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Sulzer White Paper

Reviving pump performance – Efficiency and reliability boosting pump retrofits for mid- and downstream oil and gas facilities

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High energy pumps represent a significant investment for mid and downstream oil and gas facilities. Operators in the industry realize that pump efficiency is a key characteristic in facing the challenges of minimizing costs while meeting demanding productivity targets. As application and pump performance requirements change, retrofit projects offer a cost-effective solution with an excellent return on investment.

Pipelines, refineries and petrochemical plants all have to deal with changes in market demands, which are often associated with changes in national regulations. At the heart of these operations are the pumps that move products between locations, in some cases over hundreds of miles. Large, high-energy pumps play a vital role, but at the same time, they represent a significant percentage of annual running costs.

These versatile assets can often be the victims of their own success; designed for an extended operational life and to meet the challenges of their environment, they are manufactured to deliver long-term service and reliability. However, during their operational lifetime, the requirements of the application can change. Without significant alterations to the design of the pump, this will lead to a reduction in efficiency and possible reliability issues due to off-BEP (Best Efficiency Point) operation.

Case study: Diesel charge pumps

A significant increase in the demand for ultra-low sulfur diesel (ULSD) has required refineries to adapt their processes and find innovative solutions to deliver increased capacity. In Texas, USA, these new regulations led a refinery to reach out to an experienced provider of pump retrofits to find possible solutions.

A significant part of the project required two BB5, 10-stage diesel charge pumps to increase their delivery rate by 47%. Originally installed in 2006, the pumps had a rated point of 1’110 gpm (252 m^3/hr) at 4’014 ft (1’223 m) of head. With the change in ULSD demand, reliability engineers at the refinery were interested in a capacity increase to 1’628 gpm (370 m^3/hr) at 3’450 ft (1’052 m) of head.

The operator was faced with three possible options. The first option was to purchase a new pump that met the new capacity requirements; alternatively, the second option was to modify or re-rate the original pumps or, third, operate both of the existing pumps in parallel at 100% rated capacity (depending on the pump system curve).

Costing the alternatives

A new pump selection to fit the application could be advantageous with regards to efficiency but had long lead times, in addition the cost to reroute pipework, and baseplate/ foundation modifications could make this option less attractive. As re-rating is often faster and more economical, the only major downside to the second option is that the desired performance may not always be achievable in the given frame size.

The idea was to keep the approach as simple as possible, to minimize the overall project time. In this case, a specific speed (Ns) based search, through a vast hydraulic database, revealed an existing proven design that would meet the customer's needs. This design would work well, provided the impellers were able to physically fit, and the inner-case volute nozzle areas were able to be increased enough to allow the impeller to meet as-designed performance.

A mechanical cutback was done (Picture 1) to achieve both an increase in nozzle area and lip diameter. Based on empirical data, the increase in nozzle area would allow the new impeller selection to runout to the new design point. The increase in volute lip diameter enabled the designers to achieve sufficient lip clearance. This, and the fact that the cutback was 'angled', helped with the reduction of vane pass pulsations and overall vibration amplitudes.

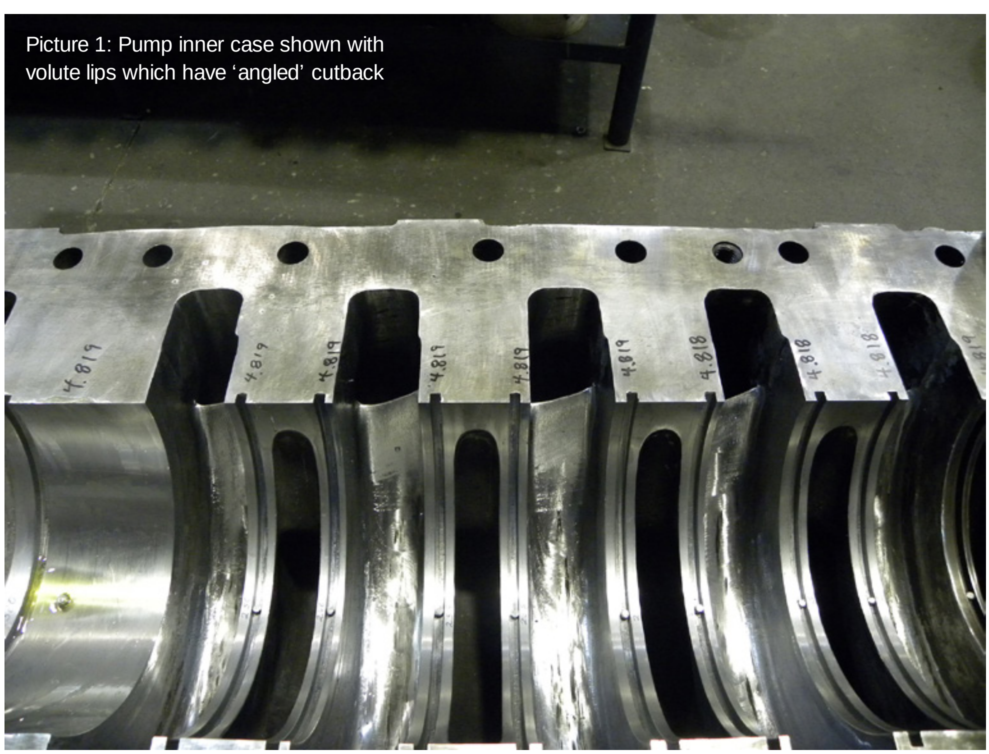
The outlet vanes of the impeller were underfiled to increase the outlet area between vanes (OABV) and help flatten the performance curve. This also pushed the best BEP to achieve higher flows.

Saving downtime

The design process highlighted the fact that the new performance level did not require all 10 stages. One stage was removed so that the impeller trim could be near-full diameter. This benefited both the efficiency and the BEP location for the pump. With the stage reduction, the effect on axial thrust direction and magnitude was analyzed; the internal bushings were resized to ensure the axial load was acceptable for the thrust bearing.

The rerate required no changes to the footprint of the existing pump, saving valuable time in completing the project. As previously mentioned, if a new pump had been specified, baseplate modifications and the re-routing of suction and discharge pipework would have been required. Changes to the surrounding infrastructure such as this, would have lengthened the project duration considerably and beyond the expectations of the operator.

The hydraulic modifications were all confined to the inner-bundle, allowing the outer-barrel to remain in-situ. This had a significantly positive effect on the overall delivery time for the project and the much shorter completion date minimized any downtime. The final major benefit was that the payback period for the cost of the project was achieved in the very short time of just 35 days.



Picture 1: Pump inner case shown with volute lips which have 'angled' cutback

Picture 2: A typical example of a Sulzer service center 3D scanning a Brand X component

Case study: Boiler feed pumps

Every large-scale oil and gas facility that uses steam turbines, either as a direct power source or for wider electricity generation, relies on boiler feed pumps to move large volumes of water. High energy requirements mean that these pumps need to be efficient as well as reliable. One plant had been equipped with nine pumps, seven duty pumps and two held in reserve. After 30 years in service, worn seals, increased clearances and reduced efficiency meant that all nine pumps needed to be operational to supply enough water to the boilers.

The option for the original manufacturer to repair or replace the pumps was explored, but the costs and lead times for both options fell well short of expectations. The customer reached out to Sulzer for an alternative solution to the original manufacturer. Sulzer was able to provide a retrofit solution which fit within the lead time required, was more cost effective, and returned the pumps to as-new performance levels.

The upgrades included efficiency increases through non-metallic wear parts, seal improvements and the installation of a mechanical improvement to the coupling system. The new parts were designed and manufactured using state-of-the-art equipment, including 3-dimensional laser scanning technology, (Picture 2), to create the engineering models that were used with the latest casting techniques to produce the parts.

The innovative manufacturing techniques greatly reduced conventional lead times and allowed the investment in the pump refurbishment to be paid off in less than three years. Considering the scale of the project and the long-term benefits, the return on investment exceeded the expectations of the operator.

Measurable advantages

Assessing pump performance and how best to match it to the current operating requirements, demands considerable engineering expertise as well as an in-depth understanding of the application. By integrating existing designs, it is possible to achieve revised specifications, often without any changes to the installation footprint.

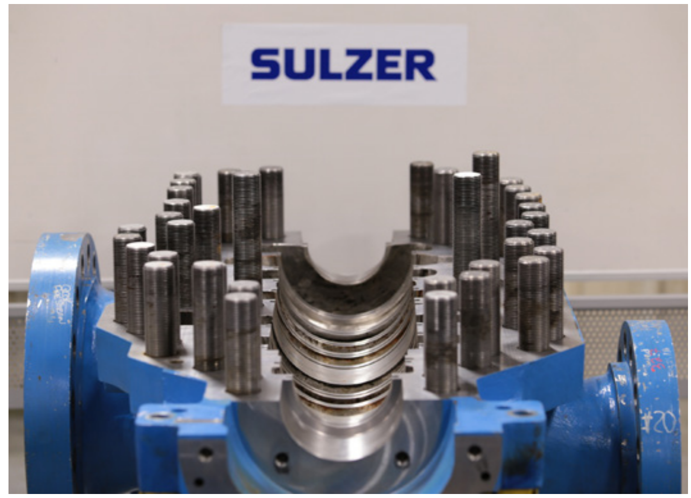
Retrofit projects offer solutions that can very often be delivered more quickly and more cost-effectively than the alternatives. For operators working in the oil and gas sector, which is highly averse to downtime and needs to minimize capital expenditure, there is an opportunity to improve performance and streamline costs.

Furthermore, it is also possible to take advantage of more recent advances in materials technology, upgrading components to improve operational service life as well as reliability. This can be especially advantageous for applications that involve abrasive or corrosive conditions.

Environmental gains

Understanding what can be achieved by a retrofit project and how best to apply it, are important skills that are gained through experience in both the industry in question and in developing state-of-the-art solutions. By developing theoretical models and fine-tuning the design, engineers can highlight the benefits and ensure that the equipment is suitable for refurbishment.

Picture 3: Retrofits offer the opportunity to upgrade components and improve reliability



Picture 4: Sulzer offers in-house machining, retrofits and reverse engineering capabilities

The ability to improve efficiency and reduce energy consumption through modern engineering also offers the opportunity to reduce the environmental footprint of the business. As more pressure is placed on industrial plants to improve the environmental impact of their operations, so the retrofit project has the potential to deliver both a cost and CO_2 emission reduction.

Conclusion

An experienced pump design and maintenance expert, such as Sulzer, that offer in-house manufacturing, retrofit and reverse engineering capabilities, can make these projects a reality. The ability to carry out comprehensive testing and provide on-site support means a turnkey package can be delivered, simplifying project management and minimizing the amount of customer resources required.

The improved efficiency and extended reliability offered by retrofit projects for high energy pumps in oil and gas applications can deliver reduced operating as well as maintenance costs, which minimize payback periods and benefit the bottom line for years to come.

About the author

Matt Kinney works for Sulzer Pump Services (US) Inc. based in Portland, Oregon. He has been with Sulzer for 12 years. He started as an engineering intern, before moving into design engineering, field engineering, and for the last two years he has been a Hydraulic Retrofit Specialist working on pump hydraulic retrofits and rerates.