LOW SHEAR AND COALESCING PUMP APPLICATION CASE STUDY

INTRODUCTION:

Typhonix has developed new multistage centrifugal pumps especially targeting produced water applications. A case study based on an actual produced water pump applications has been performed to evaluate the operational and economical benefits of the newly developed pump types. Comparisons are made to conventional low shear pump types.

Typhonix Pump Versions

Typhonix has developed two new pump versions for produced water, reject and slop water applications. The starting point for the pump designs is a multistage centrifugal pump. This pump type was chosen as it has proven to be a reliable and robust pump type.

Coalescing Pump

A multistage centrifugal pump has been developed which promotes growth of the oil droplets that are dispersed in the produced water. The pump design and operation are optimised for oil droplet growth as illustrated in Figure 1.

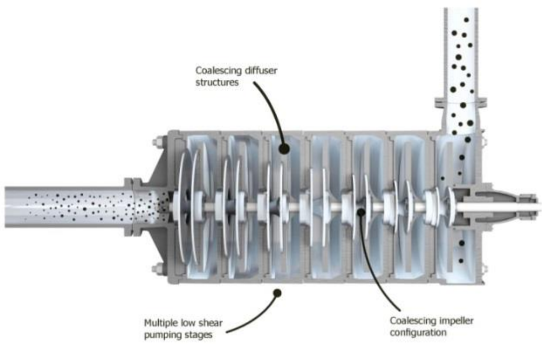

Figure 1: Coalescing pump features

Low Shear Pump

A multistage centrifugal low shear pump has been developed that prevents oil droplet break-up and emulsification of the oil and water. The Low Shear Pump utilises similar principles as those illustrated in Figure 1.

CASE INTRODUCTION:

Process and equipment specifications have been provided by an operator for an oil field in development. Figure 2 below gives an overview of the process involved. Produced water is pumped from the low pressure (LP) separator to the LP hydrocyclone package by Pump A. In addition, water from the coalescer is pumped back to the LP separator, alternatively directly to the LP hydrocyclones by Pump B.

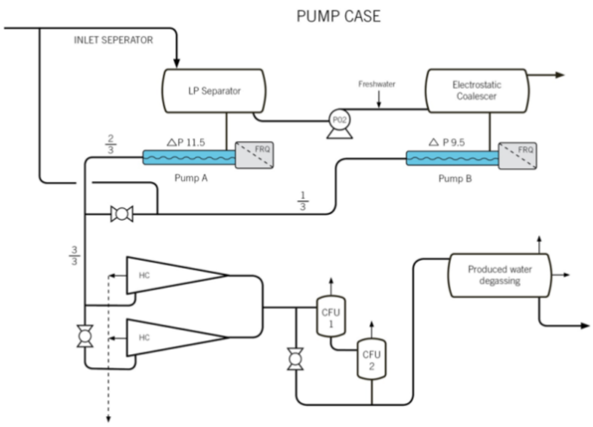

Figure 2: Process overview

At least 2/3rd of the water from the low pressure separation system is pumped by Pump A, the remaining is pumped by Pump B.
The pump differential pressure over both pumps is approximately 10 bar.

Fluid Properties

No actual process data was made available for the installation. The OiW contend used for this case study is therefore based on experience from similar fields in operation. The OiW concentration downstream the LP separator is estimated to be above 200 ppm, whereas the OiW concentration downstream of the coalescer is estimated to be below 200 ppm.
Based on the oil quality involved and on experience data it is assumed that the average oil droplet size (Dv50) is below 10 to 12 µm in the inlet to both pumps.

Existing Pumps

The operator has installed low shear pumps of eccentric screw type for both the A and B pump application.

Process Considerations

Field experience and tests performed in the Typhonix Laboratory show that eccentric screw pumps normally are good low shear pumps. Process wise this pump can therefore be compared to the Typhonix Low Shear Pump. Pumping with these pump types does not cause deterioration of the separation efficiency of downstream produced water treatment equipment as the oil droplet size is not reduced. Using the Typhonix Low Shear pump for the B pump application will therefore have no negative effect on the process.
For the A Pump application Typhonix' coalescing pump is recommended. This pump choice will have a positive effect on the separation efficiency of downstream produced water treatment equipment as it will increase the droplet size of the dispersed phase. In addition this pump will increase the processes capability to handle an upset as the increase in droplet size is linked to the concentration of the dispersed phase. An increase in concentration will result in a further increase in droplet size as can be seen in Figure 3. This will further increase the efficiency of the downstream treatment equipment.

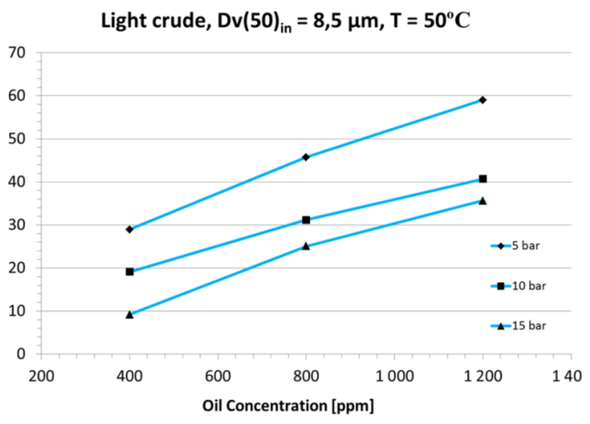

Figure 3: Relative increase in droplet size as a function of the concentration for the Coalescing pump

CAPEX AND OPEX CONSIDERATIONS:

Size and Weight

The actual size and weight of the respective eccentric screw pumps for the two pump applications are received from the operator as given in Table 1 below. The data for the Typhonix pumps selected for this application are given in Table 2.

Pump Application	Size (l/b/h) [mm]	Weight (dry incl. seal) [kg]
A	4000/1570/2050	2460
B	3400/1565/2050	1690

Table 1: Eccentric screw pumps

Pump Application	Size (l/b/h) [mm]	Weight (dry incl. seal) [kg]
A Coalescing)	3000/1420/2050	2280
B (Low shear)	2950/1320/2050	1230

Table 2: Typhonix pumps

Based on the data from Tables 1 and 2 it can be concluded that the Typhonix pumps are both significantly smaller and lighter than the eccentric screw pumps for both application A and B. Both pump types have similar capacities and can therefore be arranged in the same duty/standby arrangement.

Mechanical and Process Safety

Eccentric screw pumps are positive displacement pump types. These pumps types require blocked outlet protection to prevent severe damage to the pump and/or piping in such an event. Piping systems with positive displacement pumps are therefore normally fitted with a pressure relief valve or rupture disc assembly to prevent over pressurizing the system in a block outlet situation. This requires piping to reroute the liquid to a safe location. For this specific case a pressure safety valve (PSV) is installed for both pumps with the necessary valves pipe work and heat tracing. The necessity to install a pressure protection system has a negative impact CAPEX by increasing the amount of equipment and OPEX by increased maintenance requirements.
The Typhonix centrifugal pumps are rotodynamic pump types. These pump types do normally not

cause over pressurization of the piping system in case of a blocked outlet, as this system normally is designed for the maximal pump head. A pressure relief system is therefore normally not required. Both the eccentric screw pumps and the Typhonix pumps will normally be supplied with variable frequency drives (VFD) for optimal operation and performance. The minimum flow is therefore related to the operational range of the VFD. It is assumed that the operational range of the VFD is sufficient to eliminate the requirement for minimum flow lines. Minimum flow lines are not recommended in low shear pumping applications as the size of the droplets of the dispersed phase is likely to be reduced due to shear forces in the minimum flow control valves.

Noise

Generally, noise isolation is not desired. It is costly, bulky and reduces accessibility for inspection and maintenance. A requirement for noise isolation will therefore have a negative impact on both CAPEX and OPEX.
The area where both pumps A and B are installed has an 85 dBA noise limitation. The eccentric screw pumps require noise isolation for both pump applications due to the high noise levels of the gear boxes needed for these pumps. The added weight of the noise enclosures compared to the pump skid weights given in Table 1 is 200 kg for pump A and 175 kg for pump B.
The Typhonix pumps do not require noise isolation for these applications. The maximum noise level for the Coalescing pump recommended for application A is 66 dBA. For the Low Shear pump recommended for application B the maximum noise level is just 63 dBA. Both pump types therefore operate well below the area noise level limitation.

Maintenance and Operation

No maintenance experience of the eccentric screw pumps for these applications is available. The maintenance considerations listed here are therefore gathered from a number of operators having these pump types in use in the same application (produced water).
The main part that will be exposed to wear for the eccentric screw pump will be the stator. The stator is manufactured from a type of elastomer. Though this pump type is often reliably used to pump slurries, particles can cause significant wear to the stator when the liquid viscosity is low, as normally is the case for produced water applications.
Several cases have been reported by operators where particles caused severe problems to the stator reducing its operational life time. Reports mentioned that it had to be replaced on a frequent basis, in extreme situations even every 6 to 8 weeks.
The eccentric screw pump is also dependent on liquid to lubricate the area between the stator and the rotor. Running this pump dry will therefore cause significant damage to the stator.
Particles can also cause erosion in centrifugal pumps. Correct material selection for the exposed parts will however significantly reduce this. In addition the Typhonix pumps will be operated at low rpm and with low liquid velocities inside the pump. This will further reduce the erosion rate of the pump internals.
The gear box of the eccentric screw pump is often identified as a part that is frequently exposed to extensive wear and therefore has a reduced service life time. Centrifugal pumps do not require a gear box which will significantly reduce the potential maintenance load compared to the eccentric screw pump.
The Typhonix pumps are built in accordance with API 610 and designed for a minimum service life of twenty years, excluding normal wear parts, and at least three years of uninterrupted operation.

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