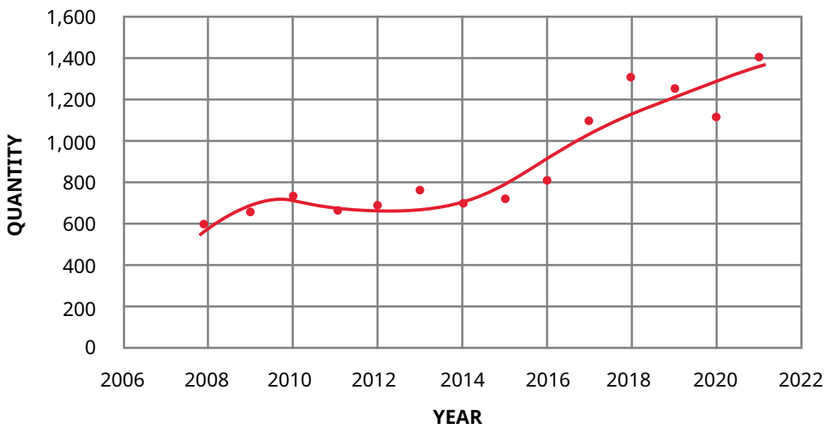
CONTAINMENT SHELLS FOR THE PUMP INDUSTRY

High-performance ceramics

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.

Development of unit sales ceramic containment shells

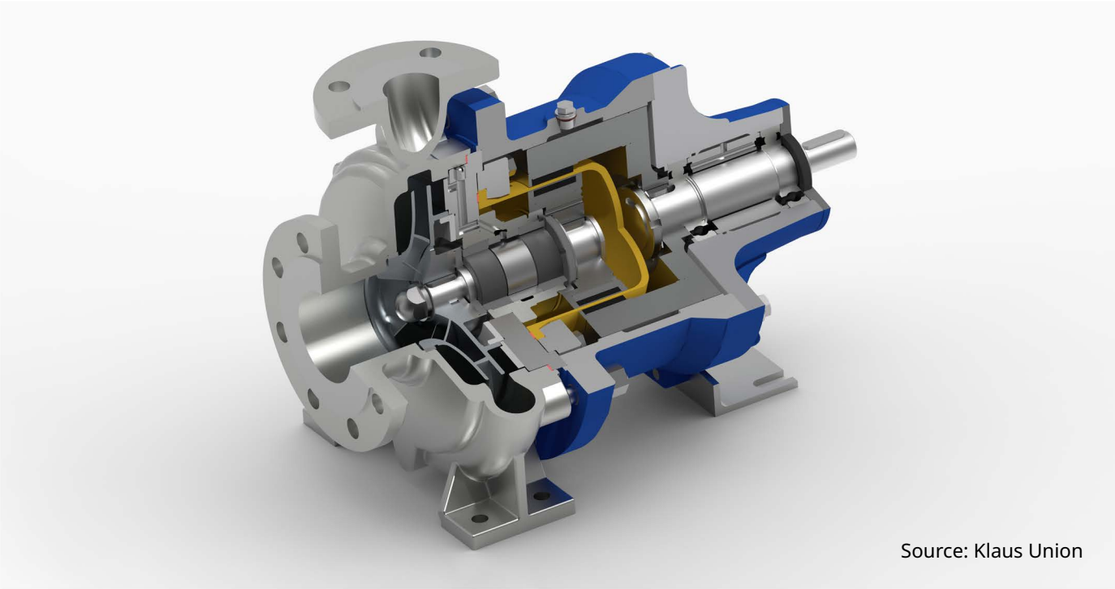


Containment shells protect pumps, environment and employees

TECHNICAL CERAMICS FROM KYOCERA

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.



Source: Klaus Union

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

- **Zirconia is not electrically conductive** - eliminating the creation of performance-impairing eddy currents and reducing electrical drive power by 10 to 15%. In addition, eddy current losses generate up to 20 kW of heat, hich can pose a safety risk depending on the process and the pumped media. For substances close to boiling point or explosive materials, additional heat input should be avoided. This can minimise hazards from any boiling distortions or deflagrations that may occur.

- **Zirconia is corrosion-resistant** - allowing for universal application to virtually all acids and bases.

- **Zirconia offers high mechanical stability** – depending on the size of the inner diameter, test pressure conditions up to PN 63 bar can be achieved at temperatures from -200 °C to 450 °C and more.
  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, containment shells made from advanced ceramics 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.

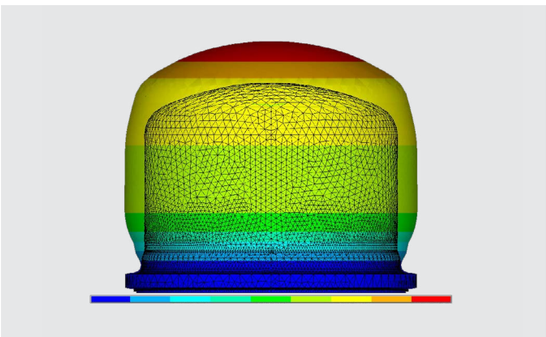
The optimal design of the transitions to the dished end and to the flange base allows for a smaller wall thickness of the containment shell and thus a more cost-effective dimensioning of the magnets used.

ZIRCONIA FZM AND FZM+

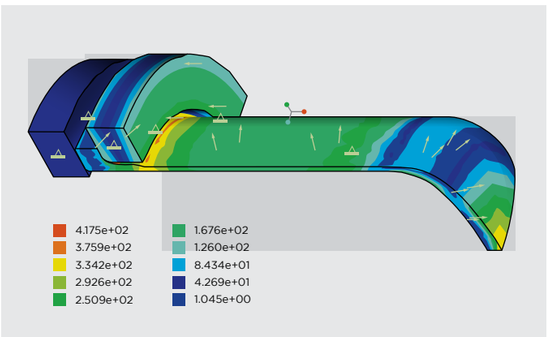
FZM has proven itself as an ideal ceramic material characterised by high fracture toughness as well as wear and corrosion resistance. Low thermal conductivity, excellent thermal shock resistance and superb thermal expansion properties comparable to cast iron round off the unique features of the material.

With the further development of FZM+, the application range of our materials can be extended even further.

The white zirconia is characterised by improved flexural strength and high fracture toughness. This allows test pressures of up to 95 bar (pressure rating PN 63) for a temperature range from -200 °C to over 450 °C.
This makes the material suitable for use in cryogenic applications as well as for external pressure applications in cans with gas as the medium.



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



FE evaluation assembly

Material properties		Unit	FZM	FZM+
Main components		-	ZrO_2, MgO	ZrO_2, MgO
Purity		wt-%	> 99.7	> 99.9
Density		g/cm³	≥ 5.7	≥ 5.75
Open porosity		Vol. %	0	0
Average crystal size		µm	50	25
Hardness	HV1		1,220	1,200
Compressive strength		MPa	2,000	2,000
Bending strength σ_m	DIN EN 843-1	MPa	500	650
Young's modulus	static	GPa	185	215
Weibull's modulus		-	> 15	> 20
Poisson ratio		-	0.3	0.32
Fracture toughness K_{Ic}	SEVNB	$MPa*m^{0.5}$	6.3	8.7
Max. operating temperature		°C	900	900
Specific heat	20 °C	J/(kg*K)	400	490
Thermal conductivity	20 °C 500 °C 900 °C	W/(m*K)	3 2.3 2	3.75 - -
Thermal expansion coefficient	20 - 100 °C 20 - 500 °C 20 - 900 °C	10^{-6}/K	9.3 10.4 10.6	9.3 10.3 -
Specific electrical resistance	20 °C 900 °C	Ω•cm	10^{10} 84	10^{10} -
Typical colour		-	yellow	white

The data indicated on this table are in line with the introductory German Industrial Standard DIN 60672-2 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.

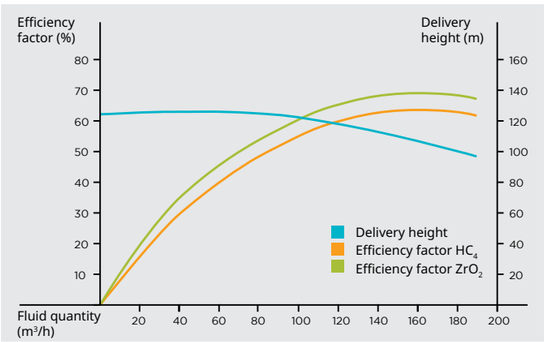
ENERGY EFFICIENCY

Electric drives in industry and commerce consume almost two-fifths of all electricity in Germany. In these two sectors, their share of electricity consumption is even around 80%. The Federal Environment Agency, for example, calculates that the use of energy-efficient pumps alone could save around 5 bn kWh of electricity[1]. The latest climate balance published by the Federal Environment Agency states that this would correspond to around 401 kt of CO_2 in 2019. Assuming an electricity price of 15 ct/kWh, the industries concerned could also reduce their energy costs by around EUR 750 m.

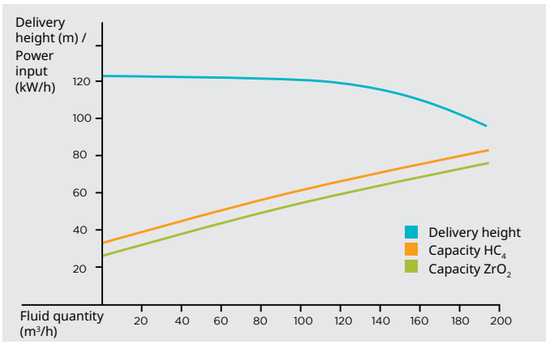
Against this background, magnetic drive pumps with metallic containment shells are increasingly coming into focus. The power loss generated in these systems has a negative effect on the efficiency of the pumps and causes a high proportion of the energy costs incurred.

Unlike metallic containment shells, ceramic containment shells are not capable of being magnetized. Eddy currents that reduce performance are prevented and energy efficiency is significantly improved It is therefore possible to reduce the drive power of a pump by up to 15%.

[1] Source: https://www.umweltbundesamt.de/themen/klima-energie/energiesparen/energiesparen-in-industriegewerbe#energieeinsparpotenziale



Comparison of efficiency ceramics / steel;
Source: Klaus Union



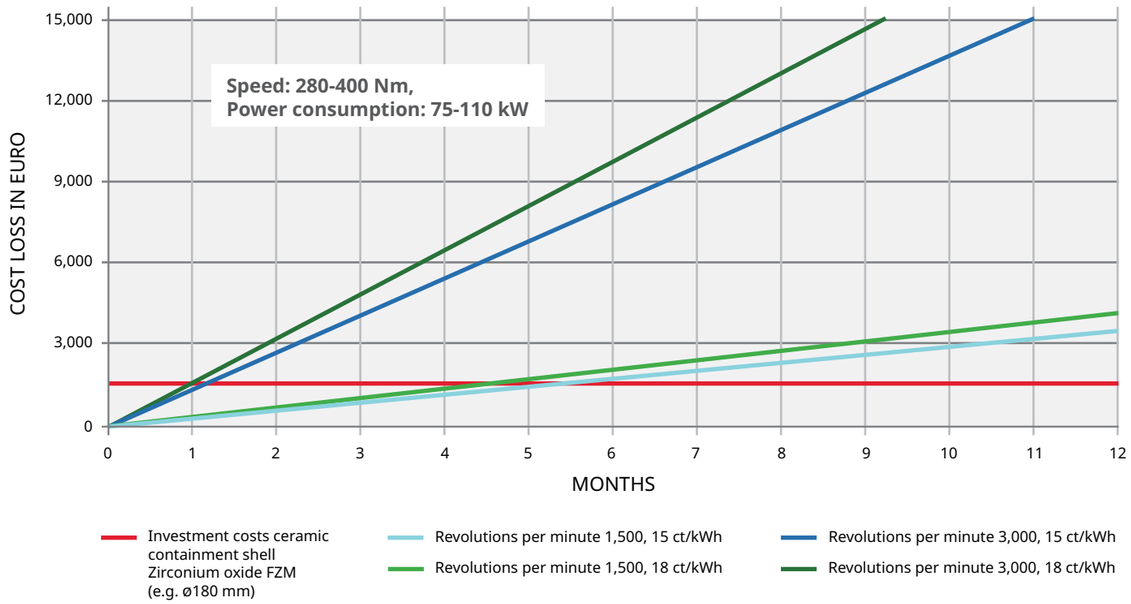
Comparison of power input ceramics / steel;
Source: Klaus Union

Magnetic coupling with metal containment shell

Revolutions per minute [rpm]	1,500	3,000
Power loss [kWh]	20,000	100,000
Cost loss at 12 ct/kWh [Euro]	2,600	13,000
Cost loss at 15 ct/kWh [Euro]	3,300	16,000
Cost loss at 18 ct/kWh [Euro]	4,000	20,000
Cost loss at 3 ct/kWh [Euro]	650	3,300
CO_2 reduction [kg]	13,400	68,000

Assumptions: 8,000 operation hours per year, speed with 280-400 Nm, power consumption with 75-110 kW

Costs due to eddy current loss with metallic containment shells

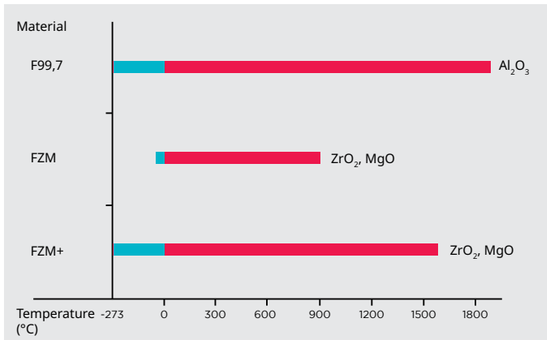


CONCEIVED FOR AGGRESSIVE PUMPING MEDIA

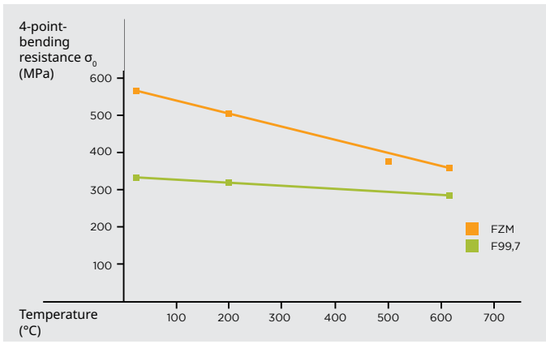
Containment shell made of zirconia are used for pumping widely varying and – in particular – very aggressive media.

These can be, e.g. heat transfer oils that are pumped up to temperatures of 350 °C or heavy oils that are pumped up to 160 °C.
Other chemicals such as methanol, acrylamide, propane, ethylene oxide, nitric acid, phenol, etc. are pumped at temperatures 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 / 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	HCI	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	2,300 ± 400
Density	g/cm^{-3}	5.2
Thermal conductivity	$Wm^{-1}K^{-1}$	30
Electrical resistance	µΩ*cm	25
Colour	-	gold

KYOCERA FINECERAMICS SOLUTIONS GMBH
THIS IS US. INNOVATION IN CERAMICS.

ELEVATOR MESSAGE

"Our extensive experience in high-performance ceramics and our alliance with Kyocera as a leading global technology group grant us access to innovation and resources that allow us to realize ambitious projects and take the lead for the future. We share our knowledge, and bring it together to create something new that goes beyond our company, beyond different industries and countries. As a team. Together with our customers."
Armin Kayser, General Manager of KYOCERA Fineceramics Solutions GmbH

KYOCERA Fineceramics Solutions GmbH - Summary

Location:	Mannheim, metropolitan Rhein-Neckar region
Founding year:	2019 - Spin-off from FRIATEC GmbH
Employees:	approx. 300 incl. approx. 30 trainees and apprentices
Subsidiaries:	KYOCERA Fineceramics Nordics AB (sales office for Northern Europe)

We look back on a long tradition in the manufacturing of ceramic products: Founded in Mannheim in 1863 as a brickyard known as "Deutsche Steinzeug", and later as "Friedrichsfeld GmbH", from 1993, the ceramics department continued its successful development under the brand FRIATEC GmbH. Since September 2019 we have been part of Kyocera Group, a leading global ceramics and technology company.

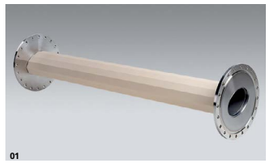
Kyocera companies benefit from the group's cross-department way of thinking and working. Because innovation and real milestones can only be achieved together. This is what we believe.

We are a provider of innovative solutions for numerous industries: system components for high-tech applications in electrical and sensor technology, mechanical engineering, analysis technology, medical and semiconductor technology, as well as laboratory technology.

We possess internationally recognized know-how in the field of high-performance ceramics, especially for ceramic-to-metal assemblies. Our products are characterized by high quality, precision, and durability. Our production and development location in Central Europe and our customized supply-chain solutions make us extremely agile and ensure maximum reliability for our customers.

We see ourselves as a partner in the development of high-performance ceramics solutions that provide added value for our customers and ensure their technological advantage in their respective markets. Our focus today is on where we want to be tomorrow – together. We develop sustainable solutions that meet the demands of the future, supported by an experienced team of 50 highly qualified and quality-oriented engineers, scientists, technology experts, and masters.

ELECTRICAL ENGINEERING

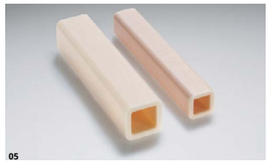

01

02

03

04

HIGH TEMPERATURE TECHNOLOGY


05

06

07

08

MECHANICAL ENGINEERING

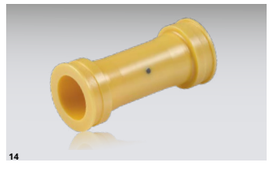
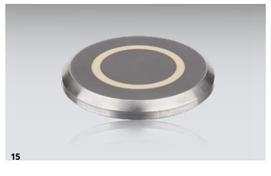

09

10

11

12

SENSOR AND MEASURING TECHNOLOGY


13

14

15

16

01. UHV vacuum chamber
02. Special insulation tube for 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

Production site and sales office:
KYOCERA Fineceramics Solutions GmbH
Steinzeugstrasse 92
68229 Mannheim / Germany
Tel: +49 621 40547-300
E-mail: info@kyocera-solutions.de
www.kyocera-solutions.de

European headquarters:
KYOCERA Europe GmbH
Fritz-Müller-Strasse 27
73730 Esslingen / Germany
Tel: +49 711 93 93 4-0
E-mail: info.fc@kyocera.de
www.kyocera-fineceramics.eu