Gear pumps for highly corrosive media

Soft shell, hard core

Gear pumps are firmly established in industrial plants owing to their enormous reliability and flexibility. However, in view of their optimal delivery characteristics there is an increasing desire among plant operators to use this type of pump for highly corrosive media as well. A particularly robust pump that is extremely resistant to wear is vital for this purpose.

As a rule, gear pumps lubricated by the process are normally considered unsuitable for applications pumping low-viscosity fluids like water and solvents, along with relatively high differential pressures. Amongst other things, the lubrication film required for reliable operation of the pump friction bearings is a function of viscosity, revolutions and the bearing load defined by the differential pressure. For some time, it has been possible to help the pumps operate under these conditions by selecting especially suited bearing materials as well as coatings for the hardened metal gearwheels/shafts. The advantage of using gear pumps for these applications is the almost pulsation-free delivery, the volumetric flow behaviour and the ability to pump even the smallest volumes safely.

Yet what happens when the properties of the pumping fluid render the use of standard, hardened stainless steel impossible for the gearwheel/shaft material because of chemical compatibility issues? More compatible materials such as austenitic stainless steels, for example, are only suitable to a limited extent due to their mechanical properties. Their low stability, susceptibility to seizure and in particular absence of hardening means this material can only be employed in applications with low differential pressure.

Against this background, a material was sought which is hard, firm and resistant to the majority of chemicals. A glance at the Witte modular system showed that such materials have been in use for a long time in various applications in the form of friction bearings, e. g. ceramics like silicon carbide (SiC) or zirconium oxide (ZrO_2).

Gear pump for highly corrosive media in the assembled state

Test passed

The specific trigger for choosing a new material was the use of a low-viscosity fluid on board submarines. Martensitic chromium steel 1.4112 with a chromium nickel coating, for instance, would definitely have been suitable for this task – but was not permissible owing to the vessel's magnetic signature.

Two other aspects resulted in an extremely hard ceramic material being selected: the process was intentionally run as close as possible to the vapour pressure curve and operated intermittently. Both scenarios can lead to inad-

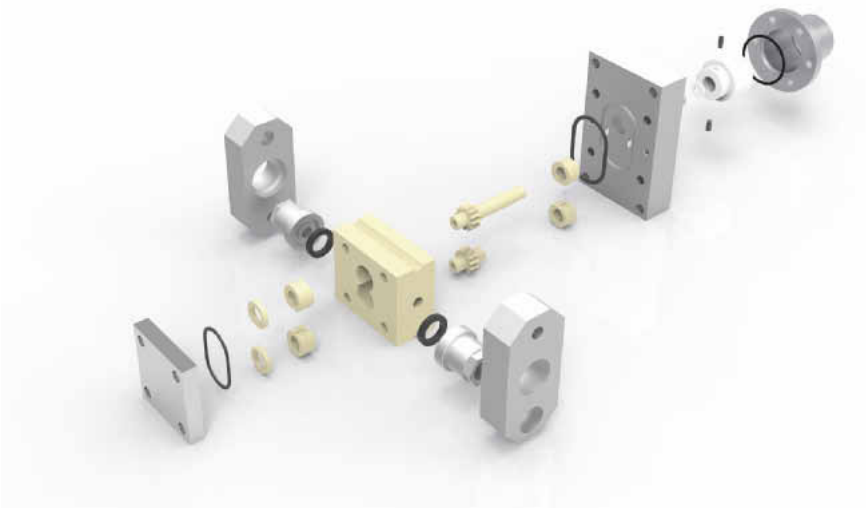
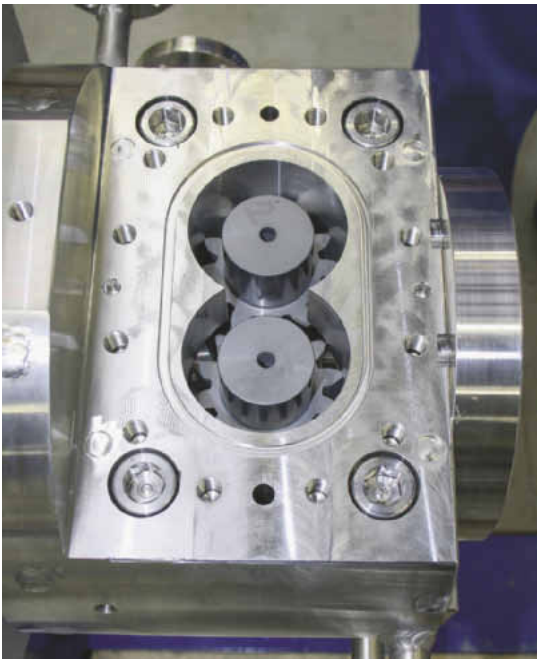


Diagram of the ceramic components such as bearings, shafts, housings and shims made of zirconium oxide (ZrO_2)

Author

Carsten Pump
Head of Sales Pump Systems,
Witte Pumps & Technology



Pump assembly with ceramic shafts and bearings in SiC

equate lubrication of the bearings and given the usual materials would lead to failure within the foreseeable future.

There was also a desire for a maintenance interval of at least 8000 operating hours. An inspection after this period of time showed the pump to be in excellent condition; wear with the ceramic material was negligible.

Other opportunities arose soon after: small quantities of formic acid (0.04 l/min) needed to be pumped to an output pressure of 11 bar in a process for the production of melamine. These pumps are meanwhile running so well that a follow-up order has already been placed. The largest application thus far has a specific volume flow of 176 m^3/rev. and a gearwheel diameter of 81 mm, and is currently pumping 3000 kg/h of a highly corrosive prepolymer. The housing and other wetted parts are made of Hastelloy C276.

The last expansion stage of the ceramic gear pumps to date is a magnetically coupled version made of zirconium oxide for pumping sulphuric acid at a temperature of +130 °C. All wetted parts such as the housing, gearwheels and plain bearings are made of ceramics. Only the inner rotor of the magnetic coupling is manufactured from stainless steel and subsequently encapsulated with PTFE.

Ceramic housing needs a new design

Apart from the production requirements for the individual components, a ceramic housing needs a completely new design as conventional connection elements can no longer be fitted. Geometries like threaded blind holes cannot currently be achieved with the necessary resilience with ceramic materials.

Of course, such solutions are unlikely to elevate the gear pump from niche status to a mass product. However, they show that innovative ideas and manufacturing techniques can add significant value to traditional, proven technologies. New applications and opportunities, which previously did not exist, can now be opened up for gear pumps.

Hall 8.0, Booth F36

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