterion to compare both pump types.

In **Fig. 7** the easy access to the pump chamber is demonstrated. Even the Flange connections do not have to be replaced to gain access to the wet end of the pump in order to change the lobes. The shafts of the pump are completely protected against the fluid that could contain corrosive substances. As a result of this the lobes can be pulled off even after long periods of operation. Wear plates protect the housing in the front and at the back of the lobes. They are fastened with bolts that are positioned outside the lobe tip circles – the bolt heads will not wear off. If necessary, lobes and wear plates can easily be changed within less than 30 minutes (**Fig. 8**). In contrast to this changing the stator of a PC pump requires much more engagement in tools and working time particularly for larger pumps.

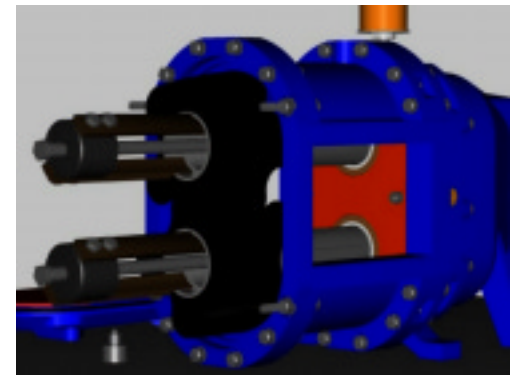


Fig. 7: Easy access to internal parts

We come back to design differences between PC pumps and rotary lobe pumps, in particular the missing bearings of the PC pump screw. The eccentrically revolving screw is supported only by touching the stator and would not run properly if this contact would be missing. The following conclusions can be drawn:

- No clearances are allowed because otherwise the radial guidance would be missing and the bearing would fail.
- The rotating speeds are limited because the eccentric movement together with an elastic bearing creates an oscillator with a characteristic oscillation frequency. To avoid vibrations maximum speed has to be below this frequency.



Fig. 8: Vogelsang Rotary Lobe Pump

The tight relationship between rotor and stator is the reason why the eccentric screw pump is able to run at low speed and still maintain good volumetric efficiency. Being necessary for the function the tightness brings a big disadvantage along: Abrasive particles are squeezed in the gaps between rotor and housing and bring along wear by friction. As the clearings have to remain zero during the whole life time Eccentric screw pumps



are permanently running under wear-by-friction conditions. Rotary lobe pumps however are operating in that way only when the particle size exceeds the clearance (**Fig. 9**).

Stable operation in a wear situation

Rotary lobe pumps do not have these problems because they are running stable even with a significant amount of lobe wear. On the contrary, abrasion is the less the longer the pump is operating. That is because the wear is only caused by back-flow velocity not by contact abrasion. (**Fig. 10, curve on top**). Because of the lack of speed limits, the internal leakage caused by wear always can be compensated by increasing speed.

For PC-pumps this is valid only with restrictions. If the stator is worn-out so that squeezing is missing the pump has to be maintained immediately. Otherwise abrasion is increasing extremely (**Fig.10, lower curve**).

Fast running pumps

A performance field of both pump types at 4 bars is plotted in **Fig. 11**. The selected pump types have a similar displacement range measured in gal/rev. The capacities of PC-pumps of a well known manufacturer are plotted in dotted lines. The capacities of the corresponding types of Vogelsang Rotary pumps are plotted in bolt lines. The PC pumps are named after the capacity in m₃/hr at about 350 rpm – first number - and a suffix 6L which stands for the state of the art rotor design with lower eccentricity. The dotted lines show the relatively wide range of capacity that different types of PC pumps can cover in theory. In reality the manufacturers have to limit the speed so that certain average sliding velocities are not exceeded. Typical limits in sliding velocities are listed in **Table 1**. The black dotted line in **Fig. 11** is the connection of all points with a sliding velocity of 1.5 m/s – recommended for sewage sludge.

Looking at the plot one can see the Rotary lobe pumps running at higher speeds. Typical tip speed is about 5 m/s. Close to this tip speed the overall efficiency is at its maximum with 4 bar differential pressure. The vertical lines show the rpm at a tip speed of 5 m/s for the 3 different Vogelsang pump series. The listed series are the center distances of the two pump shafts in mm. Lines of the same color are pumps with different pump chamber length but the same center distance.

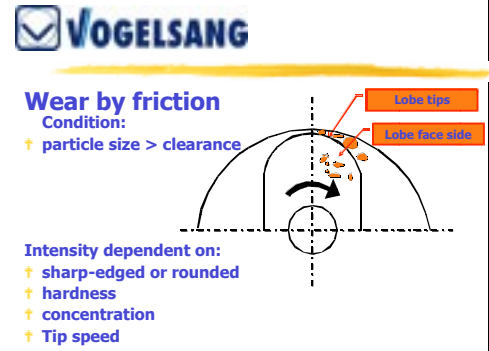


Fig.9: Wear by friction

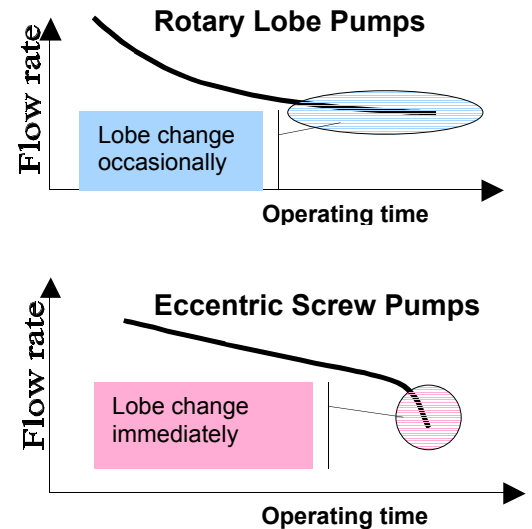


Fig.10: Operation under wear conditions

Sliding velocity v _{gl} [m/s]	Characteristics	Medium sample
0.5	Abrasive, high viscous	Lime slurry
1.5	Abrasive and viscous	Sewage sludge
2.5	Lubricating and viscous	Oil
3.5	Low viscosity	Water

Table 1: Maximum sliding velocities of PC-pumps

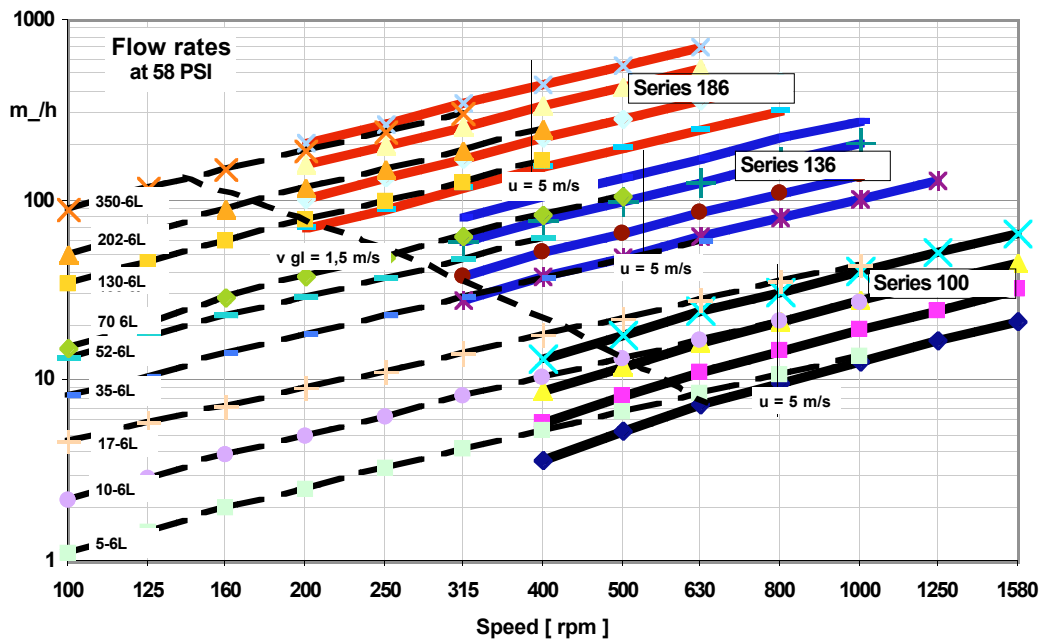


Fig. 11: Performance field: PC-pumps – Rotary lobe pumps

The type 350-6L is the largest pump of the PC-series. The overall length of this pump is about 8.2 ft without motor. Compared to that the length of the largest Vogelsang pump (VX 186-520) is only 3,7 ft with its capacity exceeding that of the largest PC pump 3 (three) times.