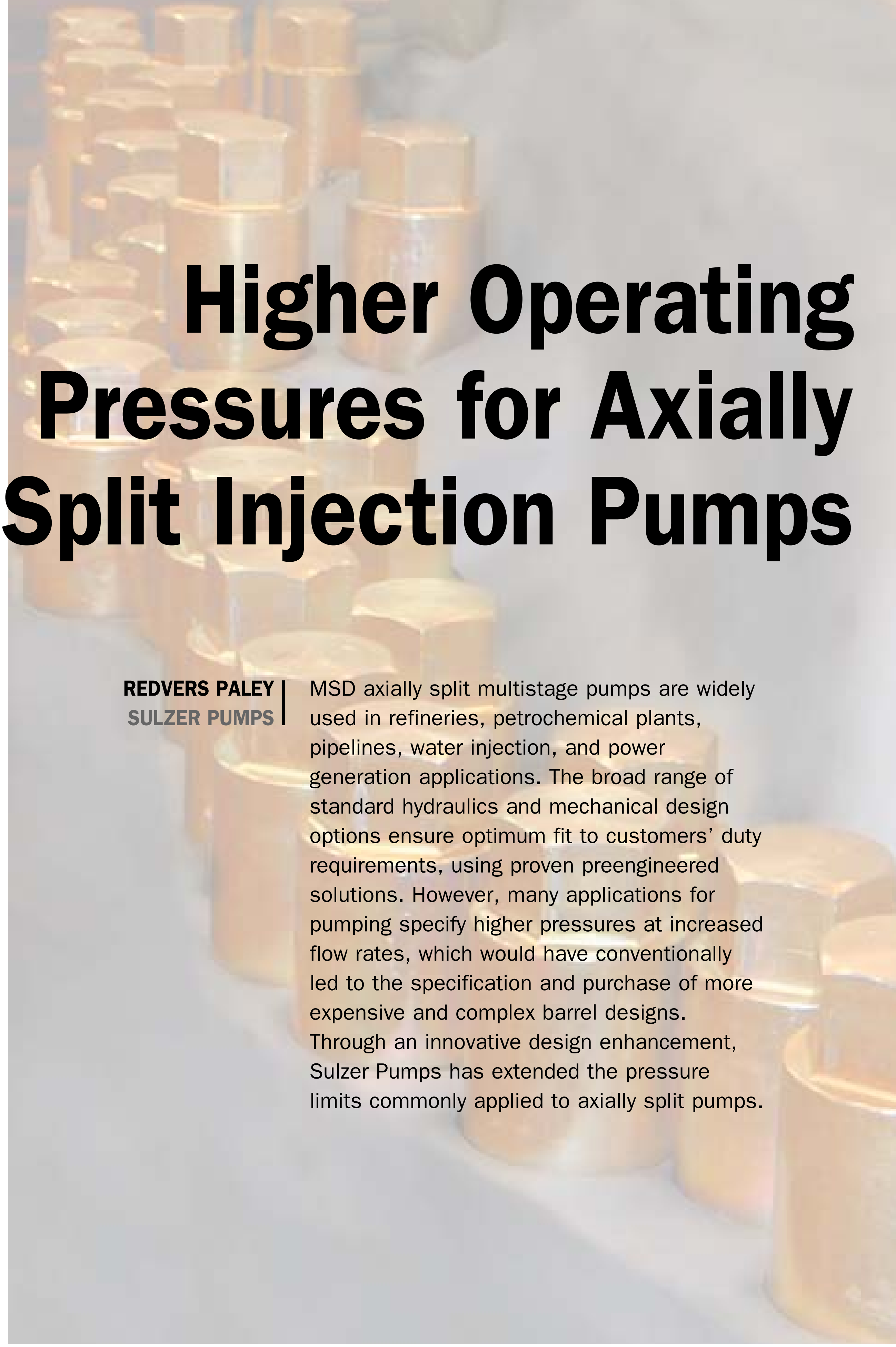

Higher Operating Pressures for Axially Split Injection Pumps

REDVERS PALEY
SULZER PUMPS

MSD axially split multistage pumps are widely used in refineries, petrochemical plants, pipelines, water injection, and power generation applications. The broad range of standard hydraulics and mechanical design options ensure optimum fit to customers' duty requirements, using proven preengineered solutions. However, many applications for pumping specify higher pressures at increased flow rates, which would have conventionally led to the specification and purchase of more expensive and complex barrel designs. Through an innovative design enhancement, Sulzer Pumps has extended the pressure limits commonly applied to axially split pumps.

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High-pressure pumps used by oil companies fall into two basic design groups, barrel casing and axially split. In a barrel casing pump, the internal components are contained within a barrel, which can be designed to withstand exceptionally high discharge pressures. Maintenance of the rotating element requires removal and disassembly of the cartridge. Only then may the impellers and wear parts be inspected and serviced.

By contrast, the casing of an axially split pump is split along its centreline. The top half can be removed and the rotor extracted as a single unit for rapid maintenance or replacement, even in the field. This type of pump is simpler to maintain; therefore, some operators take advantage of this benefit by using axially split pumps.

Although the axially split solution works well for lower operating pressures, there is a pressure limit that works to its disadvantage. The two casing halves are held together by a series of studs and bolts; as pressure rises, the pressure within the casing attempts to force the two halves apart along the centreline joint. Over the years, Sulzer Pumps has developed and refined the axially split design to allow the safe handling of higher operating pressures.

Pressure Casing Limits

As the operating pressure increases or the pump size is increased for higher flows, the standard single row bolt arrangement fails to guarantee a pressure-tight joint. The two casing halves are literally forced apart, reducing the sealed surface area of the joint and creating leakage. In larger pumps, the effect of the pressure on the expanded surface area is compounded. In addition, the greater distance between the pump centreline and the bolting places more leverage on the joint for a given internal pressure. There are no absolute figures for this; variables such as pump size, materials of construction, and individual design features all have an effect. The practical outcome, however, is that international standards (such as API 610) require the use of barrel casing designs above a certain pressure (100 bar in the case of API 610). Pump manufacturers must demonstrate experience at higher pressure levels before an axially split pump is considered for a high-pressure application.

Innovative Solution Involves Changes in Bolting

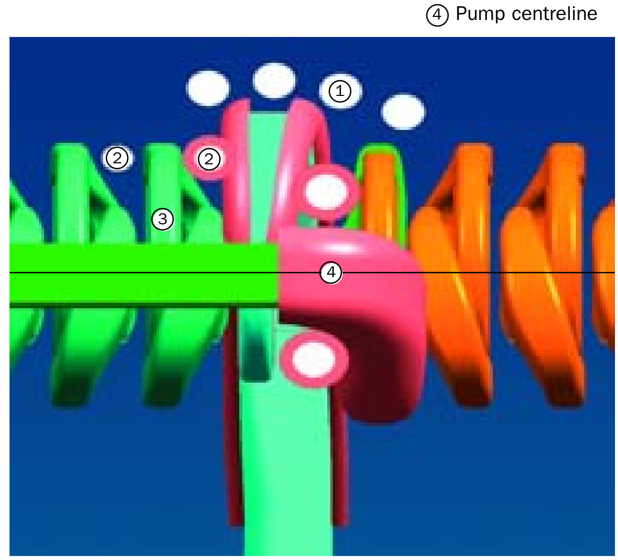
The initial solution to the pressure sealing problem is twofold:

- Increase both the size and number of studs clamping the two halves together
- Thicken the material around the casing joint for added stiffness

However, these methods have both practical and technical limits (e.g. the number of studs that can be placed along the length of the joint). To overcome these problems, Sulzer designs the casings on high-pressure units to accept a second, inner row of studs. These extra studs increase the pressure clamping the two casing halves together and, at the same time, reduce the leverage effect opening the joint.

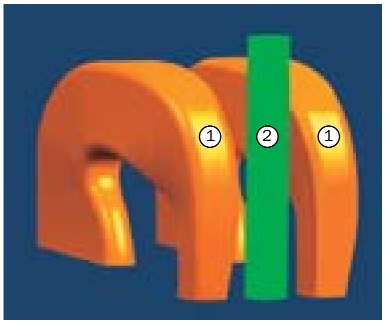
For maximum effectiveness, the second row of bolts must be as close as is practical to the pump centreline (Fig. 1). This arrangement involves design changes to the routing of the interstage hydraulic crossover, which takes fluid within the pump from one stage to the next. In order to accommodate an extra stud, the crossover passage is routed at a more vertical angle than normal; this design change allows the stud to be optimally placed to secure the casing (Fig. 2).

However, this alteration also increases the interstage distance, or the distance between each stage, which, in turn, results in the need for a longer rotor than is required by the equivalent low-pressure (single-row bolted) pump. In order



1 In the MSD high-pressure axially split pump, the second row of bolts is placed as close as is practical to the pump centreline, in order to ensure a pressure-tight joint.

① Crossover passage
② Stud



2 The crossover passage follows a more vertical path, which allows the stud to be optimally placed to secure the casing joint.

to minimise the change in interstage distance, the second row inner studs are smaller in diameter than the outer studs, and to ensure the stability of the longer rotor, a full rotodynamic analysis is always performed on the high-pressure version of an axially split pump.

The addition of second row bolting increases the design pressure by at least 15% compared to single row bolting and can make the selection of an axial split design over the more complex barrel pump a realistic option. In many cases, this figure can be comfortably exceeded, the actual increase however is dependant on factors such as pump size and materials of construction.

Case Study

Water is routinely injected into oil reservoirs in order to increase the amount of oil produced. A major international oil company had been successfully using Sulzer MSD axially split casing pumps for many years for water-injection duties; they required increased injection pressures at higher flow rates than had previously been applied. After discussing the duty requirements with the customer, Sulzer Pumps engineers were able to demonstrate the benefits of using a double-bolted axially split pump for the new application.

Two MSD 6 × 8 × 13.5 twelve-stage pumps manufactured in super duplex stainless steel were selected for the duty (Fig. 3). Driven by a 4.75 MW motor via a variable speed gearbox, each pump delivers 416 m^3/h to a head of 1800 m. The design supports pressures up to 255 bar and the casings have been successfully pressure-tested to 382 bar.

This solution provided a number of advantages, namely:

- Lower capital investment than an equivalent barrel pump
- Similar layout to many existing lower pressure pumps; the operators were immediately familiar with the design
- Nearly identical maintenance procedures to the existing pumps, and simpler maintenance than with the alternative barrel pump solution
- Similar skid layout and logic (lube and seal systems, pipework, and other auxiliaries) to the existing units

Sulzer Pumps' knowledge and experience in the practical application of double-row bolted axially split casing pumps allowed the operator to confidently select a familiar solution that was lower in capital cost and simpler to maintain than the barrel-pump alternative that had also been proposed. ◀

3 A major international oil company uses the MSD super duplex axially split pump designed for pressures up to 255 bar.

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