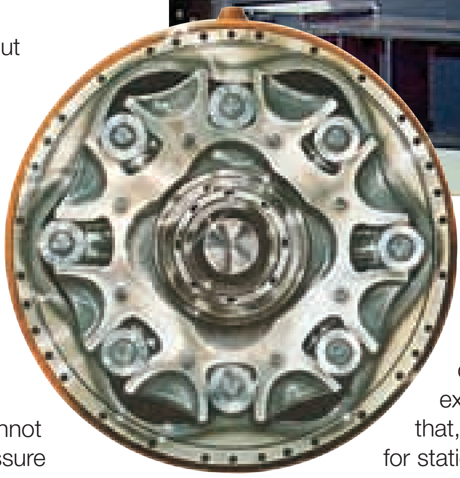
Pump suction

Net positive suction head is a key factor in selecting and engineering pumps for difficult environments and duties, writes Oliver Brigginshaw



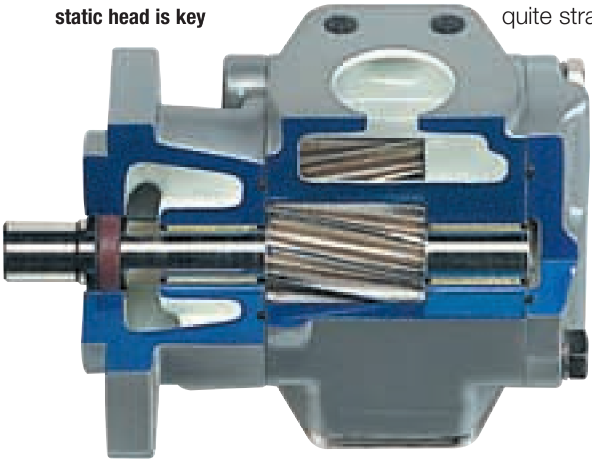
Selecting a pump is always about balancing several factors – for example, the volumes and contents to be pumped, the efficiency required and how frequently the pump will be run. But where space is at a premium, or the cost of changing structures or pipework is prohibitive, plant engineers may also have to deal with an additional factor – namely poor suction static head. Failure to take this into account can cause cavitation, with catastrophic consequences.

Cavitation occurs when the pump cannot pull enough liquid, and the resulting pressure reduction causes liquid to vaporise and form bubbles. These can grow to the extent that they choke the inlet, further reducing liquid flow and hence also pump performance. Just as importantly, they can implode, causing excessive noise and vibration, and leading to premature component problems and, in some cases, impeller failure.

To prevent cavitation arising on your application, the pump manufacturer should ask you for the net positive suction head NPSH (A) available at the pump, and ensure that this exceeds the head required by the pump to operate within its acceptable range – known as NPSH (R).

Calculating NPSH (A) is quite straightforward, taking into account the suction static head, friction losses, atmospheric pressure and the vapour pressure of the liquid involved. However, caution must be exercised with the latter parameter, since in an industrial process the liquid may be a cocktail of chemicals, meaning the vapour pressure may need to be determined experimentally. Beyond that, there is the potential for static head to change during the process of pumping a liquid – for example, during vessel emptying.

Volume flow rates, pumped media, required efficiency and frequency of operation are not the only factors in choosing a pump: static head is key



Optimum efficiency

That said, for a given NPSH (A), a pump manufacturer should provide a pump with an NPSH (R) that is less than NPSH (A) by some 0.5m – although, if the accuracy of your data is in any way suspect (particularly where fluid vapour pressure is not accurately known), it may make sense to increase this differential value.

So far, so good. But here's a thing. Pump manufacturers design their products to work at maximum efficiency and lowest cost over a particular range of running speeds and, generally, that's how they're sold – meaning NPSH (R), which is defined by those parameters, is effectively preset. That's why plant engineers sometimes find they can't achieve the necessary static head to run a particular pump at its optimum efficiency without, for example, costly changes to plant structure, the pipework or associated equipment.

So, if you're faced with that situation, what are your options? The answer is: not many. Lots of pumps on the market today are based on designs that date back 50 years, so low NPSH versions are often simply not available. In the end, you may need

the services of a specialist pump designer and manufacturer that has invested in computer modelling for fluid dynamics and is capable of offering equipment able to run both efficiently and in low NPSH environments. Such engineering firms are typically able to tune their designs and re-engineer key components to produce pumps capable of delivering the required overall performance. The only caveat: be sure to check their test facilities; finding the point of cavitation reliably is a crucial, but often fairly empirical, process.

Clearly, the ideal pump is one that can deliver the specified performance within the suction static head constraints, at an efficiency approaching that of a standard unit. Be warned: achieving that through modification is rarely cheap, but it's also true that the price is almost always outweighed by the cost, or sheer impracticability, of changing the plant itself.

Small, but powerful

A recent example was on the Triton floating, production, storage and offloading (FPSO) vessel in the North Sea. Deep-water engineering consultant Wood Group was working with Amerada Hess on a filtration system designed to enable Triton to meet the OSPAR (Convention for the Protection of the Marine Environment of the North East Atlantic) regulations. The project required 10 high-specification water pumps, small enough to squeeze within the constraints of the vessel infrastructure, but also capable of operating at a very low NPSH (A), given the poor head available.

Initially, vertical in-line pumps were considered, but these were quickly ruled out, as there was insufficient headroom to remove their motors for maintenance. Additional pipework before and after the pump would also have been required, expanding the footprint beyond the space available.

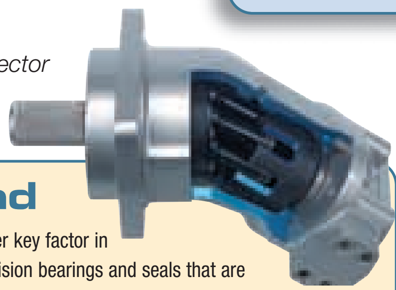
However, given the contract deadline, a new pump design was not feasible, so Amarinth proposed a hybrid design, based on its 'C' series heavy-duty ISO 5199 chemical pump. This horizontal unit would fit the space constraints and was already suited to operating in low NPSH environments. The alternative would have been to redesign the plant and pipework, or to build new decks to deliver the NPSH (A).

Up-rated API 610 bearing brackets were designed and incorporated to allow the pump to meet the demands of this application, thus achieving Wood Group's requirements of low-maintenance, high-reliability pumps, with low NPSH (R). Wood Group was able to make significant cost savings on the overall project, because the major system and vessel changes that would have been required to accommodate alternative pumps were eliminated. PE

Oliver Brigginshaw is managing director of specialist pump designer and manufacturer Amarinth

Pointers

- Poor suction static head risks causing cavitation and early impeller failure
- Net positive suction head (NPSH) available (A) must exceed that required by the pump itself (NPSH (R))
- Be warned: older pump designs often have fixed NPSH (R), so can't be tuned
- If there's a problem, look for low NPSH pump designs, or pump engineering firms willing to develop specials
- For robust, quality performance, don't forget good bearings and seals



Bearing in mind

Look beneath the surface and there is another key factor in choosing hydraulic pumps. They require precision bearings and seals that are reliable and efficient, if they are to withstand tough operating conditions. Consider gear pumps, for example, among the workhorses of industry – supplying coolants and foodstuffs, keeping hydraulic systems in motion, powering mobile hydraulic equipment and machinery.

Dr Steve Lacey, engineering manager at bearings specialist Schaeffler UK, says that, for gear pumps, the firm recommends its Permaglide plain bearings or high quality needle roller bearings, to ensure that the gears perform with almost zero losses. He also notes that the supply medium is often used as the lubricant for the bearings. So, for fluids with low lubrication characteristics, needle roller bearings are increasingly preferred – enabling higher speed operation, since less heat is generated from the bearings.

"The pump speed and load often determine whether ball bearings, cylindrical roller bearings, radial spherical roller bearings or plain bearings are selected for an application," explains Lacey. "However, because there are many different pump designs, we have developed a wide range of bearing types, designs, cage variants and seals." He cites Schaeffler's X-life INA and FAG bearings, which are low noise and maintenance-free, specifically optimised for high load carrying capacity.

He also refers to bent axis pumps and motors, used in hydraulic systems to generate pressure. Stroke motion of the axially oscillating pistons is generated by the main output axis, which is bent towards the rotor axis. "We manufacture geometrically accurate steel seals with split butt joints for designs, with either centred or eccentric crowned outer diameters, as well as for other contours," he explains – noting that these seals have low press-on force, minimal leakage, low wear, high resistance to abrasion and good resistance to oil and temperature.