KYOCERA

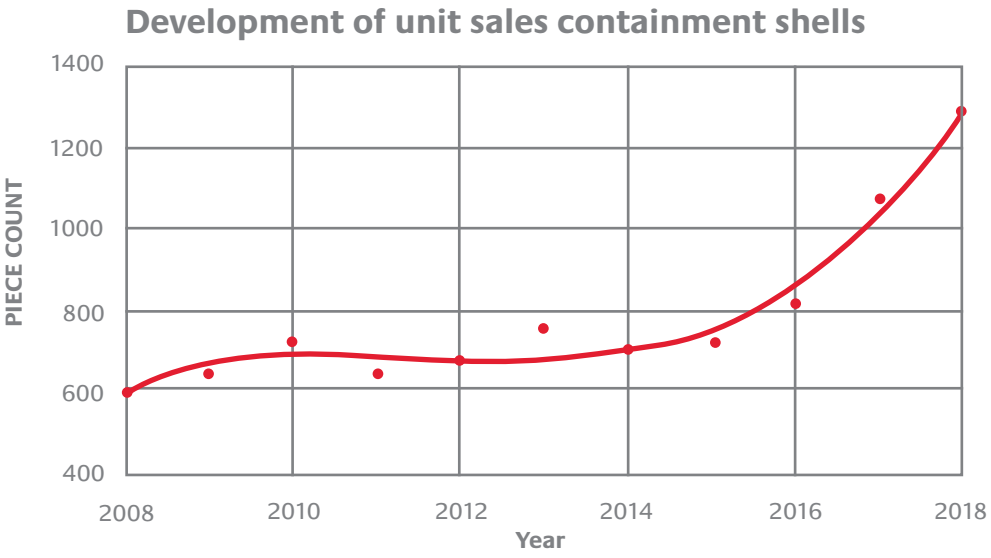
CONTAINMENT SHELLS FOR THE PUMP INDUSTRY

High-Performance Ceramics

www.kyocera-solutions.se

WELL-ESTABLISHED ON THE MARKET

The current development of state-of-the-art sealing systems applied in the pump industry focuses on magnetic couplers more and more. Here, containment shells made of oxide ceramics form the central element. That is because of the unique magnetic, corrosive and mechanical properties ceramic materials offer to realise such applications. In close cooperation with our customers we develop tailor-made solutions meeting their very specific requirements.



No failure damage caused by the ceramic containment shells known so far.

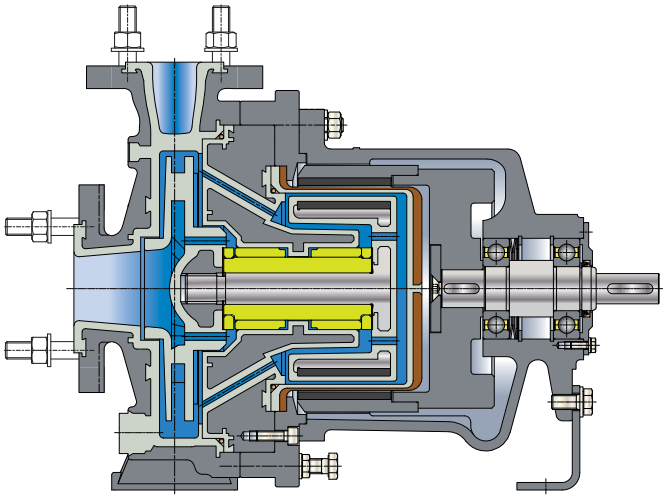
Containment shells protect pumps, environment and employees.

HIGH-PERFORMANCE CERAMICS

Magnetically coupled centrifugal pumps require non-magnetic components highly resistant to mechanical forces and corrosion. High-performance ceramics hold suitable material properties to meet such exceptional combination of requirements.

Magnetic couplers ensure hermetic sealing of the pump against the drive. Minimum maintenance requirements allow for leakage-free operation. This prevents any environmental impact caused by spilt pumping media from the outset.

Meeting highest pumping standards.



Source: Rheinhütte Pumpen

Compared to conventional materials, containment shells made of FZM high-performance ceramics hold the following benefits:

- FZM is non-magnetic – eliminating the creation of performance-impairing eddy currents and reducing electrical drive power by 10 to 15 %.
- FZM is corrosion-resistant – allowing for universal application to virtually all acids and bases.
- FZM offers high mechanical stability – depending on the size of the inner diameter, test pressure conditions exceeding by far 60 bar at temperatures of 450 °C and more can be controlled. A relatively small elastic modulus ensures a certain elastic deformation capacity.

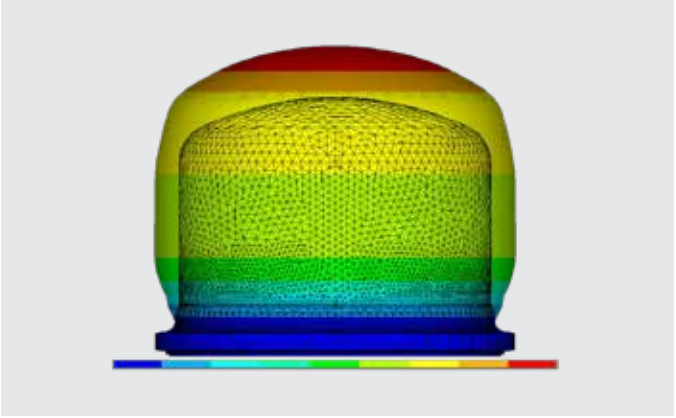
To keep the magnetic split as little as possible the wall thickness in the cylindrical section of the containment shell ranges between 1.5 and 3 mm, only – again depending on the inner diameter.

Thanks to the above-mentioned properties, FZM containment shells for magnetically coupled pumps stand for the ideal choice for any application in the chemical industry. The design of the containment shell is adapted to the individual pump type specified by our customers.

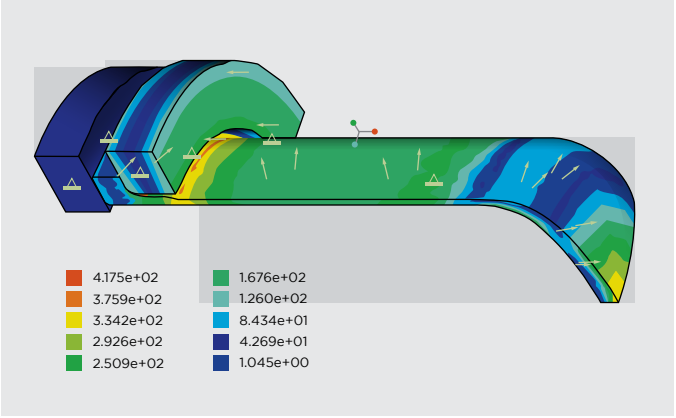
FZM

FZM has proven itself as an ideal ceramic material characterised by high fracture toughness as well as wear and corrosion resistance. Low thermal conductivity, excellent thermal shock resistance and superb thermal expansion properties comparable to cast iron round off the unique features of the material.

Optimum design of the transition to the bottom end cap and flange hub allow for a low wall thickness of the containment shell and thus a more cost-efficient dimensioning of the integrated magnets.



Global deformation (50-fold stilted presentation)
Pressure: inner pressure 36 bar, inner temperature 250 °C



FE evaluation assembly

Top-drawer application results.

MATERIAL PROPERTIES FZM

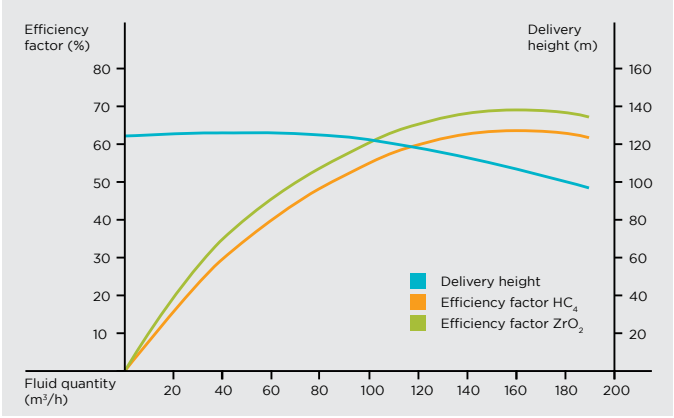
Properties		Unit	Specific value
Main components		-	ZrO_2, MgO
Purity		wt-%	> 99.7
Density		g/cm³	≥ 5.7
Open porosity		vol.-%	0
Average size of crystallites		µm	50
Bending strength σ_m	DIN EN 843-1	MPa	500
Weibulls modulus		-	> 15
Toughness K_{Ic}	SEVNB	MPa * $m^{0,5}$	6.3
Compressive strength		MPa	2000
Young's modulus	static	GPa	185
Poisson's ratio		-	0.3
Hardness	Knoop, 100 g	GPa	16
Maximum service temperature in air		°C	900
Linear coefficient of expansion	20 – 100 °C 20 – 500 °C 20 – 900 °C	10^{-6}/K	9.3 10.4 10.6
Specific heat	20 °C	J/(kg*K)	400
Thermal conductivity	20 °C 500 °C 900 °C	W/(m*K)	3 2.3 2
Resistivity	20 °C 900 °C	Ω*cm	10^{10} 84
Typical colour		-	yellow

The data indicated on this table are in line with the introductory German Industrial Standard DIN 40680 and relate to test specimens from which they were obtained. They are not unconditionally applicable to other forms of the same material. The data must be regarded as indicative only. All data refer to a temperature of 20 °C, unless otherwise specified. The material is extremely resistant to corrosion. We should be pleased to send you brochures about the corrosion resistance of oxide ceramics.

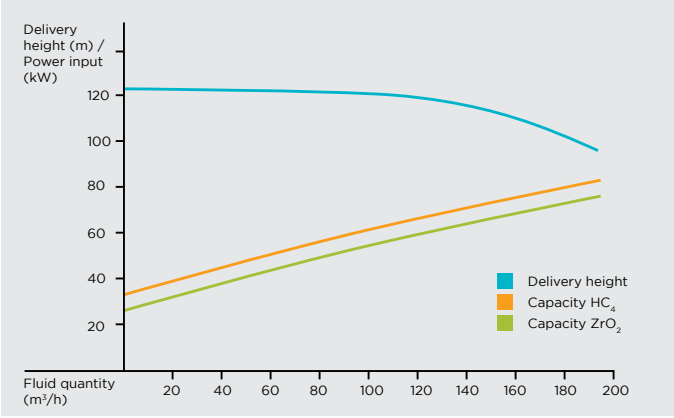
ENERGY-EFFICIENCY

Thanks to the high specific resistance of the FZM ceramic material of 10^{10} $\Omega mm^2/m$, eddy currents are prevented.

Increasing the energy efficiency of pumps and pumping systems is of great importance. According to an EU survey, pumps account for about 20 % of the energy consumption of motor-operated systems. Based on the extrapolation of the German Energy Agency, over 10bn kWh could be saved each year if pumping systems were optimised.

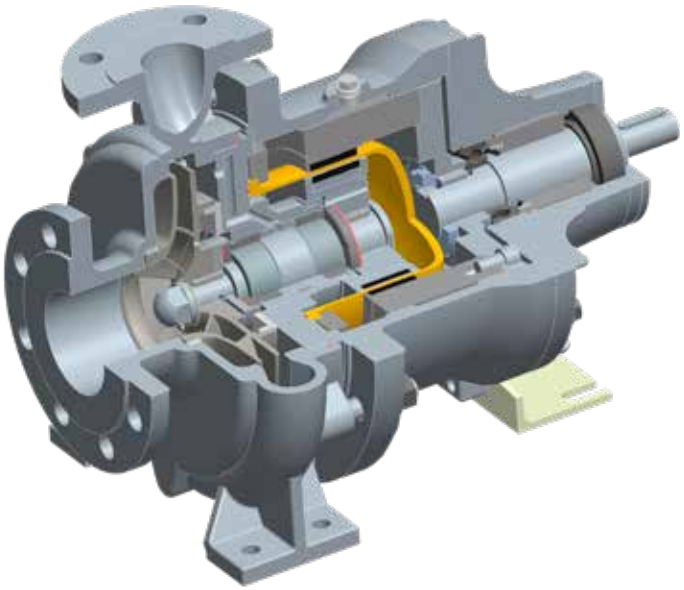


Comparison of efficiency ceramics / steel; Source: Klaus Union



Comparison of power input ceramics / steel; Source: Klaus Union

Cost reduction through ceramics.



Source: Klaus Union

The costs accruing over the total life cycle e.g. of water-conveying pumping systems are composed as follows:

- Acquisition costs approx. 8 %
- Maintenance, upkeep and other costs approx. 10 %
- Energy costs approx. 82 %

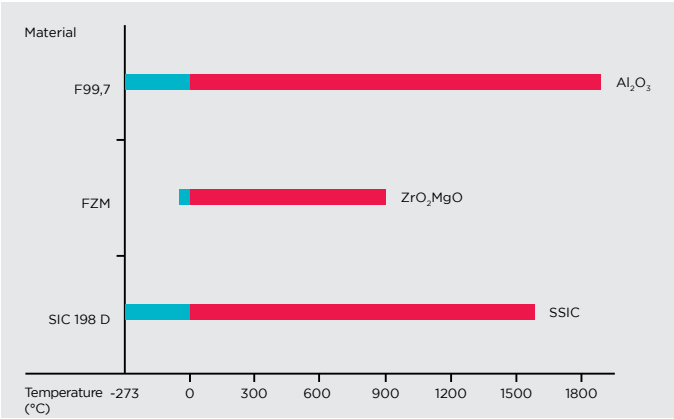
Against that backdrop, magnetic coupling pumps with metal containment shells take centre stage more and more often. The dissipation loss generated in these systems has a negative effect on the efficiency of the pumps and accounts for a major share of the incurring energy costs. Modern ceramic materials such as FZM prevent the generation of eddy currents and contribute to energy-efficient operation.

CONCEIVED FOR AGGRESSIVE PUMPING MEDIA

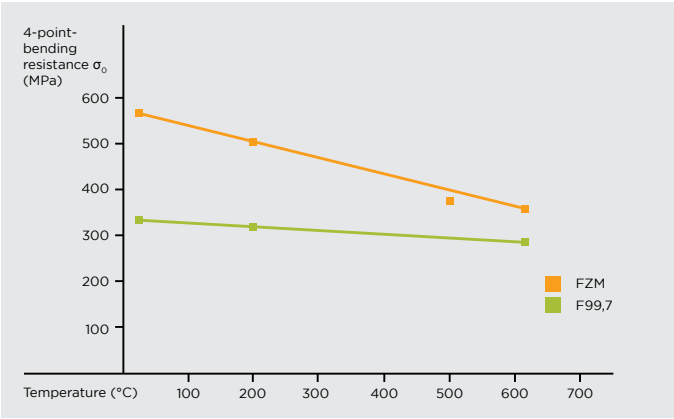
Containment shell made of zirconium oxide FZM are used for pumping widely varying and – in particular – very aggressive media.

Such media include e.g. heat transfer oil at temperatures of up to 350 °C, heavy fuel oil up to 160 °C, methanol, acrylamide, propane, ethylene oxide, nitric acid, phenol, etc., the latter chemicals being pumped at temperatures ranging between -30 °C and 250 °C.

To protect the ceramic material against the extremely aggressive hydrofluoric acid (HF) the inner surface of the containment shell may be coated with a chemically resistant and pore-free lining.



Operating temperature of oxide ceramic materials applied in oxidizing atmosphere



Bending resistance in relation to temperature

Excellent materials containing corrosion.

CORROSION RESISTANCE LIST

Agent	Chemical formula	Concentration (%)	Temperature (°C)	F99,7	FZM
Methanol	CH_3OH	all	Rt	A	A
Phenol	C_6H_5OH	pure	Rt	A	A
Nitric acid	HNO_3	7	Rt	A	A
Hydrochloric acid	HCl	0.5	Rt	A	A
Sulfuric acid	H_2SO_4	2	Rt	A	A

Excerpt. Full list available on our website.

A resistant
Rt room temperature

EXPLOSION PROOFNESS

Directive 94/9/EC on equipment and protective systems intended for use in potentially explosive atmospheres (ATEX) does not provide for any limitation for integrating ceramic containment shells into any Group II Category 2 equipment for application in Zone 1.

Diversion of electrostatic charges through coating.

In collaboration with the National Metrology Institute of Germany (Physikalisch-Technische Bundesanstalt) in Braunschweig extensive measurements were conducted to determine the antistatic discharge capability as per IEC 60093 and IEC 60167. Eventually, it was established that only an additional external coating could considerably underrun the limits for surface resistivity and discharge resistance (RA < 106 Ω).

Hence, a modified ceramic containment shell can be operated in contact with all inflammable media and in any explosive atmosphere.

COATING EXAMPLE

Properties	Unit	Specific value
Coating thickness	µm	approx. 3
Service temperature	°C	< 450
Micro hardness	HV 0,05	2300 ± 400
Density	g/cm^{-3}	5.2
Thermal conductivity	$Wm^{-1}K^{-1}$	30
Resistivity	µΩ cm	25
Colour	-	gold

HIGH-PERFORMANCE CERAMICS

ELECTRICAL ENGINEERING


01


02


03


04

HIGH TEMPERATURE TECHNOLOGY


05


06


07


08

MECHANICAL ENGINEERING

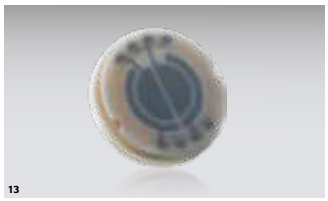

09


10


11


12

SENSOR AND MEASURING TECHNOLOGY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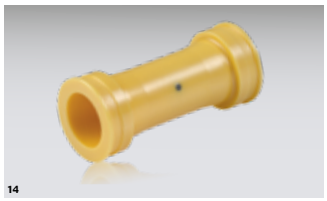
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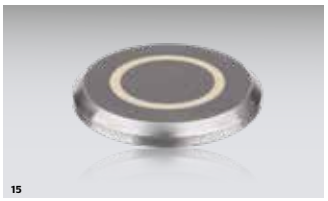
15


16

01. UHV vacuum chamber
02. Special insulation tube for physical 02. research institutes
03. Feedthroughs with ISO-KF flange
04. High-voltage feedthrough

05. Rectangular tubes
06. Multi-bore tubes
07. Crucibles, boats and annealing
06. boxes
08. Plates with hole

09. Forming tools used in body construction
10. Dosing unit used in the pharmaceutical and cosmetic industry
11. Containment shells for the pump industry
12. Grinding tools used in metal processing

13. Pressure sensor for aerospace
14. Flow meters
15. Humidity sensor
16. Oxygen sensor

INNOVATIVE SOLUTIONS FOR THE GLOBAL MARKET

INNOVATIONS FOR MORE THAN 150 YEARS

With more than 150 years of experience in ceramic manufacturing, we offer a range of innovative solutions for many industries: system components for high technology applications in electrical and sensor technology, mechanical engineering, analytical technology, medical and semiconductor technology as well as laboratory technology. In the field of ceramic-to-metal assemblies we possess international leading know-how.

SPECTRUM OF INNOVATIVE SOLUTIONS

We see ourselves as a partner in the development of high-performance ceramic solutions, which give our customers added value and ensure their technological advantages. Our team advise comprehensive on the selection of ceramic materials, product design and project execution - from the development stage over the prototype fabrication to the serial.

PARTNER OF A POWERFUL COMMUNITY

Founded in 1863 in Mannheim as brickyard, known as “Deutsche Steinzeug” and later as “Friedrichsfeld GmbH”, the business area Ceramics continued its successful development. Since September 2019, we are part of the KYOCERA Corporation, a world-leading ceramic and technology company.

Kyocera Fineceramics Solutions GmbH is a specialist company for products made of non-corroding and wear-resistant materials.

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