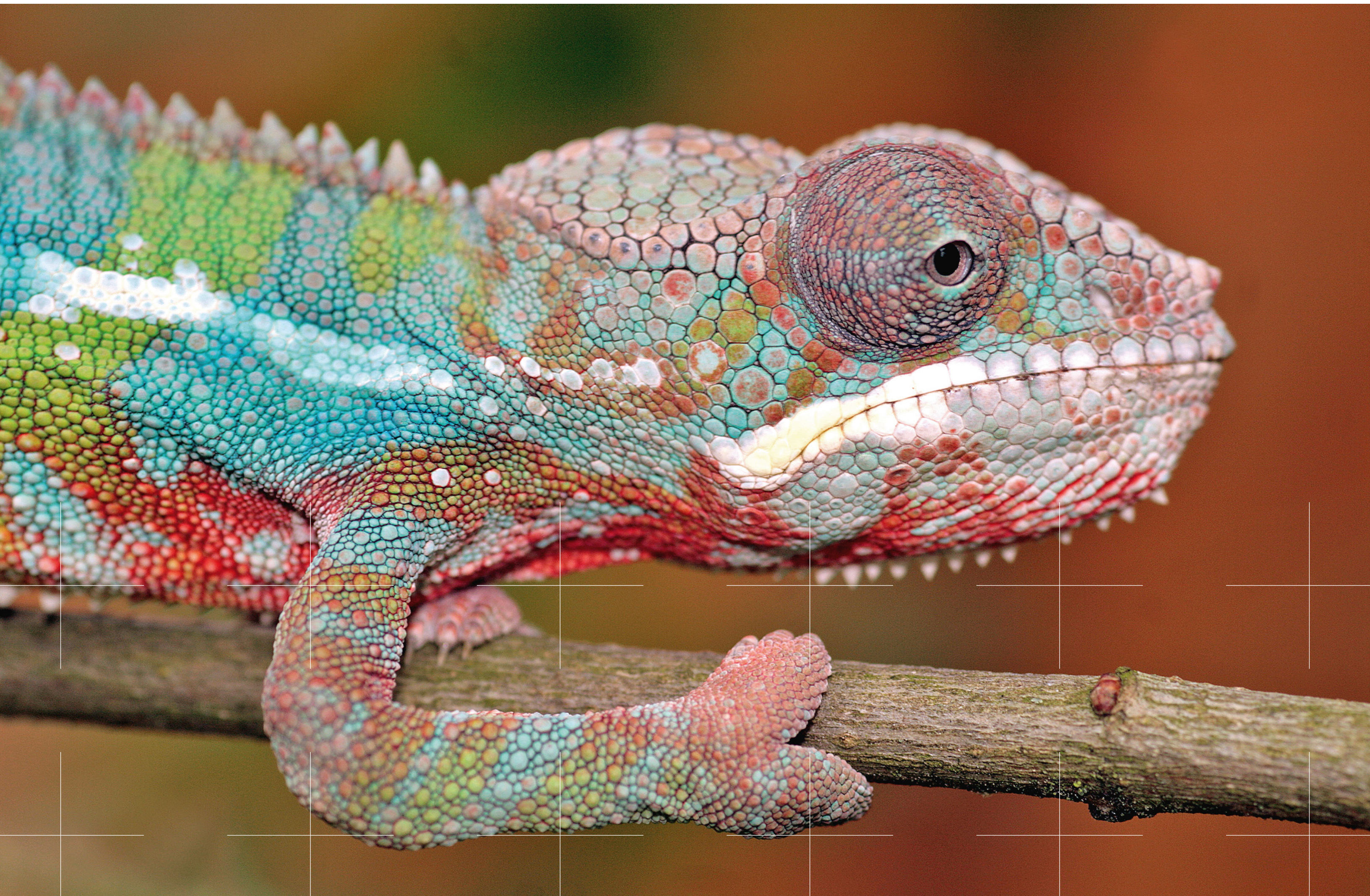
CASE STUDY

Fit for Changes

Changing conditions are a huge challenge for pump operators. Not only can the operating costs skyrocket, but the risk of production downtime can too—which is unacceptable, especially in businesses like oil and gas, power, and water. The example of a water injection pump retrofit shows how Sulzer helps to ensure reliable operation and to reduce energy consumption.



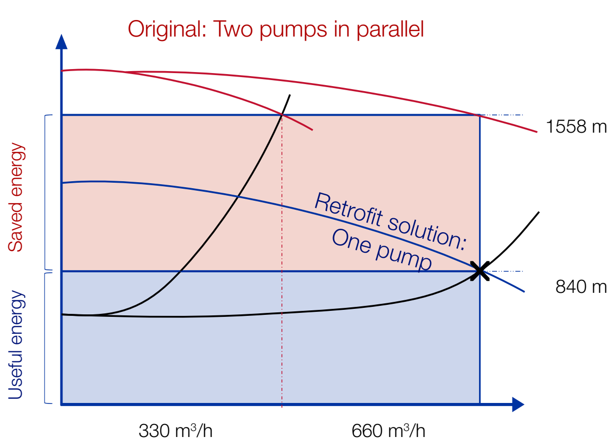
A major oil company runs an offshore platform in the Norwegian continental shelf in the North Sea. On this platform, two Sulzer HPcp BB5 type pumps have been in operation since 2002. They reinject produced water into the well to increase the pressure in the oil field and enhance oil production. These pumps were designed for a flow of 331 m^3/h and a head of 1558 m. One of the pumps served as standby unit in case of failures, while the other one was in operation. In the years following the installation, it became apparent that the well required less than two-thirds of the originally specified discharge pressure. That meant that the pump needed to be throttled, and a lot of energy was lost. In 2009, the situation deteriorated further because the process conditions changed once again. At that point, the required pump flow doubled, while the required pump head further decreased. A single pump could not achieve the higher capacity by itself. However, operating both pumps in parallel was also not an option. Without a standby unit, a failure would lead to a considerable production loss. That risk was not one the company was prepared to take.

The operator asked Sulzer to evaluate the possibility of rerating these pumps to provide more flow so that the injection requirements could be met with only one pump. During these discussions, the desired duty flow for each pump was set at 660 m^3/h (or as close as possible) at a discharge pressure of approximately 100 barg (pump head 840 m, suction pressure 10 barg).

Tailored retrofit solution

Sulzer conducted a hydraulic study at one of its global retrofit competence centers in the UK. Sulzer's engineers determined the optimal hydraulic design for the confines of the existing barrel casing, while reusing as many of the existing cartridge components as possible. The components retained from the existing design included mechanical seals, bearing, and coupling assemblies as well as the electric motor.

Sulzer had several hydraulic designs that were geometrically similar to the one required for this application, but they were too large to fit this injection pump barrel. However, by adopting the proven laws of dynamic similitude, Sulzer physically scaled down these designs so that the operating conditions were satisfied. This approach had the advantage of allowing the engineers to reliably predict the new, scaled performance from experience. The effects of incremental changes to this basis are well understood and allow the base performance curve to be modified to suit individual applications.



	Original pumps	Retrofitted pumps
Frame size HPcp	150-338-22/8s	150-315-36/6s
Pump flow	2 pumps: 2 x 331 m3/h	1 pump: 660 m3/h
Pump head	1558 m	840 m (new condition)
Efficiency	75% (per pump)	78%
Absorbed power	2 pumps: 2 x 1902 kW = 3804 kW	1875 kW (savings: 1929 kW)
Number of spare pumps	None	1

The red curves show the performance of the original pumps. The black cross marks the new required operating point that could not be achieved with one pump before the retrofit. The blue curve shows the performance of the retrofitted pump. The pump achieves the required capacity using less energy.

To accommodate the flow increase, Sulzer had to increase the impeller outlet passage width, which also required an increase of the distance between each stage. Sulzer replaced the following components:

- All impellers
- All series stage diffusers
- Last-stage diffuser
- Pump shaft
- Balance drum and liner

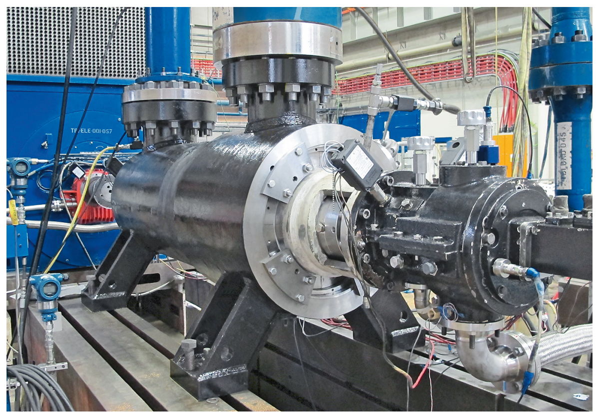
Because of the higher velocities in the pump suction nozzle caused by the increase in duty flow, the pump required a new advanced suction inlet casing design. Sulzer conducted a full CFD (computational fluid dynamics) analysis on this new design to ensure that an ideal distribution of flow was achieved from the inlet to the suction impeller eye. To verify the integrity of the pump mechanics, Sulzer performed a full rotor-dynamic analysis at the retrofit center.

Massive energy savings

Performance testing confirmed that the retrofitted pump met the new duty conditions (in compliance with API 610). The retrofit was completed using a reasonable number of the existing cartridge components and without modifying the existing motor. The new cartridges were installed into the existing barrel casings after only one week per cartridge. None of the piping or major site ancillary equipment needed modification.

Since the retrofit, the customer has been able to achieve the required water injection performance with one pump alone. One pump is therefore left as a standby unit, and the risk of injection failure—and consequently production loss—is minimized.

The duty flow required to achieve 100% operation with one pump was achieved with a significant reduction in pump discharge pressure—meaning that surplus pressure no longer has to be throttled down across valves. Hence, a significant amount of energy is saved. To achieve 660 m3/h with the two existing pumps operating together, 3804 kW of absorbed power at the pump coupling would be required. The retrofitted cartridge requires only 1875 kW to achieve the same flow in singular operation. The energy savings of 1929 kW in input power amounts to more than 16.8 million kWh annually. At an energy unit cost of USD 0.06 per kWh, the recurring savings translates into more than USD 1 million per year. Thus, the payback period of this retrofit was less than one year.



After a Sulzer retrofit, pumps are performance tested at one of Sulzer's test beds (here a third party BB5 pump).

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