Multisafe Double Hose-Diaphragm Process Pumps for the Wet Oxidation of Wastewater

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Reactor feeding requires hermetically sealed displacement pumps with a maximum of reliability and availability. Minimum variations in terms of flow and pressure are additional criteria for pump selection. Hose-diaphragm pumps have adapted better to this type of application than the traditional diaphragm pumps and have proved to be most successful in worldwide applications. With built-in redundancy and fault finding diagnostics this unique pump design sets new standards in pump technology.

Wet oxidation of wastewater is becoming more important worldwide. In terms of stronger ecological awareness, traditional sewage treatment systems are increasingly extended or replaced by new technologies. In wet oxidation processes, organic wastes are completely deleted in a reactor by means of oxygen under high temperature and high pressure. The decisive aspect is that no harmful emission is released into the atmosphere or into the water cycle.

The conventional mechanical sewage treatment works of larger cities are often improved by wet oxidation systems. During the process of mechanical treatment, coarse solids are removed by means of strainers whilst smaller solids are subject to sedimentation and decantation. Biological treatment removes organic contaminations using the micro-organisms of the wastewater. In order to degrade organics to an extent that mineral residues are produced, such wastes are additionally subject to digestion and wet oxidation. Since digestion cannot fully eliminate any organic materials from the wastewater, additional oxidation is required. During the oxidation process, the slurry is fed under high pressure into a reactor, heated to high temperature and mineralized by the addition of air or oxygen. The resultant fluid produced is easily bio-degradable.

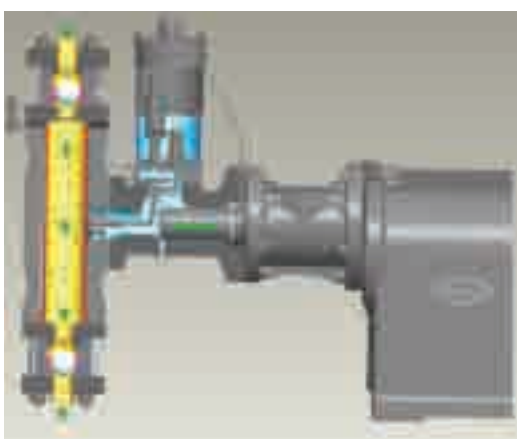

Fig. 1 Multisafe Double Hose-Diaphragm Pump. Series DS 35

Beyond recycling there are manifold options for the reutilisation of the inorganic materials.

Since high CO_2 emissions result from the combustion of wastes, wet oxidation moreover contributes to a considerable reduction of the greenhouse effect.

There are a series of patented wet oxidation systems available worldwide, operating at working pressures between 60 and 300 bar. However, all these systems are alike in one respect. They all require displacement pumps to feed the reactor and are therefore key items within the process and have to meet very exacting requirements.

Hermetical Sealing

Normally, hydraulically actuated diaphragm pumps are used for high pressure applications. With Multisafe double hose-diaphragms pumps, two hose-diaphragms, which are arranged one inside the other, provide the hermetical sealing between the wet end and the drive end, although the pump needs only one to operate. The fluid is led in a linear flow path through the inside of the hose-diaphragm and is in contact with the primary hose-diaphragm and check valves only (see Fig. 1).

High Operating Safety and Economical Value by Means of Unique Double Hose-Diaphragm Design

With traditional diaphragm pumps, failure of the diaphragm inevitably results in contamination of the hydraulic chamber and causes considerable damage and costs for cleaning, repair and downtime. With double hose-diaphragm pumps the slurry will not come into contact with either the pump casing or the hydraulic chamber, even if one of the hose-diaphragms fails. The second hose-diaphragm will maintain the hermetical seal so that the pump operation can be continued until the process allows for a shut-down and repair. The lifetime of hose-diaphragms is considerably extended beyond that of flat diaphragms. Moreover, there are no clamping areas which might allow for the settling of solids, resulting in premature diaphragm failure.

A wide variety of elastomer materials are available for the hose-diaphragms. For high pumping temperatures and such fluids that require extraordinary chemical resistance, a special mixture of PTFE is used.

Unlike traditional diaphragm pumps,where the size of the pump casings is a result of the diameter of the flat diaphragm, Multisafe pumps have the cylindrical shape of the hose-diaphragms and so can offer potential cost reductions, especially in the case of high-pressure applications. The construction material of the pump casings is not determined by the resistance to the conveyed fluid. Moreover, the cylindrical shape allows for considerable weight reduction of the casings and thus for an overall compact design.

Minimum Pulsation

A typical characteristic of a reciprocating positive displacement pump is the hydro-dynamic independency of the delivery flow from the pressure and vice versa. The reason for this feature is due to the mechanics of pressure generation by means of a displacement piston, which prevents backflow and thus an escape of the displaced volume into the pipework. On the one hand, this principle allows the achievement of extraordinarily high efficiencies. Conversely, this reciprocating movement causes undesirable flow fluctuation and pressure pulsations.

However, similar to coal gasification units, a linear flow of material without pulsations is required for wet oxidation systems, in order to maintain the proper balance of materials within the reactor and to avoid damages as a result of inconsistent flow. On the other hand, it can hardly be avoided that solids are at times caught between the valve ball and valve seat, especially when handling wastewater sludge.

This not only results in leaks within the respective check valve, but also contributes to a correspondingly reduced flow.

Fig. 2 Multisafe Pumps are available for max. flow rates of 600 m“/h (6 pump heads) and max. pressures of 320 bar

In order to avoid a negative influence on the flow under such circumstances, Multisafe double hose-diaphragms are provided with double check valves, when used in wet oxidation facilities (see Fig. 2). Even in the event that one of the two valves is not sealing properly as a result of a trapped particle, the second valve reliably prevents a reduction of flow. In spite of the provision of double check valves, this does not equate with increased costs for wearing parts, since wear is proportional to the differential pressure.

The cassette design of the check valves and the provision of jacking screws allows for easy servicing and dismantling without prior removal of pipings.

To avoid pressure pulsations, hose-diaphragm type pulsation dampeners are applied. The accumulator is pre-charged to approx. 80 % of the working pressure in such a way that the discharge flow on each pump stroke that exceeds the average flow, is stored by compression of the air volume within the accumulator. The stored volume is then released during the suction stroke. The conveyed fluid is hermetically sealed from the air cushion by a double hose-diaphragm and an actuation fluid that is compatible with the pumped fluid. For spare parts standardisation, hose-diaphragms of the pulsation dampener are interchangeable with those of the pump unit.

Working Principle

The Multisafe design essentially mimicks the use of the perfect mechanism of the human heart by the principle of contraction and release of veins via variable speed.

At the heart of this pump are two hose-diaphragms, which are arranged one inside the other and fully enclose the conveyed fluid. In step with the piston stroke, they are subject to pulsating action, comparable with that of a human vein, and pump the fluid through the pump body in a linear flow path. The double pump vein offers reasonable redundancy. It substitutes interval-based or preventive maintenance and in many cases the installation of a stand-by pump.

High Availability by means of Condition Monitoring

There is nothing that plant operators fear more than an unscheduled shutdown. Therefore, Mulitisafe pumps are provided with comprehensive safety and diagnostic features (see Fig. 3) for early fault recognition (not recognition of failure, which would leave no freedom for action at the time of the alert). Main focus being on hose-diaphragms and check valves.

The space between both hose-diaphragms is unpressurised. If one of the hose-diaphragms leaks or fails, either process fluid or actuation fluid will get into the intermediate chamber and generate pressure, which is transferred to the hose-diaphragm condition monitoring unit. The early warning provides the operator the possibility of scheduling service requirements in time. Even in the case of a leaky hose-diaphragm, pump operability is maintained until the unit can be shut down for repair.

The measuring principle of custom-made valve detectors is based on the analysis of structure-borne sound and detect leaks between valve seat and ball or cone already at a time when the loss of flow rate is still < 1.0 %. The sensor is fixed to the outside of the valve casing and not in contact with the conveyed fluid.

Moreover, the 4 in 1 diagnostic system gives information about the suction pressure as well as the hydraulic and/or gearbox temperature.

Touch Panels

The redundant nature of Multisafe pumps is supported by touch panels, which are integrated into the control cabinet (see Fig. 4) and provide information on current operating parameters and the condition of fundamental parts.

The link to local process control is made by bus systems for communication and control of VFD, PLC, touch panels and the Feluwa Valve Performance Monitoring System. Touch panels cover check valves, hose-diaphragms, suction & discharge pressure, hydraulic temperature, stroke rate, pre-compression of pulsation dampeners, oil lube systems of crank drive and intermediate gear, motor, transformer and VFD. Teleservice allows for immediate online corrective action and makes in many cases site service unnecessary.

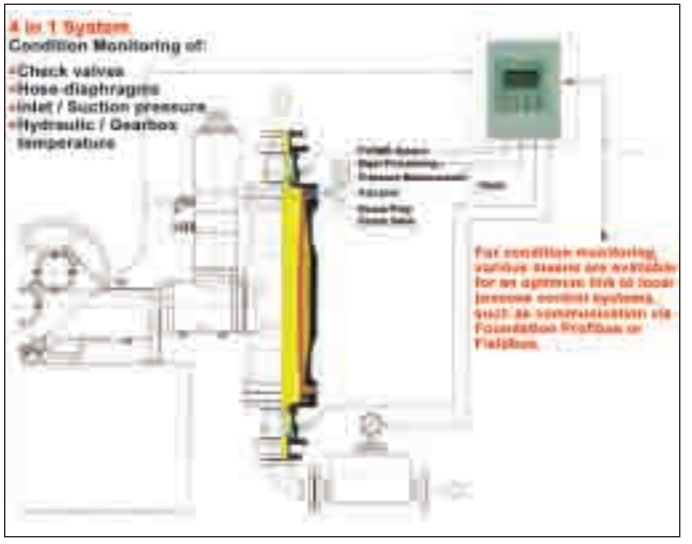

Fig. 3 Multisafe 4 in 1 Diagnostic System

Fig. 4 Feluwa Touch Panel