Forward-looking pump choice for critical fields of application

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When selecting pumps, operating safety and reliability should be almost natural criteria. Previously, plant manufacturers were often said to focus on the investment costs when choosing their pump systems. Along with the installation costs, they are rather modest compared to the overall investment volume for the construction of a production plant. It can be by far more expensive if a malfunctioning pump causes damages. It must not necessarily be the blaze or the environmental disaster. Operators of production plants are interested in safe pumping, long service-lives and the efficient operation of pumps. Production failures quickly cause high costs, in addition to the expenditure of time, which is reflected in the total operating costs. Up to 90 % of the damages to pump systems can be attributed to wrong design or improper operation. Frequently, problem areas such as the occurrence of cavitations or dry running of sealing and bearing units are concerned. The optimum pump selection – whether it is a new acquisition or a replacement - first requires the operator's precise description of parameters like medium and application conditions. Also, the inlet conditions should be carefully specified. Particular requirements apply to media in the chemical industry. Pumping of aggressive or toxic media is further complicated by high temperatures or solid particles contained in the medium. The compliance with legal requirements, such as TA Air or explosion protection is also an important precondition for the successful utilization of pumps.

The operator is given the task to clearly specify the special characteristics of the pumping process. The more precise the description of the plant, of the location and of the medium to be pumped, the better are the preconditions for the selection of the adequate pump hydraulics and shaft seals. Usually, the pump manufacturer handles the design. Additional control and monitoring components form the pumping system, which has to fulfill the pumping task in a cost-efficient way, without risks for the environment, with utmost operating safety and at low maintenance cost.

With hot, toxic, viscous, gaseous, boiling or solid-particle containing and corrosive pumping media, the chemical and petrochemical industrial enterprises belong to the critical fields of application – the main field of action for the robust centrifugal pump which, with a share of 80–90 %, belongs to the pumps that are most commonly used. They owe their suitability for solids-containing media, as they frequently occur in these industries, to the fact that they do not require closed pump chambers or valves, in contrast to positive displacement pumps.

Their functional principle is based on hydraulics in an impeller, in the housing and in the sealing and bearing unit. The selection and combination of sealing and bearing unit is of great importance.

Decision-making procedures for pump seals

The task of the sealing system is to seal the rotating shaft towards the environment. Here, the application of a pump sealing system has great influence on the operating and maintenance costs – and thus on the life cycle costs of the pump. The choice ranges from glands over single or double mechanical seals up to magnetic coup-

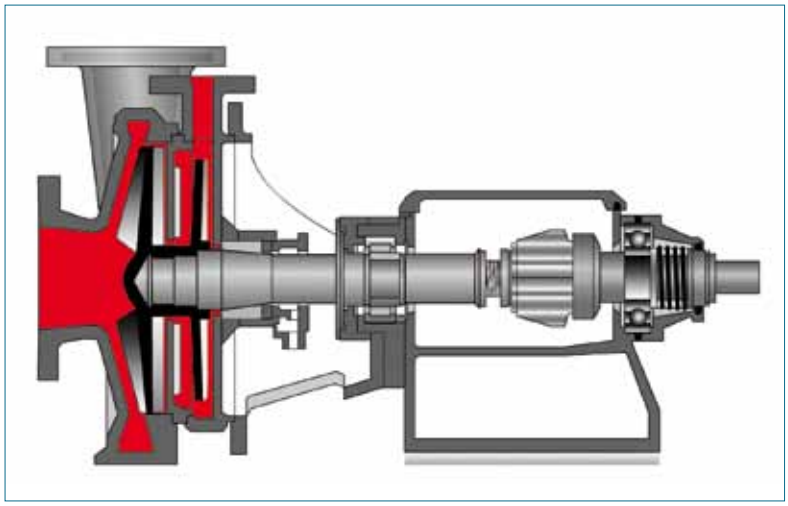

Fig. 1: Hydrodynamically sealed pump with dry-run protection

lings and canned motors. Pumps with magnetic couplings are used twice as often as the canned motor variant. It works with static seals which, in contrast to mechanical seals, are more resistant to wear and maintenance-free.

In the canned motor pump, pump and motor form a unit. Rotor and impeller are arranged on a shaft. In contrast to the double mechanical seal, which is sealed with an external medium, it does not work independently from the pumping medium. The medium flows around the can and the slide bearings. Pumps with magnetic couplings and canned motors require additional measures, such as additional rinsing, to be able to pump gaseous or magnetizable media and solids. In considering the life cycle costs, also high energy losses due to induced eddy currents (in the can) and viscosity influences are a factor. The two leakage-free pump types must also meet high legal requirements. With these pumps, the permissible emission values (MAK-values) can be easily observed, as the can guarantees hermetic sealing towards the environment. If, in case of sealing with can or single mechanical seal, the emissions exceed the permissible values (e. g. within the context of the TA Air), double-acting mechanical seals can be used. The barrier systems required for this are complex and maintenance costs are high. Recently, the magnetic coupling pump has proved to be a reasonable alternative for such critical applications. More difficult pumping tasks are fulfilled by another variant which has become established, in particular, with vertical pumps: the gas-lubricated mechanical seal. It is also approved for this kind of application and is characterized by

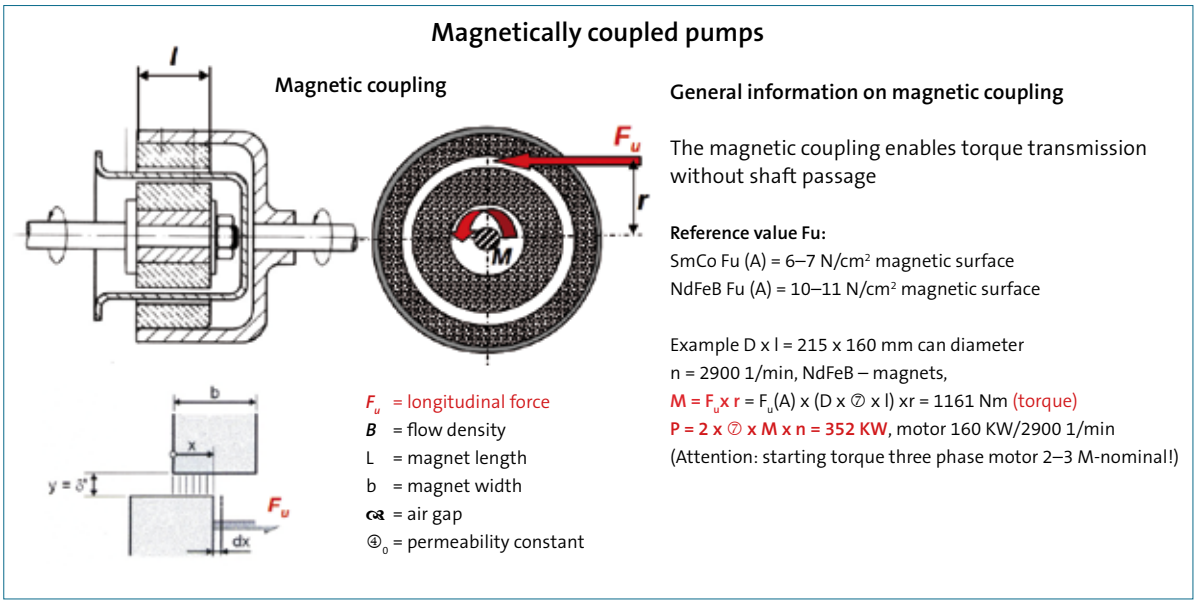

Fig. 2: The magnetic coupling enables torque transmission without shaft passage

low operating and maintenance costs due to the simple gas supply. In a survey, the distribution of the different sealing methods for pumps in a chemical park was examined. 48 % were contributable to single mechanical seals, 27 % to double mechanical seals, 19 % to magnetic couplings and only 6 % to the canned motor.

Requirements and solutions

The complex interplay of pumping media, such as acids, bases or toxic, corrosive, precious or gaseous solutions is difficult to cope with for standard pumps. To comply with the provisions of TA Air, hermetic pumps are indispensible for toxic or aggressive pumping media. Also, liquids close to the boiling temperature, liquid melts, suspensions and slurries or explosive liquids or those which crystallize out as well as gelling or sticky liquids often cause failures in conventional chemistry pumps.

Solids in liquids or excessive suction pressure can also be problematic. Along with high temperatures, conventional magnetically coupled centrifugal pumps with mechanical seals lubricated by the pumping media will soon reach their limits. They must not run dry and immediately react with failures in presence of solids in the pumping media. Suitable for solids-containing media is the hydrodynamic sealing used in combination with a can, which however was not taken into consideration in the survey mentioned above. The advantage of the hydrodynamic shaft seal is its frictionless operation.

In case of hydrodynamical centrifugal shaft seals, the pumping media at the backside of the impeller is carried along by friction and begins to rotate. Back vanes on the back of the impeller enhance this effect, with the speed of the rotating liquid ring being able to achieve up to 90 % of the pump speed. The rotating liquid ring reduces the pressure applied at the outer diameter towards the shaft down to the ambient pressure. With the right design, there is no liquid at the shaft passage during pump operation, which renders the shaft seal superfluous. Problems arise upon standstill of the pump: the sealing is ineffective. A standstill seal is necessary.

An example is the horizontal pump which combines the hydrodynamic sealing with a centrifugal force system. As soon as the pump is started and the hydrodynamic sealing relieves the shaft passage, the shaft is axially shifted towards the suction side of the pump. This causes the radial separation of the cone-shaped gland packing from the shaft. During pump operation, the standstill seal is completely frictionless. Pumps with these sealing systems, combined with gland

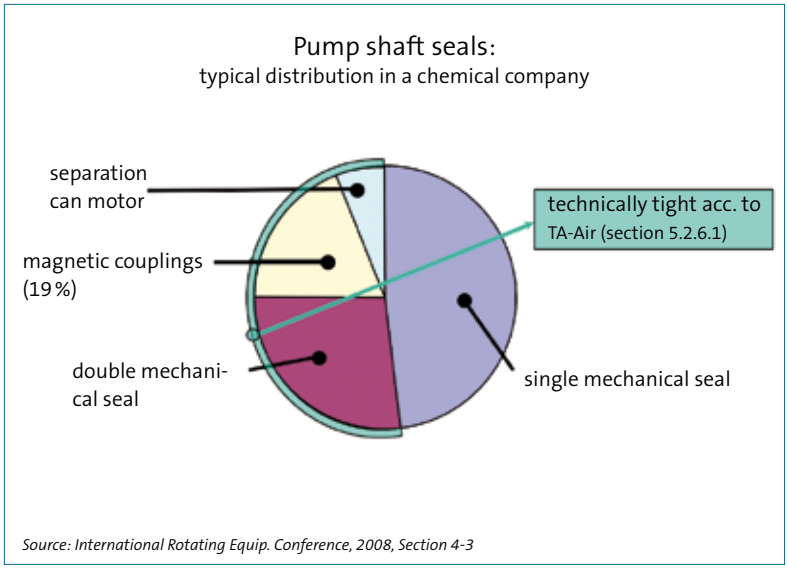

Fig. 3: Application frequency of sealing types in chemical companies

packings, are well suited to the application in the fertilizer and paper industry for the pumping of solids-containing, non-toxic products. Since hydrodynamic sealing systems are wear-free and work without sealing liquid, life-cycle costs are low. The systems can be operated for several years with little maintenance expenditure and long annual service life of the pump. Disadvantageous is the higher energy demand compared to the conventional centrifugal pump. An energetically economical and extraordinarily durable variant is the intelligent combination of dry-running magnetic coupling with hydrodynamic sealing. It allows use independent from the pumping medium and the dry run of the pump.

Hydrodynamic sealing meets hermetically tight magnetic coupling

A new variant results from the combination of the frictionless hydrodynamic sealing with the hermetic sealing of a magnetic coupling. The pump provides unlimited dry run protection and is thus excellently suited for

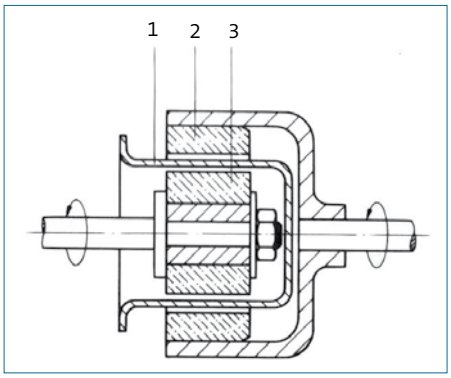

Fig. 4: Structure of a magnetic coupling : 1. Can, 2. Outer magnetic rotor, 3. Inner magnetic rotor

duct entry during the pump standstill or in case the nitrogen introduction is interrupted. This hermetic sealing works independently from the pumped medium. In comparison to conventional magnetic pumps with metallic cans and mechanical seals, the pump – in particular when working with viscous liquids – provides improved efficiency.

Intelligent solution and efficient energy consumption

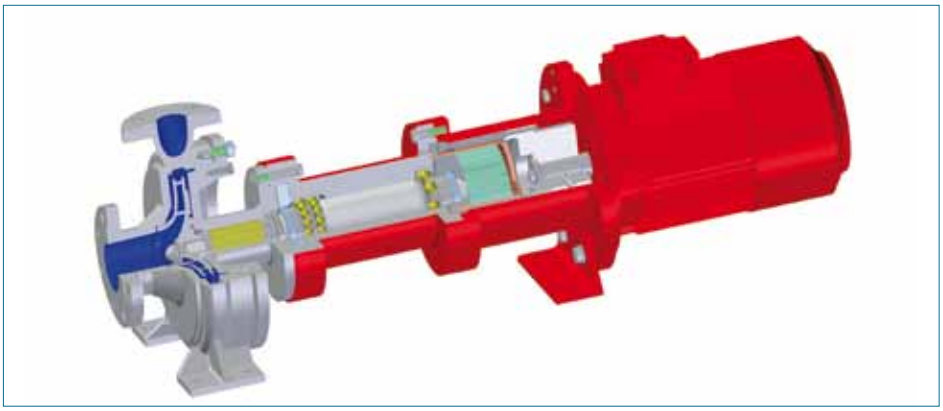

*Fig. 5: Dry-running magnetically coupled horizontal pump: A recirculation labyrinth system is arranged between bearing and pump hydraulics *(Originally, this technique comes from the field of vertical pumps.)*

media which are very difficult to seal. Bearing and magnetic coupling run absolutely dry. For this purpose, the impeller is equipped with a vertical pump* with back vanes – which forms the hydrodynamic sealing. The magnetic coupling is arranged in the upper part of the pump, which is completely relieved from the delivery pressure of the pump. The can is made of electrically non-conductive material (ceramics). This helps avoid eddy currents and the resultant heat development. The bearings are anti-friction bearings. To prevent product vapors from entering the bearing and sealing unit, nitrogen is specifically introduced below the bearing. The arising gas cushion prevents the pro-

To enable the use of horizontal pumps for applications faced with extreme challenges, the dry-running frictionless sealing concept with magnetic coupling of the vertical pump was transferred to the horizontal pump and completed by a recirculation labyrinth system between bearing and pump hydraulics. Here, liquids are separated from solids and gas particles. The safety of the sealing system is ensured by the monitoring of the nitrogen volume. Increasing nitrogen consumption or falling pressure would indicate a damage. Due to the hydraulic relief, only supply pressure is applied to the dry separating can. If the gas supply is monitored by a humidity sensor, the safety level of a magne-

tic coupling pump with double can is reached. With the constructive measures described, the hydrodynamically sealed magnetic coupling pump is able to run dry without limitation. In contrast to the standard magnetic coupling pumps, it can be used for nearly all pumpable liquids without additional measures.

In addition, the pumps are characterized by good performance and significant energy savings compared to standard pumps.

Conclusion

This chemical pump with energy saving effects has proven its worth as a problem solving pump for toxic media and pumping liquids containing solids or gas. Due to the eddy-current-free magnetic field transmission and the anti-friction bearings used, this pump reaches the overall efficiency of a standard pump with single mechanical seal. Depending on application, pump performance and service life, energy savings can quickly reach the five digit range. At the same time, the pump is characterized by very low maintenance and operating costs – an example for innovative and energetically efficient technology, which is well tried and tested.

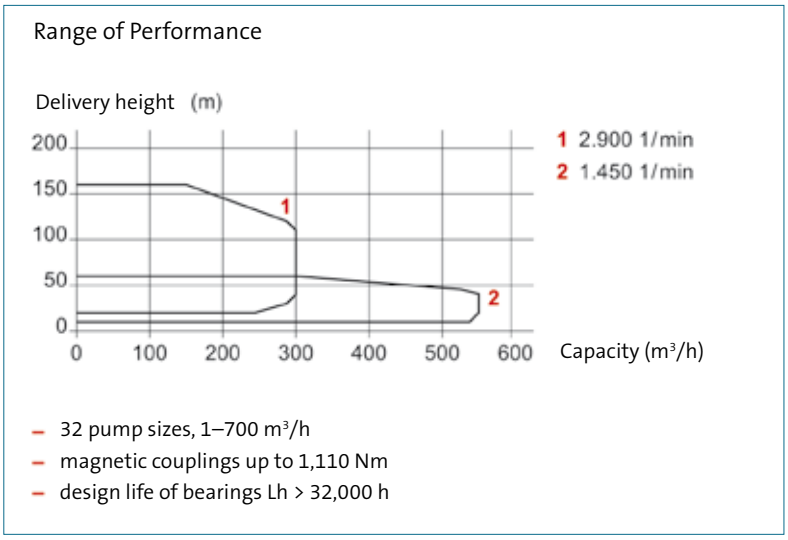

Fig. 6: Available performance range of dry-running magnetic coupling pumps

Dry-running magnetically coupled pump
Low energy consumption compared to standard magnetic pumps with slide bearings

Pump type: 80/250
Design point: 150 m³/h/81 m Fl. S.
Speed: 2900 1/min

Viscosity	Delivery height at: 150 m³/h	Pump performance dry-running magnetically coupled pump	Efficiency dry-running magnetically coupled pump	Eddy current loss Hastelloy D. 165 mm/ l = 10/8 cm M = 303/383 Nm	Hydraulic loss	Total performance standard magnetic pump	Efficiency standard pump	Savings dry-running magnetically coupled pump at 8000 h operating time	Savings dry-running magnetically coupled pump 8000 h operating time (10 ct/KWh)
mPas	m Fl. S	KW	%	KW	KW	KW	%	KWh	Euro
1	81	48	69	8.3	1.2	57.5	58	7,600	7,600
100	77	58	54	10.4	4.6	73	43	120,000	12,000
200	74	63	48	10.4	6.1	79.5	38	132,000	13,200
300	66	67	40	10.4	7.3	84.7	32	141,600	14,160

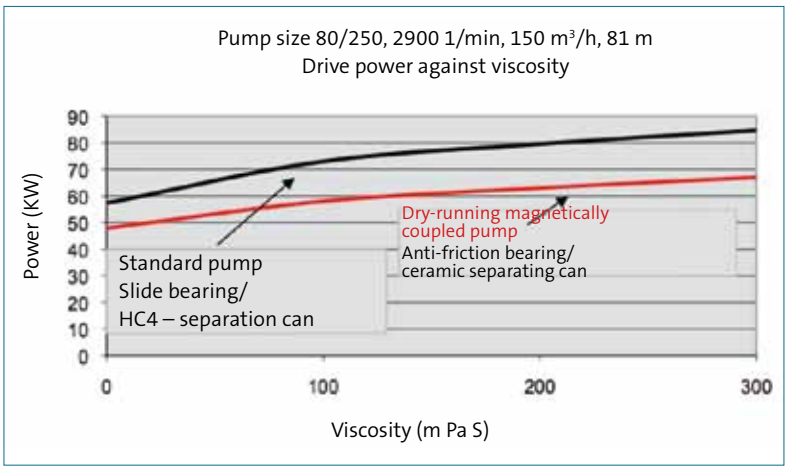

Fig. 7: Reduction of driving power through application of a dry-running magnetic coupling

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