RUHRPUMPEN

Specialist for Pumping Technology

Session 25 –

Magnetic Drive Pumps

Simon Smith September 2023







Presenter Profile – Simon Smith

Simon graduated with an honours degree in Chemical Engineering from the University of Surrey in 1978 and began a long career in the engineered pump industry spanning 40 years (so far!) with Peerless Pump, BW/IP International / Flowserve, SPP Pumps, Ruhrpumpen and Ebara Cryodynamics.

Over his long career he has filled various roles as Applications Engineer / Manager, Project Manager, Key Account Specialist, Vertical Pump Product Specialist, International Sales Engineer / Manager / Director and he has considerable experience in Training & Mentoring young engineers.

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Ruh*RP*umpen Short Courses

Here is a listing of all the previous courses.

- No 1 – API610 12th v 11th editions
- No 2 - Curve Shape
- No 3 – The Importance of System Curves
- No 4 - Selecting the Right Pump for the Application
- No 5 - NPSH & Nss
- No 6 - Mechanical Seals & Systems
- No 7 - Firepumps
- No 8 - BB5 Barrel Pumps
- No 9 - Pump Instrumentation
- No 10 – Non-Destructive Examination
- No 11 - Vertical Pumps (Part 1) Type VS1, VS2, VS3
- No 12 – Vertical Pumps (Part 2) Type VS4, VS5, VS6 & VS7
- No 13 – Performance Testing of Centrifugal Pumps; the What, the Why & the How
- No 14 – Testing & Inspection of API 610 Pumps
- No 15 – Start-Up, Commissioning & Troubleshooting Centrifugal Pumps
- No 16 – Introduction to Positive Displacement (Plunger) Pumps
- No 17 – Refresher Session
- No 18 – Overhung Process Pumps OH1 & OH2
- No 19 – Vertical Overhung Process Pumps OH3-OH6
- No 20 – New Developments in the VS6 Market
- No 21 – BB4 Multistage Pumps for the Power Industry
- No 22 – Coking Process and Hydraulic Decoking Equipment
- No 23 – Pumps for the Desalination Market
- No 24 – Cryogenic Pumps

Any you have missed you can get from our website using this link https://short-courses.ruhrpumpen.com/

Or from www.ruhrpumpen.com and follow the link to RP Short Courses

Ruh*RP*umpen Short Courses

www.ruhrpumpen.com

More Articles

- Introducing the new Ruhrpumpen Website
- Impeller Lift Procedure
- Newsletter Ruhrpumpen Fire Systems - December 2022
- VTP pumps for major water transfer project in Bolivia
- COVID-19 UPDATE
- Introducing the RP ANSI Process Pump Range
- Ruhrpumpen Resources
- Coolant System Maintenance
- RP delivers API 674 pumps for Gas Dehydration Package in Algeria
- Packing strips and packing gland tightening procedure

All Courses

Ruh*RP*umpen Short Courses

https://short-courses.ruhrpumpen.com/

SHORT COURSE 12

Vertical Pumps (VS4/5, VS6, VS7)

Full session.

Downloads. (14.73 MB)

SHORT COURSE 13

Performance Testing and Inspection of API 610 Pumps

Full session.

Downloads. (4.58 MB)

SHORT COURSE 14

Performance Testing and Inspection of API 610 Pumps

Full session.

Downloads. (7.30 MB)

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SHORT COURSE 14

Performance Testing and Inspection of API 610 Pumps

Full session.

Downloads. (7.30 MB)

SHORT COURSE 15

Start-Up, Commissioning & Troubleshooting Centrifugal Pumps

Full session.

Downloads. (6.14 MB)

SHORT COURSE 16

Introduction to Positive Displacement (Plunger) Pumps

Session part 1.

Session Part 2.

Downloads. (10.50 MB)

Ruh*RP*umpen Short Courses

Session 25 –
Magnetic Drive Pumps

This Short Course will look at Magnetic Drive Pumps used in the Chemical & Process Industries, to ANSI, ISO & API 685 standards.

A “dark art” to many pump engineers (even experienced ones) this course is aimed at Process and Mechanical Engineers and Consultant Engineers who specify pumping equipment as well as Applications & Sales Engineers selecting and quoting them. It will address the subject matter from first principles.

Pumping Technology for Life…

RUHRPUMPEN

Magnetic Drive Pumps Training

Adam Pye

Agenda

1. What is Mag-Drive
2. Why choose a Mag-Drive
3. How does a Mag-Drive work
4. Features and Benefits
5. Industrial Standards
6. Questions and Answers
7.
8.
9.
10.

Magnetic Drive Sealless Pumps| **What** is a Magnetic Drive Pump?

Pumping Technology for Life…

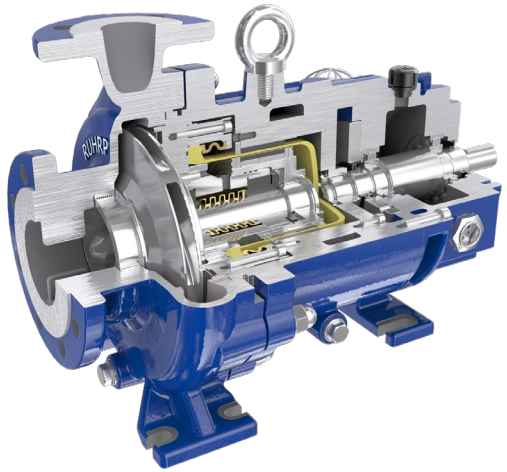
What is a Mag-Drive?

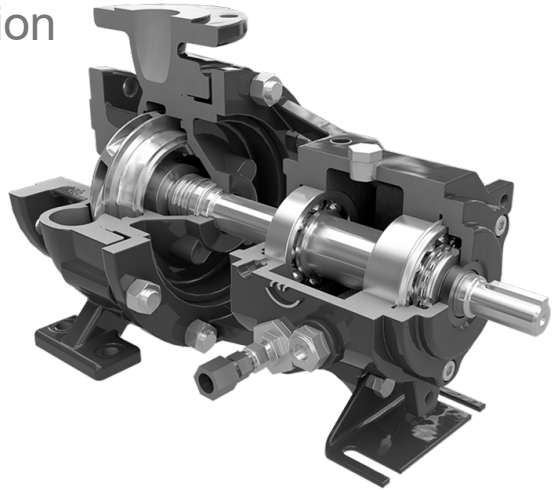
- Magnetic Drive refers to the method of how the Hydraulic is driven and how the liquid is handled within the machine.

Resulting in:

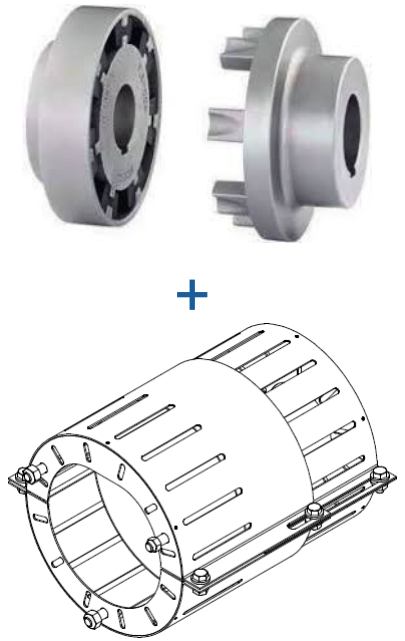
- The liquid being fully ‘contained’ within the Containment Shell.
- Drive and Driven ends are completely separated from the process fluid.

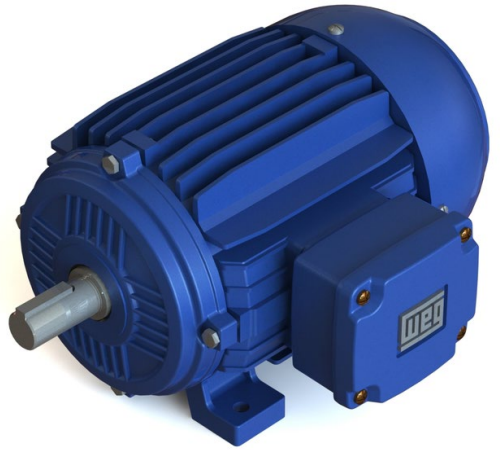
	Magnetic Drive	**Mechanical Seal**
Basic Principles	☑ Magnetic Coupling ☑ Containment Shell ☑ Internal Bearing Feed System ☑ Internal Bearings ☑ No Leakage	☒ Mechanical Seal ☒ Seal Support System ☒ Thrust Roller Bearings ☒ Shaft stiffness/deflection ☒ Leakage





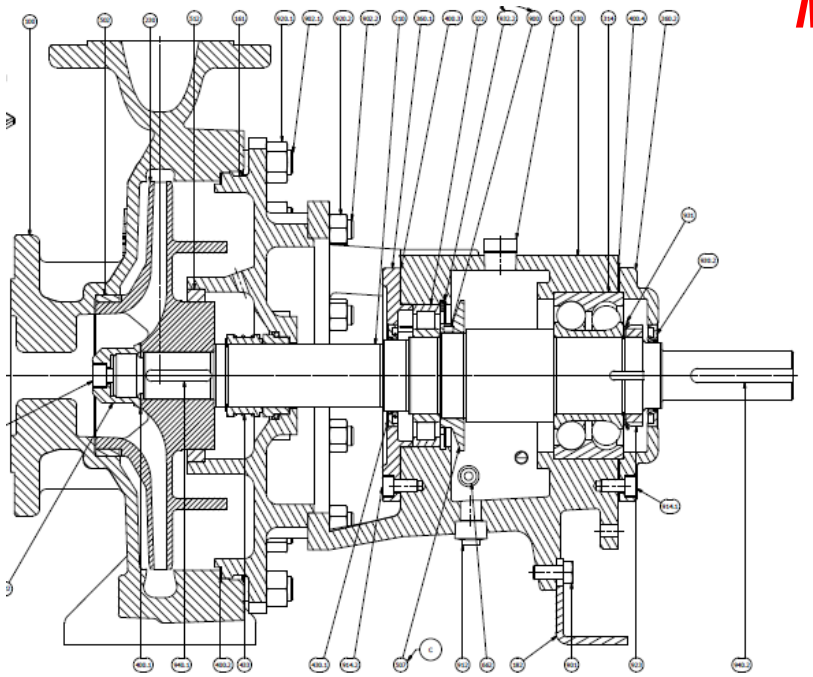
What is a Mag-Drive?



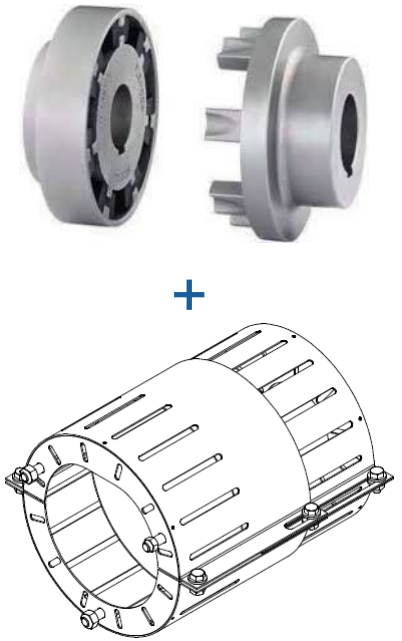


What is a Mag-Drive?

Motor → Flexible Coupling → Pump Shaft → Impeller

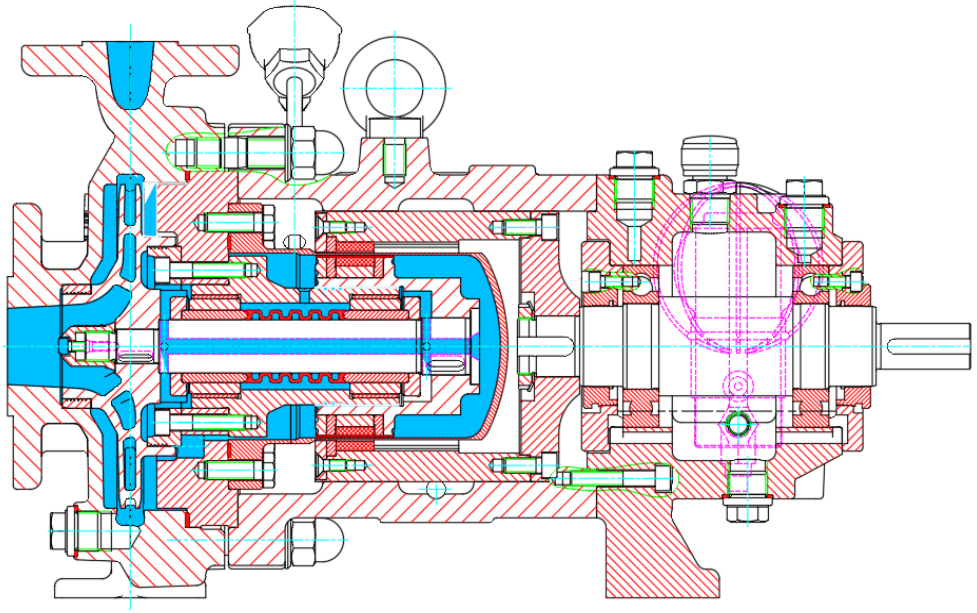


Mechanically Sealed Pump

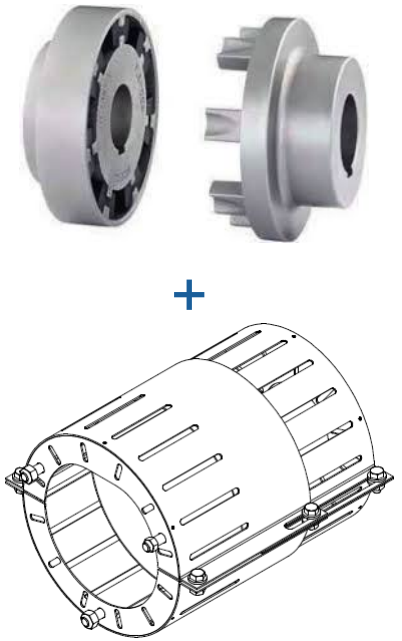


What is a Mag-Drive?

Motor → Flexible Coupling → Pump Drive Shaft → Outer Magnet Carrier → Inner Magnet Carrier → Pump Shaft → Impeller



Sealless Magnetic Drive Pump



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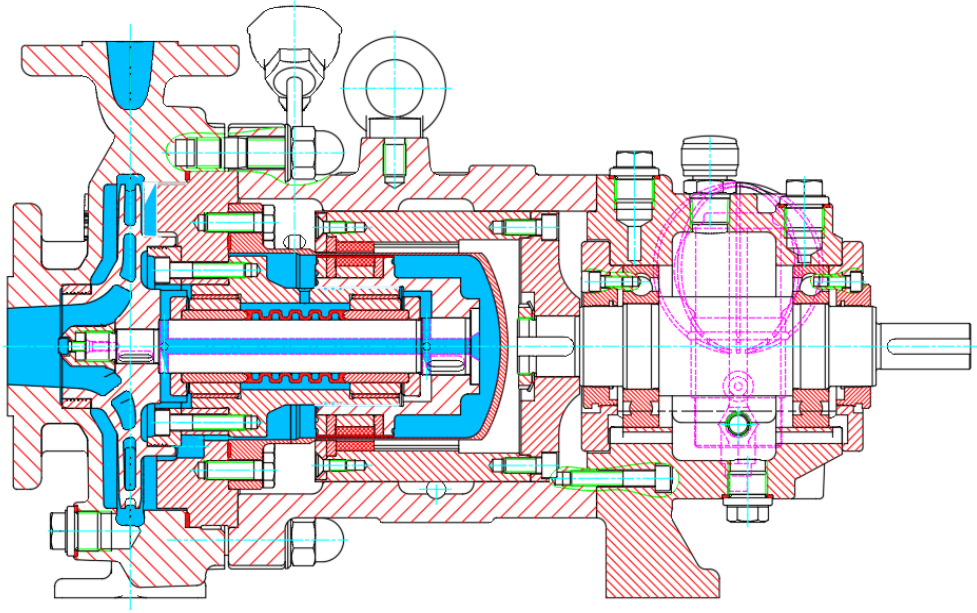
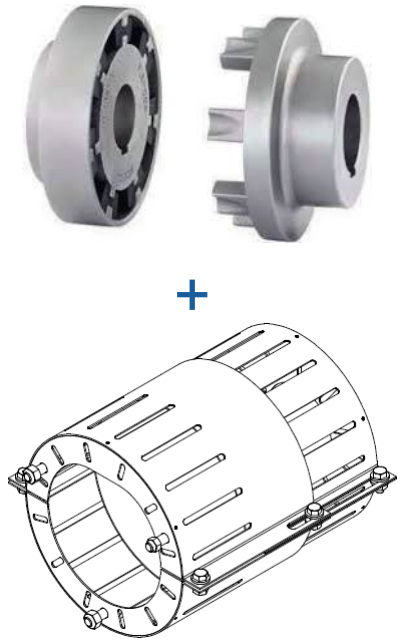


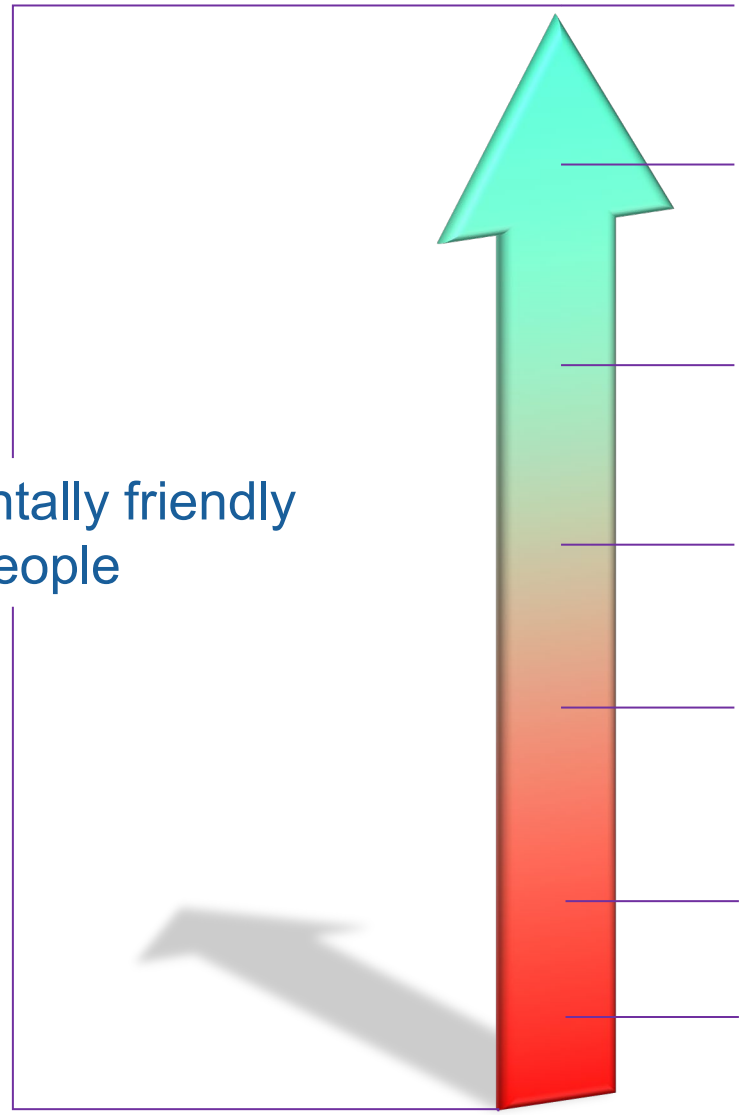


Magnetic Drive Sealless Pumps| **Why** choose a Magnetic Drive Pump?

Pumping Technology for Life…

Why use a Mag-Drive?

- Environmentally friendly
- Safety of People



Mag-Drive – Secondary Containment
- Zero leakage even with catastrophic failure.

Mag-Drive – Secondary Control
- Small amount of leakage, controlled to a ‘safe-area’ only with a catastrophic failure.

Mag-Drive – Basic Construction
- Leakage to atmosphere only with a catastrophic failure.

Double Mechanical Seal (Pressurised)
- Leakage to atmosphere only with seal or bearing failure.

Double Mechanical Seal (Unpressurised).
- Contaminated fluid leaks to atmosphere (process leaks to buffer).

Single Mechanical Seal (Unpressurised)
- Process fluid leaks to atmosphere.

Packed Gland
- Process fluid leaks to atmosphere.

Why use a Mag-Drive?

- Types of Fluids:
  - Harmful, toxic, flammable, explosive, heat transfer or expensive.
- Less Maintenance
  - Unmanned applications.
- Reduced installation costs (compared to double mechanical seal).
- Temperatures (-120°C to +450°C) [-184°F to +840°F].

Why use a Mag-Drive?

- WHY NOT?

- Common limitations…
- Pressure - (Dependent on size).
- Power - Maximum the selected Magnetic Coupling can transmit. (Again dependent on hydraulic/size)
- Viscosity - Stick within Manufacturer's limits.
- Vapour - Vapour Pressure margin must be maintained! – *See Slide 36.*
- Solids - Narrow flow passages might be clogged, but there are common fixes for this problem so it is not a big constraint – *See Slides 35 & 43*

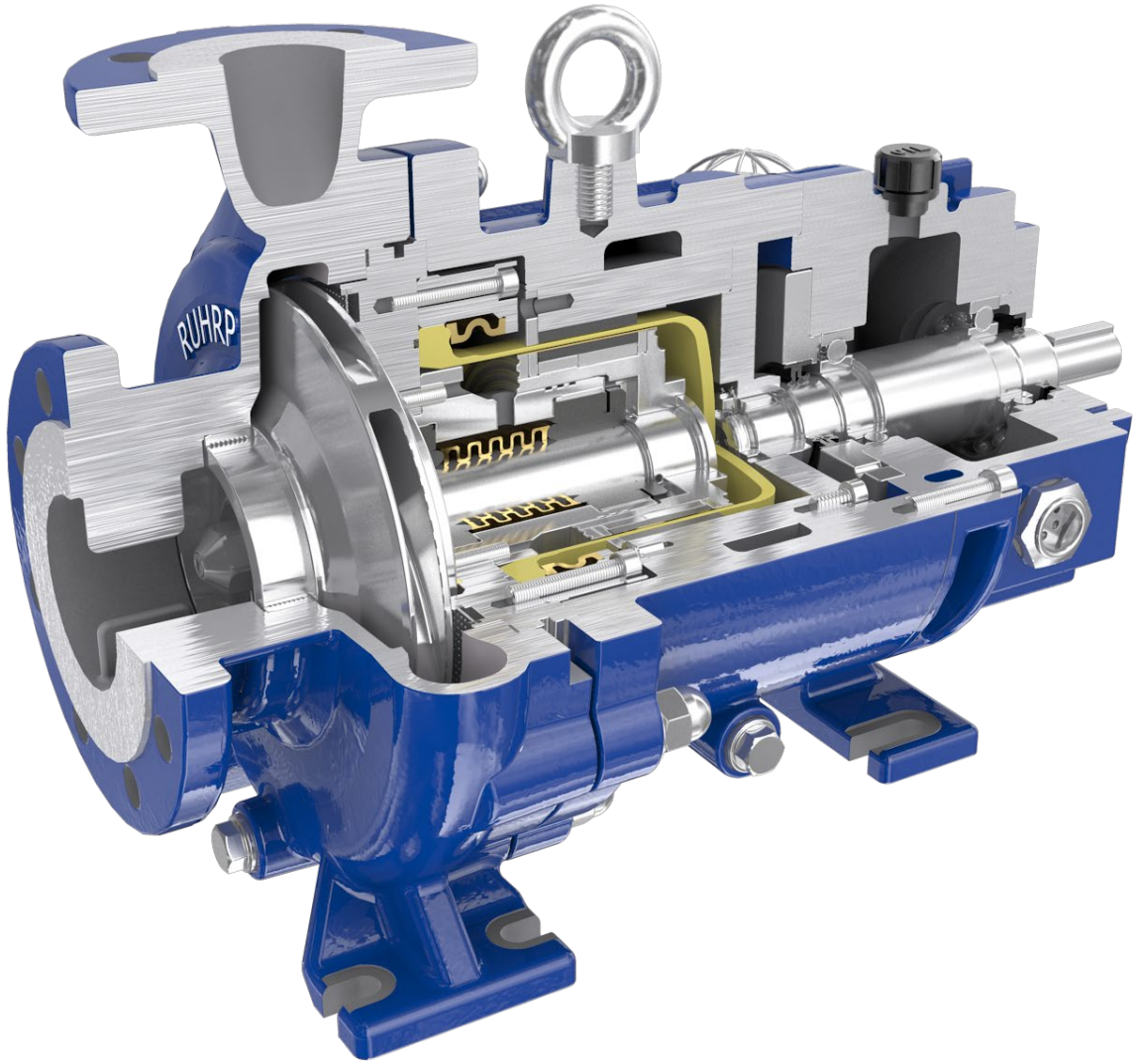
Magnetic Drive Sealless Pumps| **How** does a Magnetic Drive Pump work?

Pumping Technology for Life…

How does a Mag-Drive work?

Magnetic Drive

- ☑ Magnetic Coupling
- ☑ Containment Shell
- ☑ Internal Bearing Feed System
- ☑ Internal Bearings
- ☑ No Leakage



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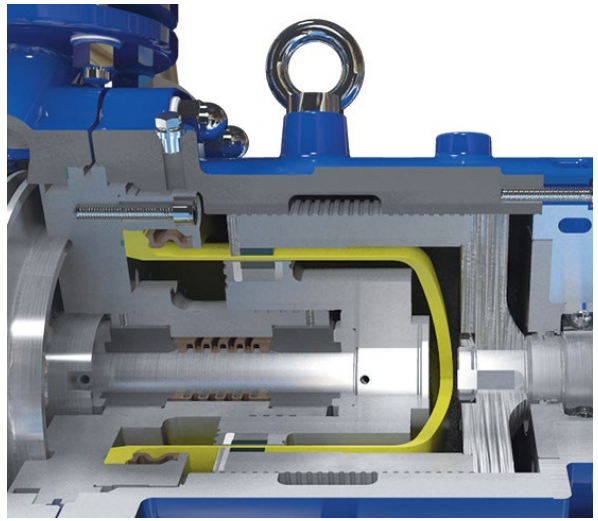

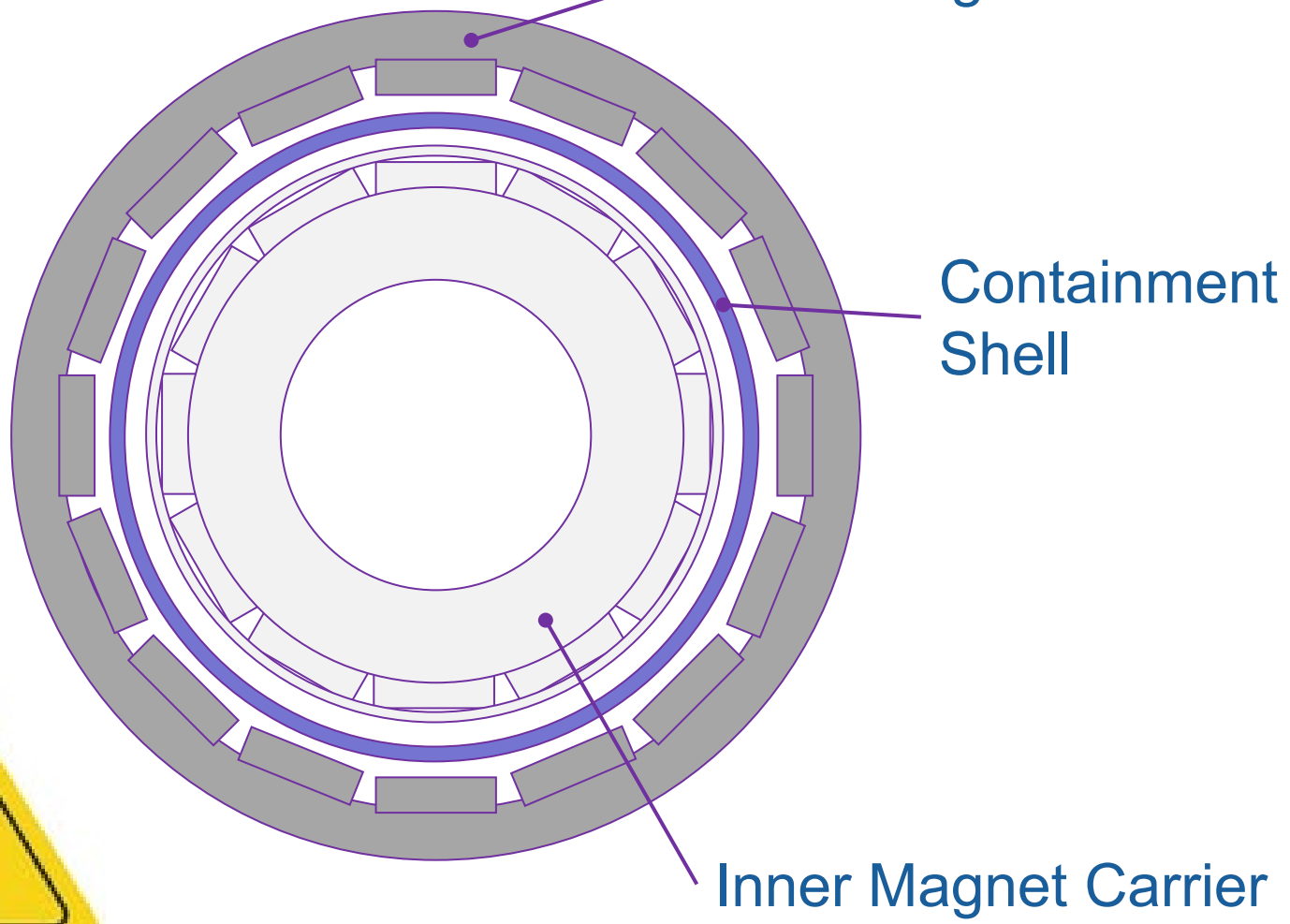

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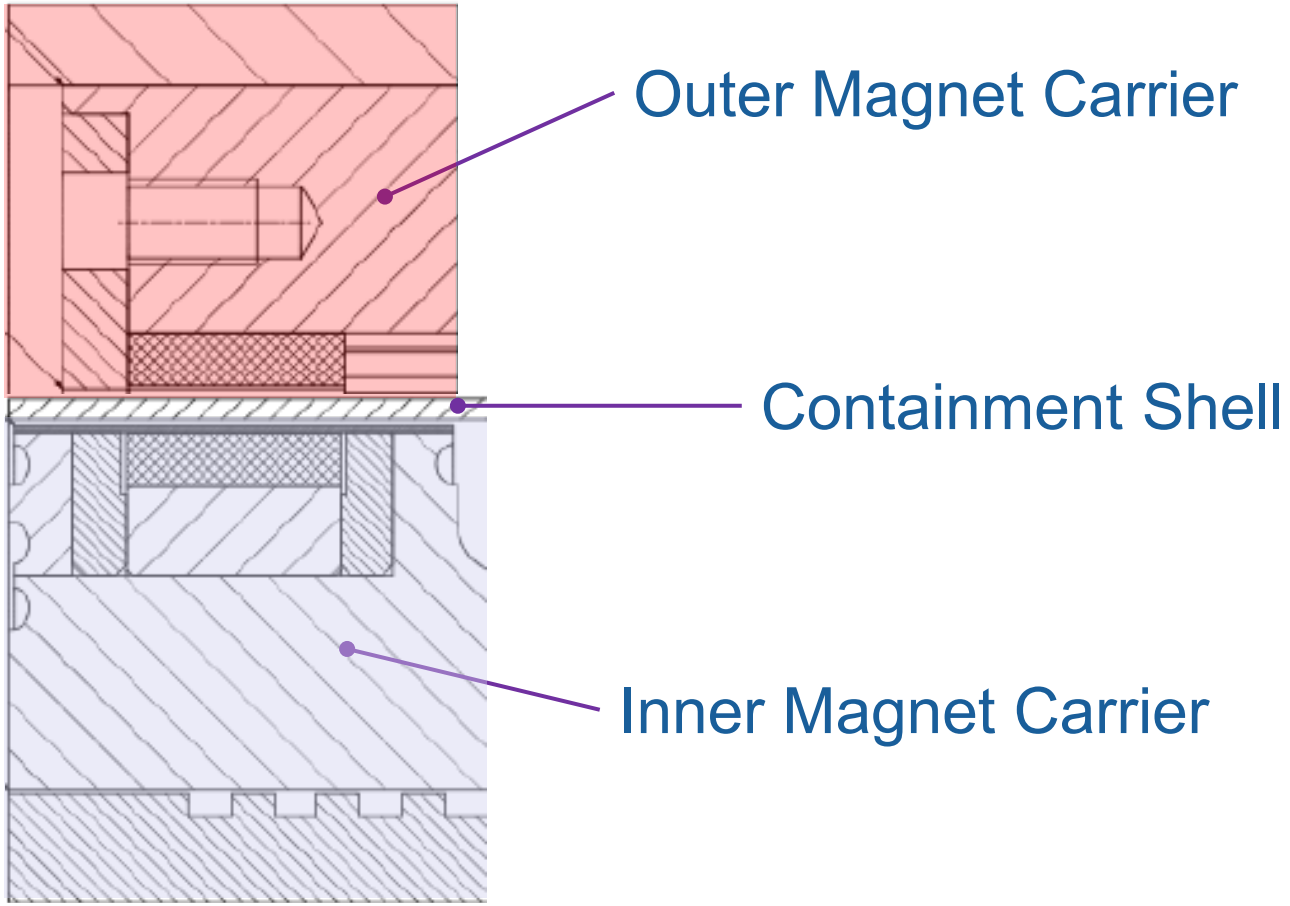

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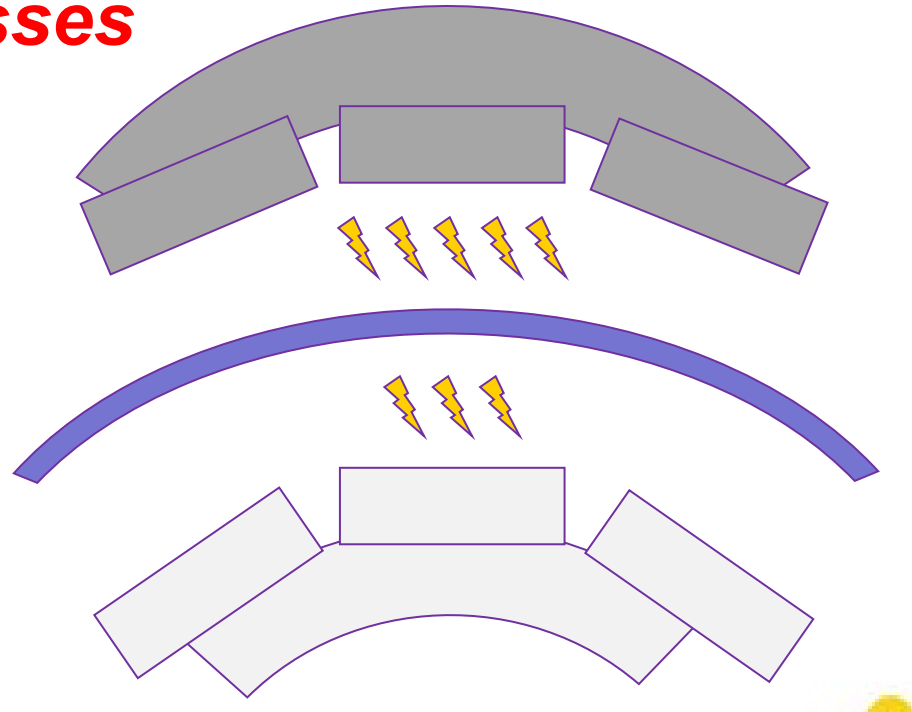
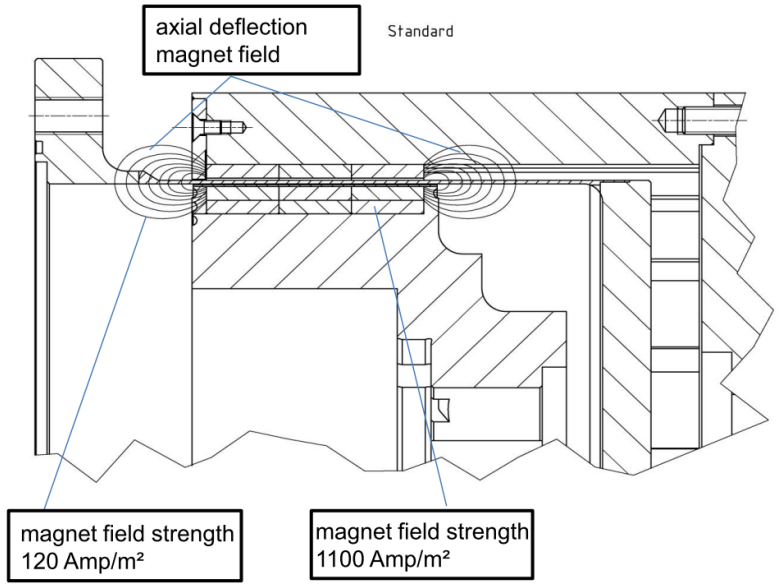
Magnetic Losses





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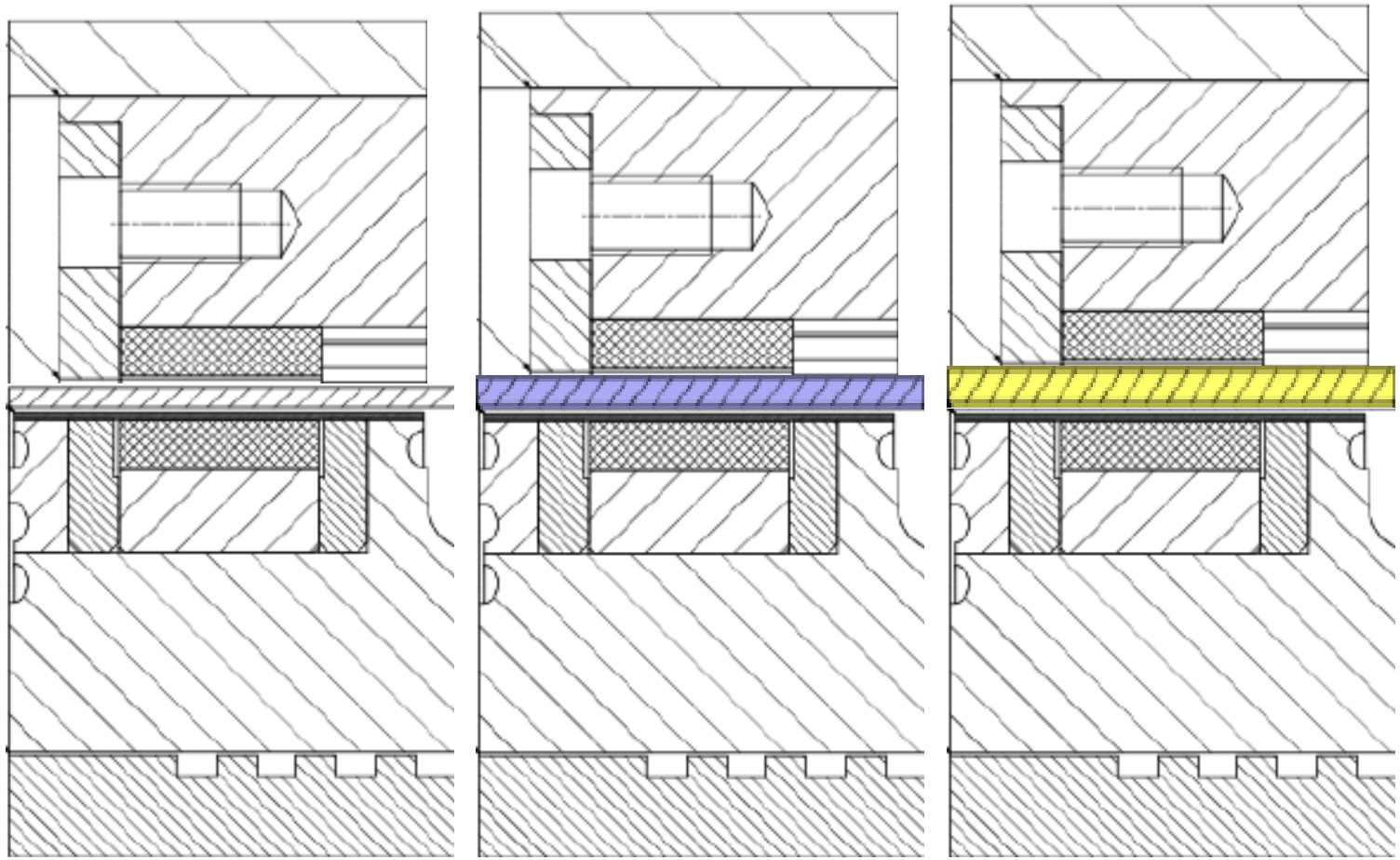

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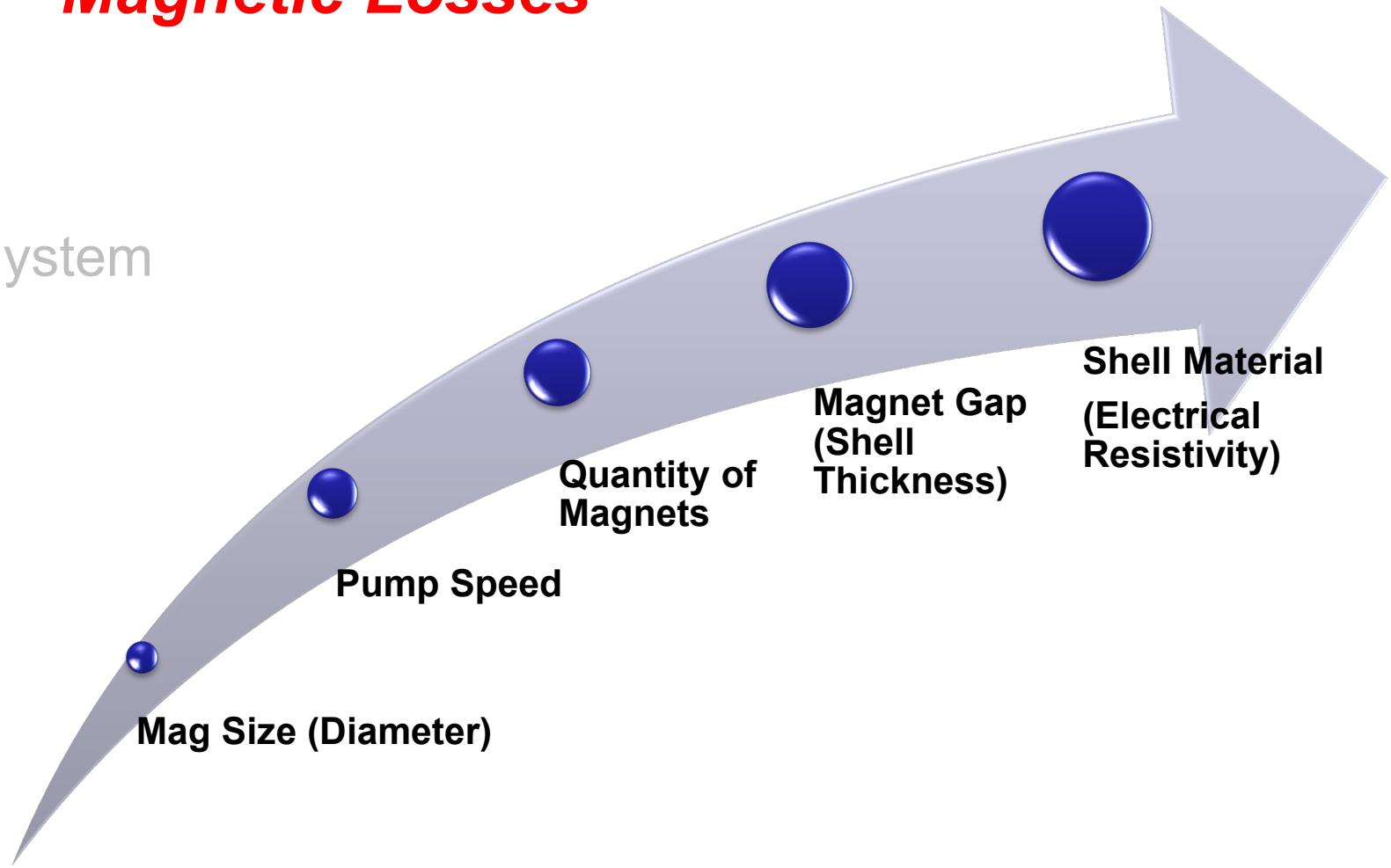

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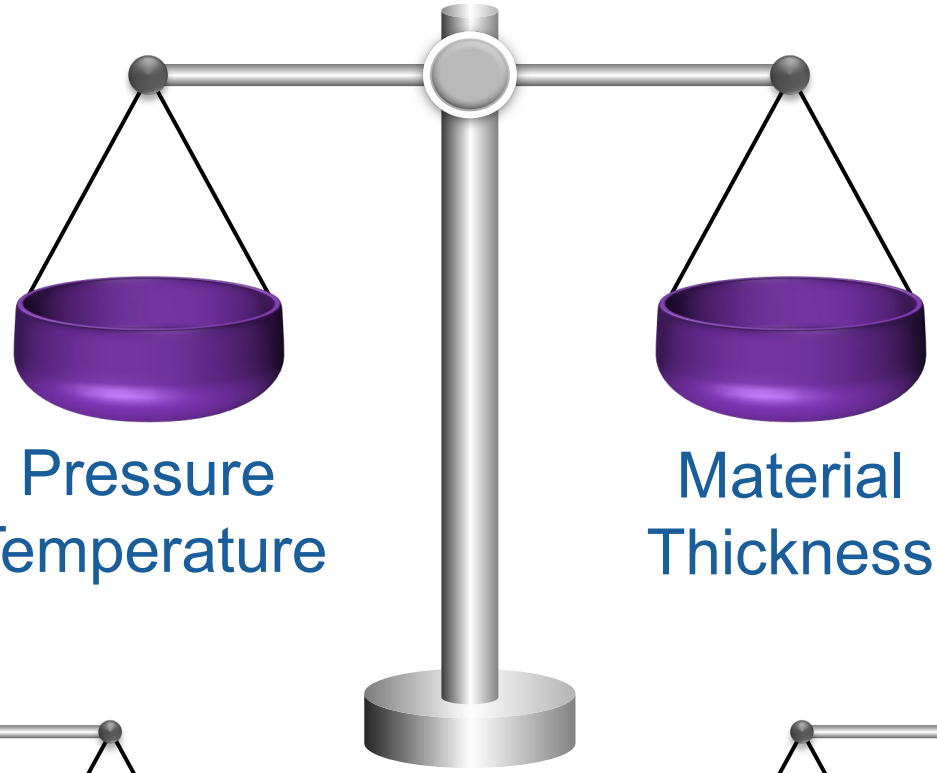
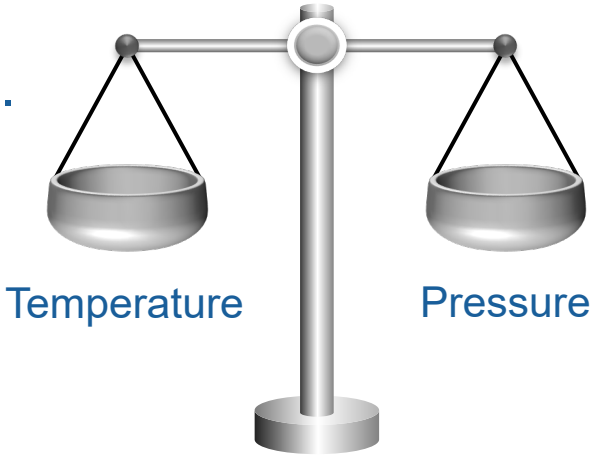
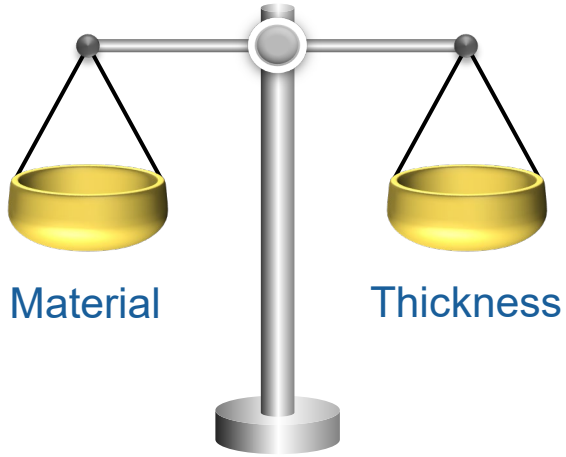
Variables:

- Size of Magnetic Coupling.
- Pressure.
- Temperature.
- Material.
- Thickness







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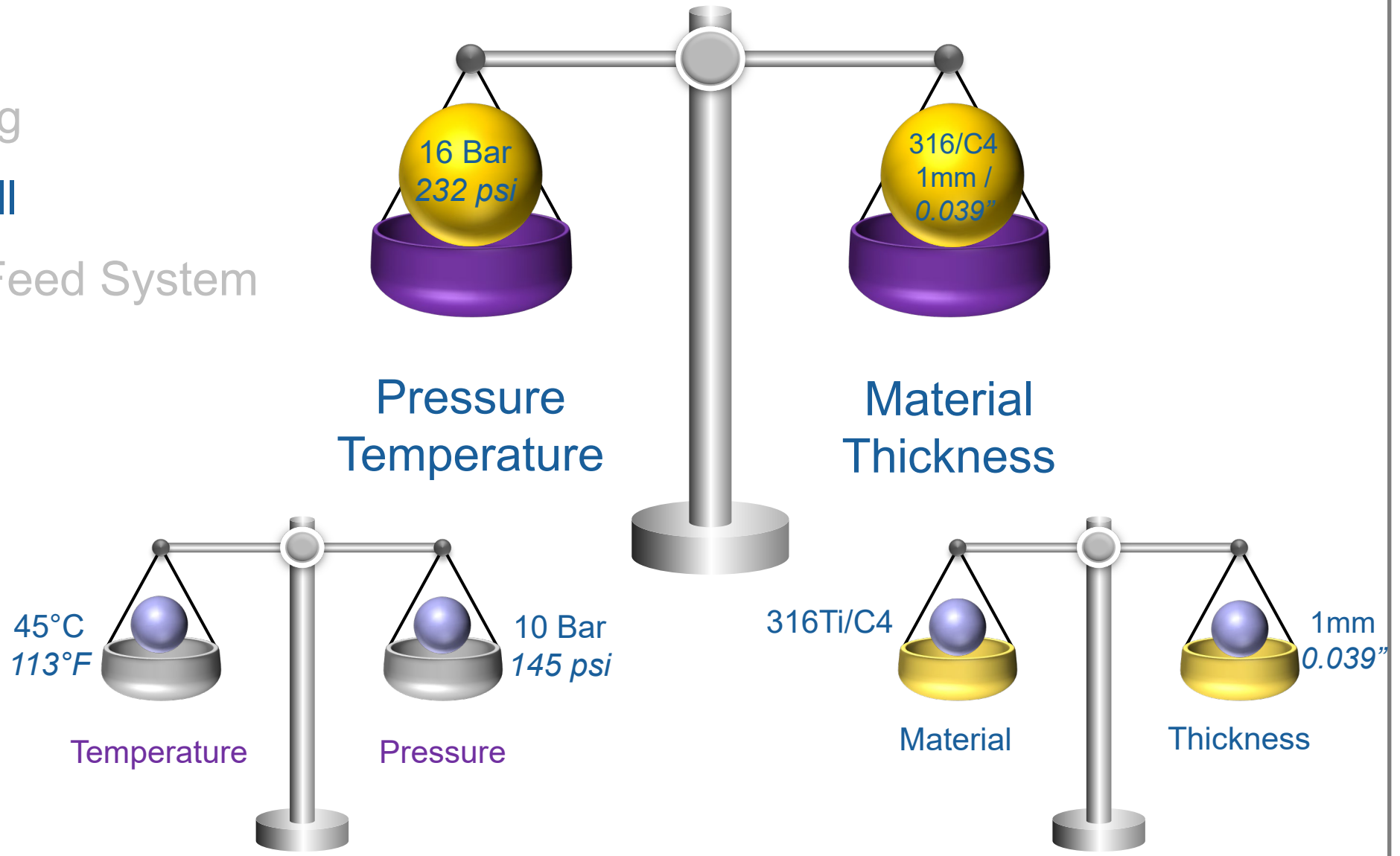

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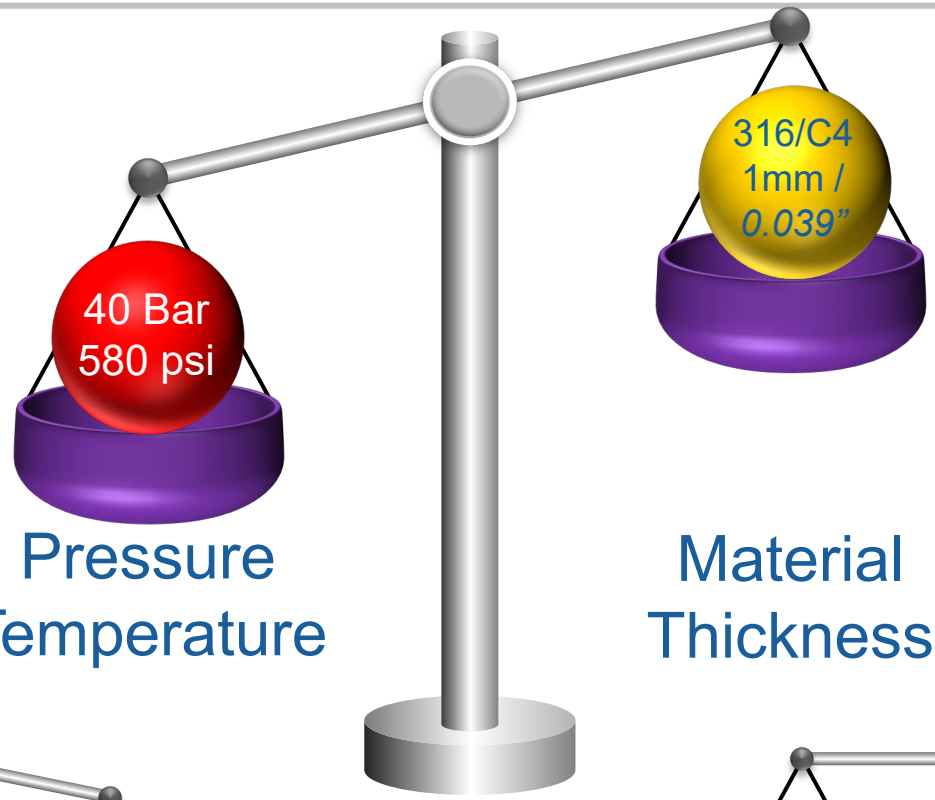

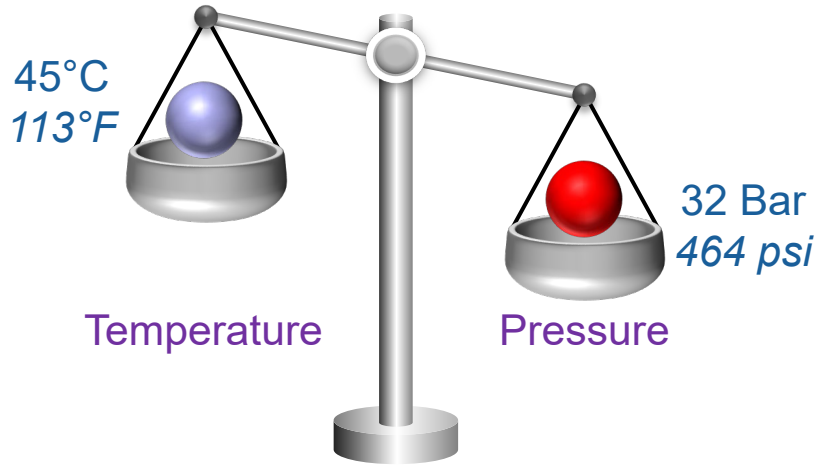

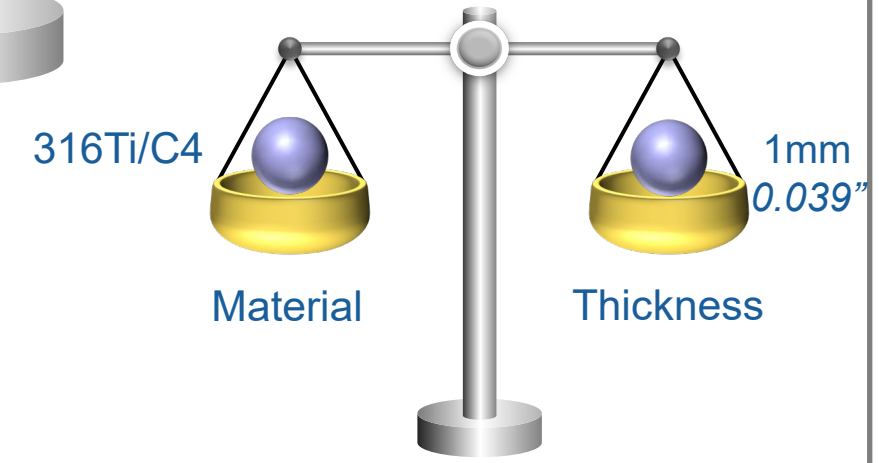

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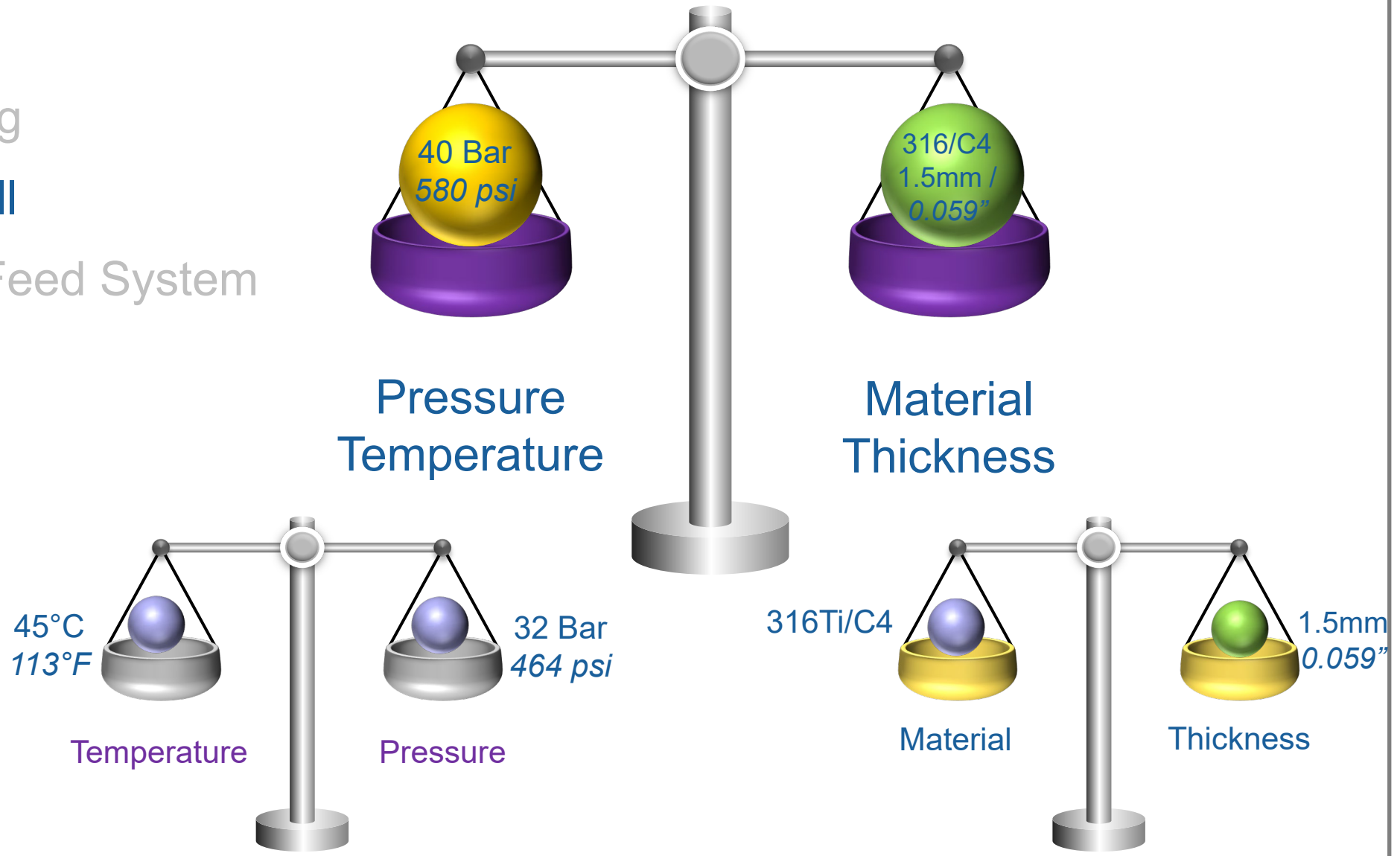

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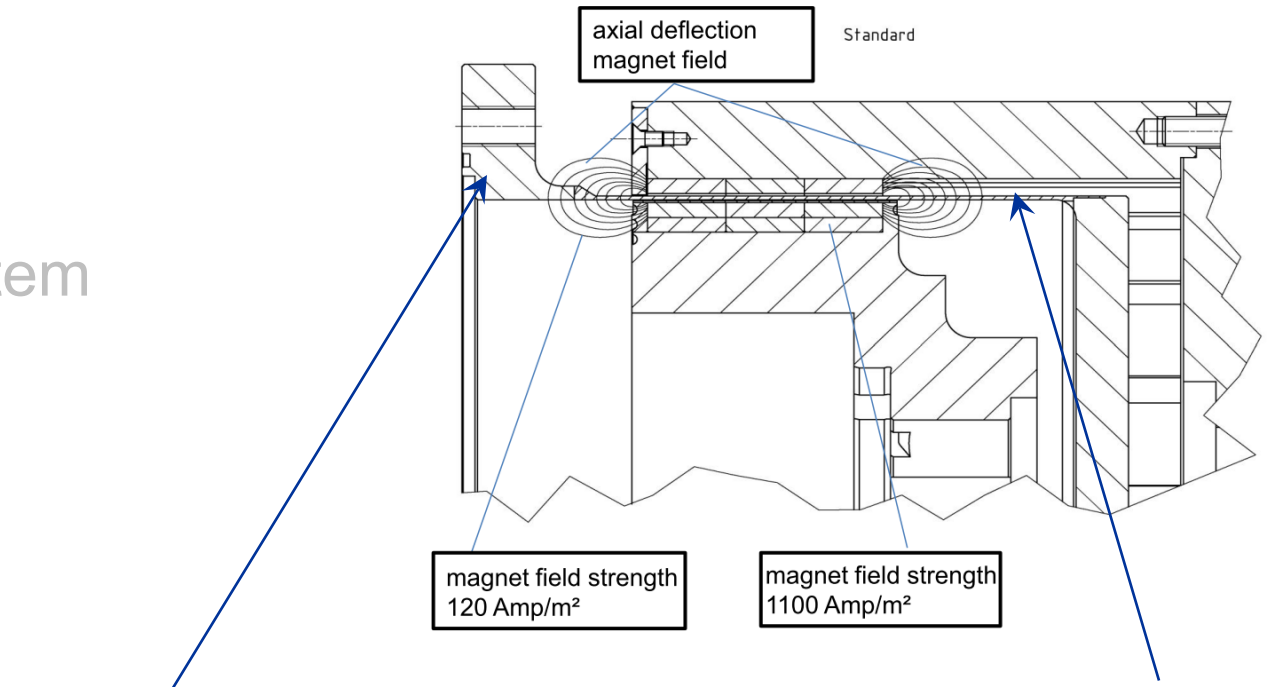

316 SS / Hastelloy Hybrid Containment Shell

How does a Mag-Drive work?

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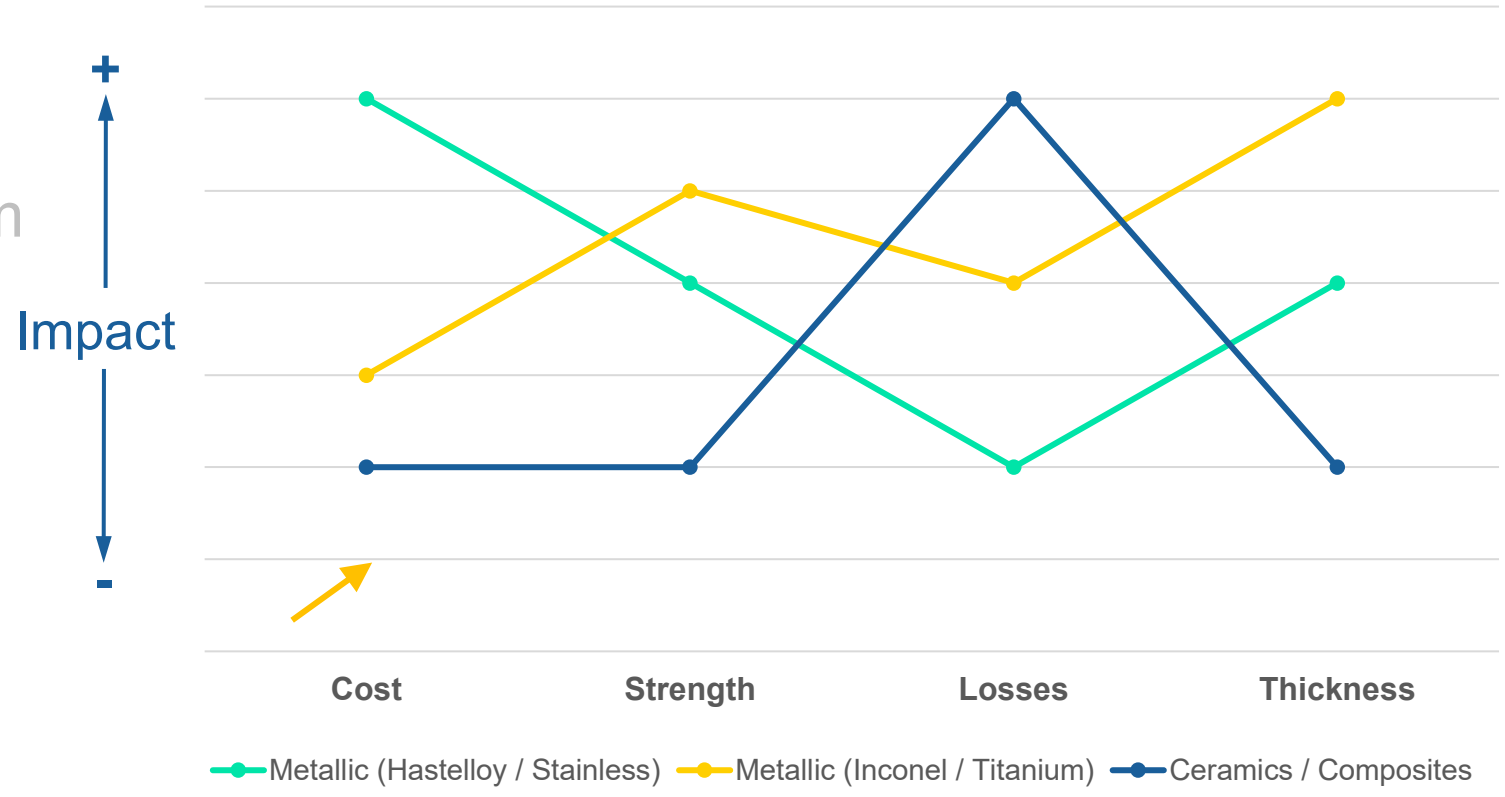
- ☑ Containment Shell
- ☑ Internal Bearing Feed System
- ☑ Internal Bearings
- ☑ No Leakage

- Metallic Hybrids.
- Full Metallic Fabrications.
- Solid Machined.
- Ceramics and Composites.
- Plastics.



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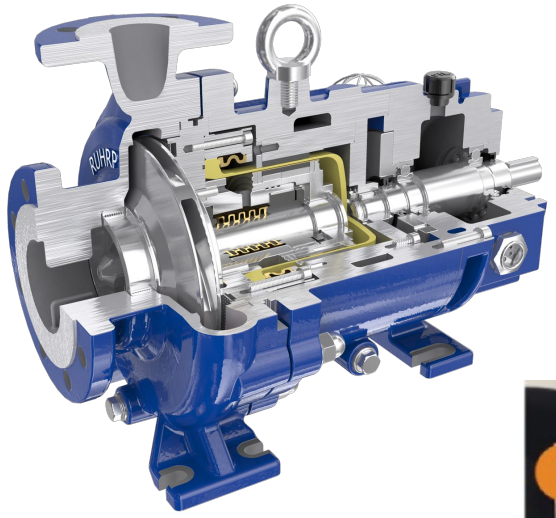

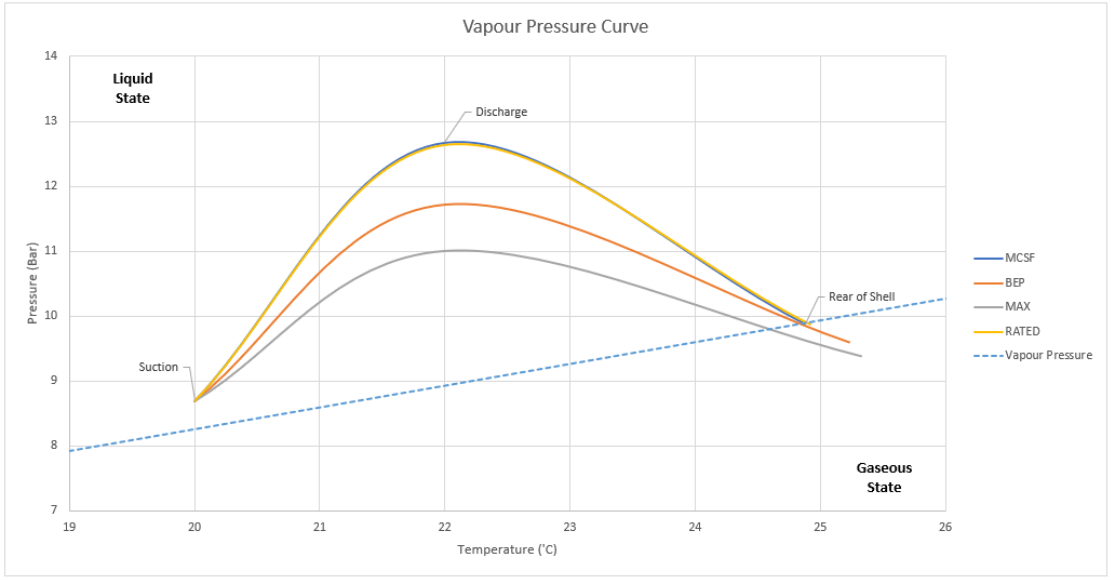

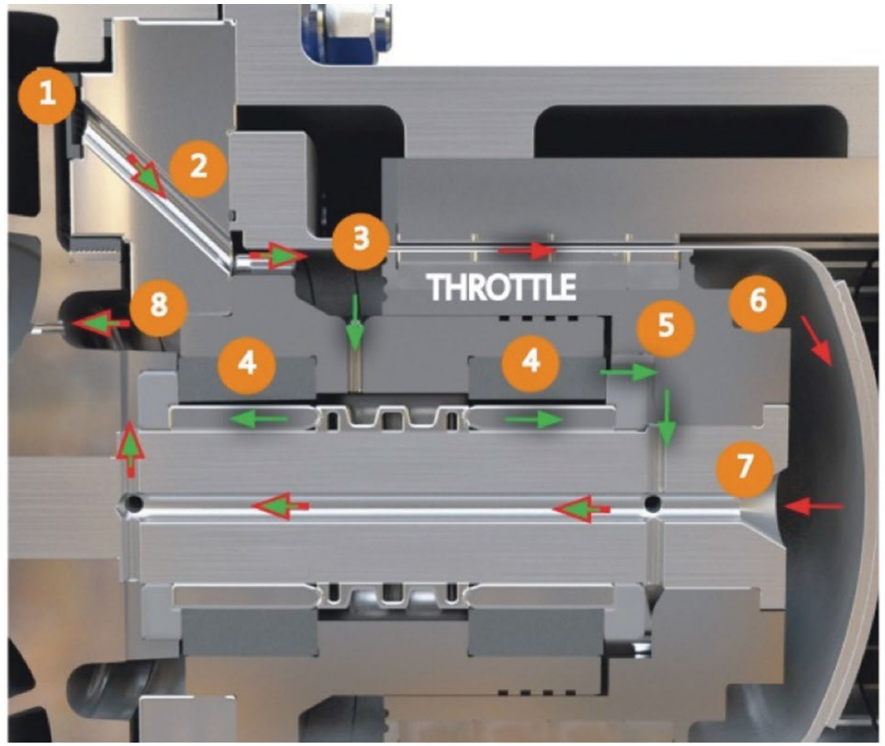

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- ☑ Containment Shell
- ☑ Internal Bearing Feed System
- ☑ Internal Bearings
- ☑ No Leakage

Heart of the pump!

Potential Risks:

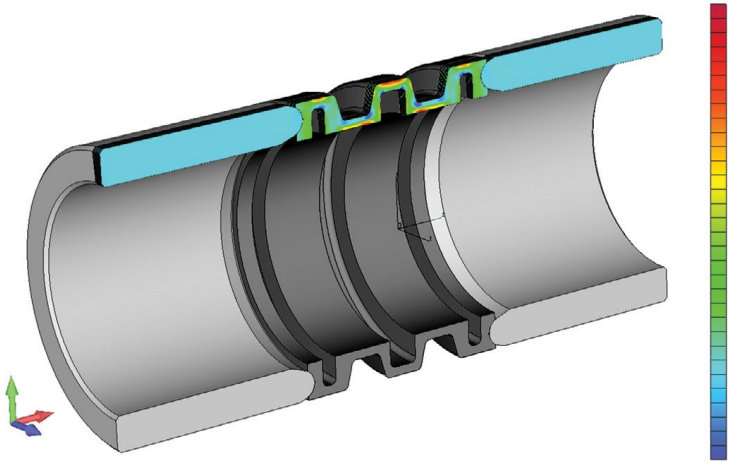
- Viscosity
- Solids
- Lack of Flow

Typically:

- Silicon Carbide.
- Carbon.

- Heat-Shrunk into position.

- Include Flow/Lubrication Grooves.



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- ☑ Internal Bearing Feed System
- ☑ Internal Bearings
- ☑ No Leakage

Heart of the pump!

Potential Risks:

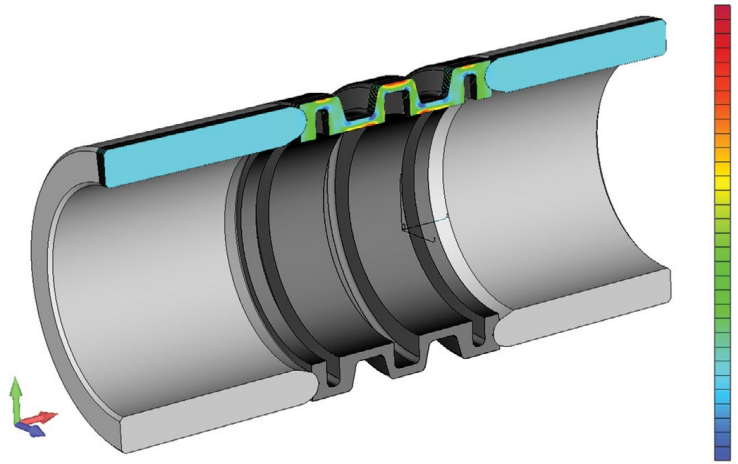
- Viscosity
  Maintain Manufacturer's Limits
- Solids
  1%-5% by Weight, 0.15mm-0.4mm
  (0.006"-0.015") in Size
- Lack of Flow
  Be above MCSF

Typically:

- Silicon Carbide.
- Carbon.

- Heat-Shrunk into position.

- Include Flow/Lubrication Grooves.



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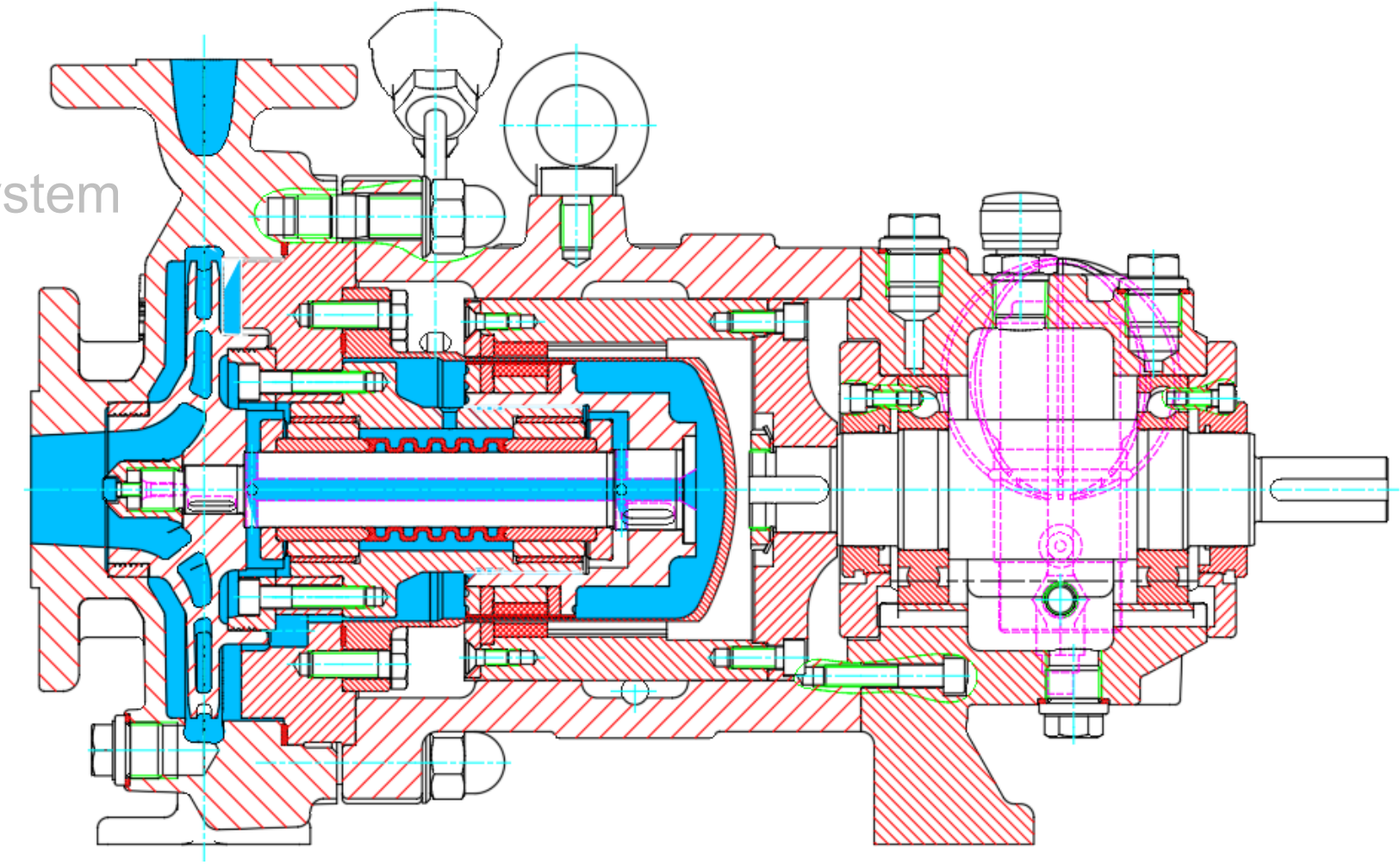

How does a Mag-Drive work?

Magnetic Drive

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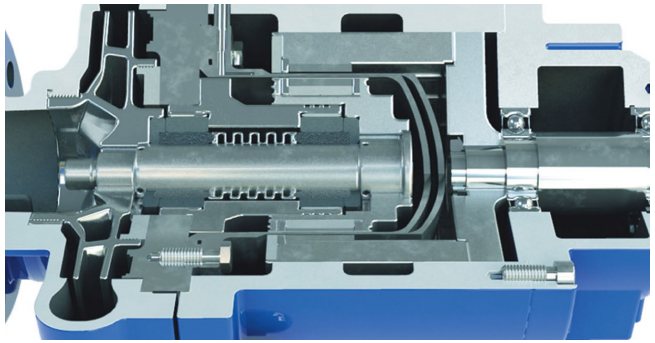
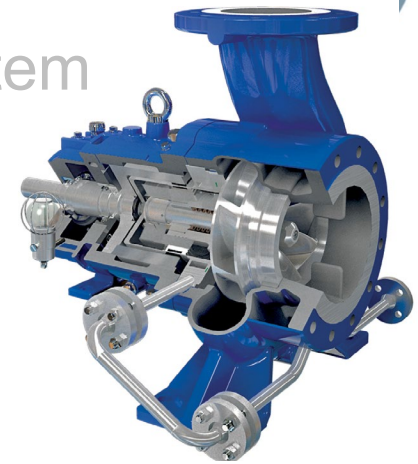
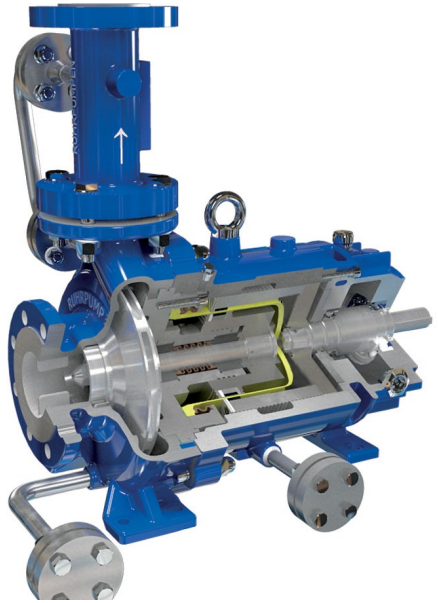
- ☑ Containment Shell
- ☑ Internal Bearing Feed System
- ☑ Internal Bearings
- ☑ No Leakage
- ☑ Options

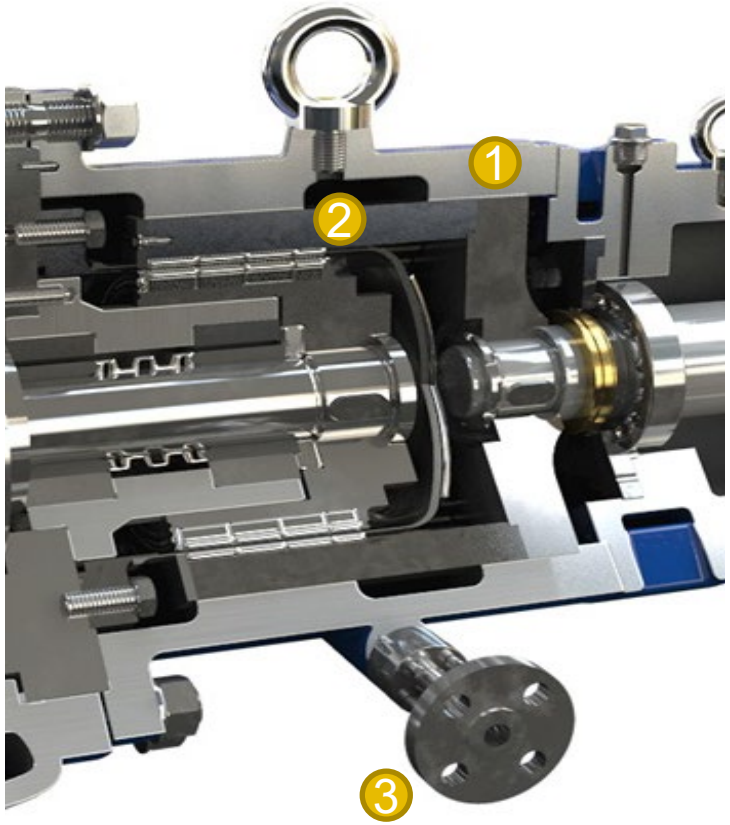






- Secondary Control – Traditionally through a Bearing Isolator.
- Secondary Containment – Double Walled Containment Shell, or other mechanical seal.
- Filtration – Internal or External.
- Heating – Casing and/or Magnetic Coupling Housing.
- Inducer – Low NPSH applications.
- Vortex / Turbulence Preventer – Suggested for applications with solids.

Optional: Secondary Control System

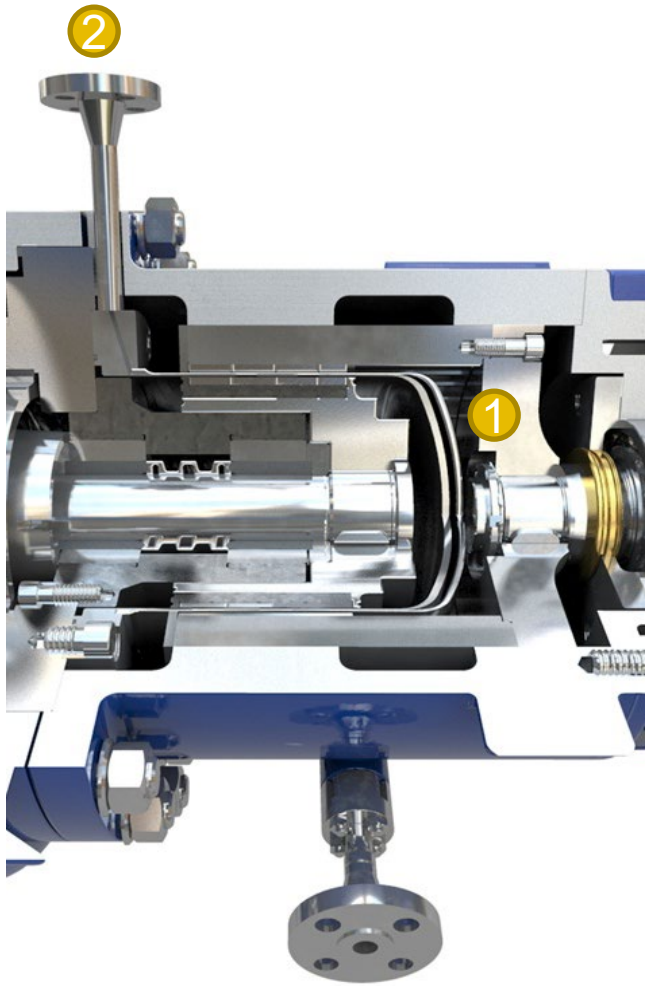


1. The intermediate housing acts as a secondary pressure casing and is equipped with a labyrinth system to the atmosphere

2. A Secondary Control System also includes an additional labyrinth system on the containment shell to help restrict flow in case of a containment shell failure

3. The presence of liquid or the increase in pressure can be monitored and the liquid can be drained

Secondary Containment System



1. In addition to the internal standard containment shell a secondary containment shell is supplied in order to provide full secondary containment

1. Each containment shell has the same pressure rating and wall thickness

2. A monitoring system can be used to monitor the integrity of both the internal and external shell for damage

Secondary Control vs Secondary Containment (API-685)

3.65
secondary containment
Confinement of the pumped liquid within a secondary pressure casing in the event of failure of the primary containment shell or stator liner.

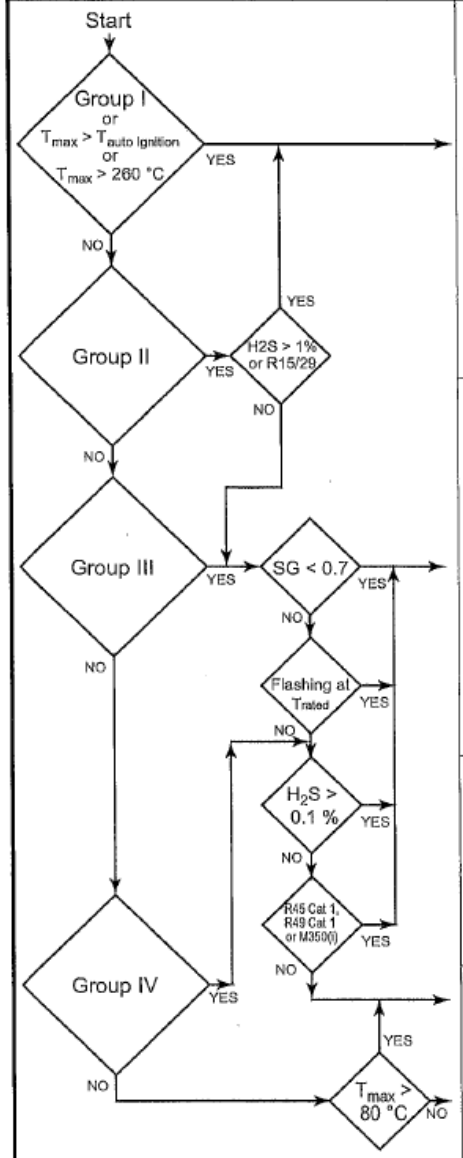
3.66
secondary containment system
Combination of devices that, in the event of leakage from the primary containment shell or stator liner, confines the pumped liquid within a secondary pressure casing that includes provisions to indicate a failure of the primary containment shell or stator liner.

3.67
secondary control
Minimization of release of pumped liquid in the event of failure of the containment shell or stator liner.

3.68
secondary control system
Combination of devices (including a secondary pressure casing) that, in the event of leakage from the containment shell or stator liner, minimizes and safely directs the release of pumped liquid. It includes provision(s) to indicate a failure of the containment shell or liner.

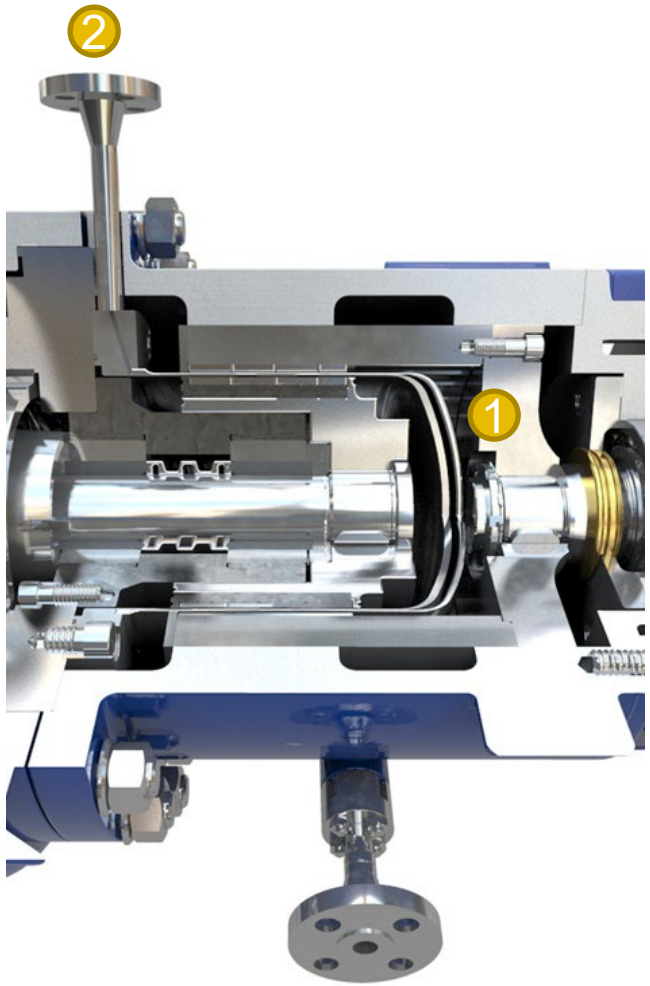
6.7.3 The secondary control system shall have a stand-by life of at least 25,000 hours in a pump operating mode and shall have a functional life of at least 24 hours in the event of containment shell failure.

Figure B.1—Logic Diagram



Secondary Control/Containment Logic	Secondary Control/ Containment	Canned Motor Pumps	Magnetic Drive Pumps
	Secondary containment system (3.66)	— Leakage detection in pump stator (7.4.2.3). (S) — Pump power monitoring (7.4.2.2) or flow monitoring. (A) — Liquid detection in vertical section of discharge piping or on top of the heat exchanger if the pump has an external cooler. (A) — Stator Liner temperature monitoring (7.4.2.4). (A) — Motor winding thermocouple. (S) — Flanged secondary casing drain (6.7.9). — Decontamination flush (9.2.2.11).	— Secondary pressure casing. — Secondary pressure casing pressure monitoring. (S) [1] — Containment shell temperature monitoring. (A) [2] — Pump power monitoring (7.4.2.2) or flow monitoring. (A) — Liquid detection in vertical section of discharge piping. (A) — Containment shell temperature monitoring (7.4.2.4). (A) — Flanged secondary casing drain (6.7.9).
	Secondary control system (3.68)	— Leakage detection in pump stator (7.4.2.3). (S) — Pump power monitoring (7.4.2.2) or flow monitoring. (A) — Liquid detection in vertical section of discharge piping or on top of the heat exchanger if the pump has an external cooler. (A) — Stator Liner temperature monitoring (7.4.2.4). (A) — Motor winding thermocouple (9.2.2.12). (S) — Flanged secondary casing drain (6.7.9). — Decontamination flush (9.2.2.11).	— Single containment shell. — Containment shell temperature monitoring. (S) [2] — Pump power monitoring (7.4.2.2) or flow monitoring. (A) — Liquid detection in vertical section of discharge piping. (A) — Containment shell temperature monitoring (7.4.2.4). (A) — Flanged secondary casing drain (6.7.9) or vent connected to plan 65 drain pot or Plan 75 vent system. (S) — Bearing protector seal to be approved by User (9.1.2.2.2).
	Secondary control (3.67)	— Pump power monitoring (7.4.2.2) or flow monitoring. (A) — Liquid detection in vertical section of discharge piping or on top of the heat exchanger if the pump has an external cooler. (A) — Motor winding thermocouple (9.2.2.12). (S)	— Single containment shell. — Pump power monitoring (7.4.2.2) or flow monitoring. (A) — Liquid detection in vertical section of discharge piping. (A) — Flanged secondary casing drain (6.7.9). — Bearing protector seal to be approved by User (9.1.2.2.2).
	none	— Liquid detection in vertical section of discharge piping or on top of the heat exchanger if the pump has an external cooler. (A) — Motor winding thermocouple (9.2.2.12). (S)	— Single containment shell. — Liquid detection in vertical section of discharge piping. (A) — Bearing protector seal to be approved by User (9.1.2.2.2).

Secondary Containment System

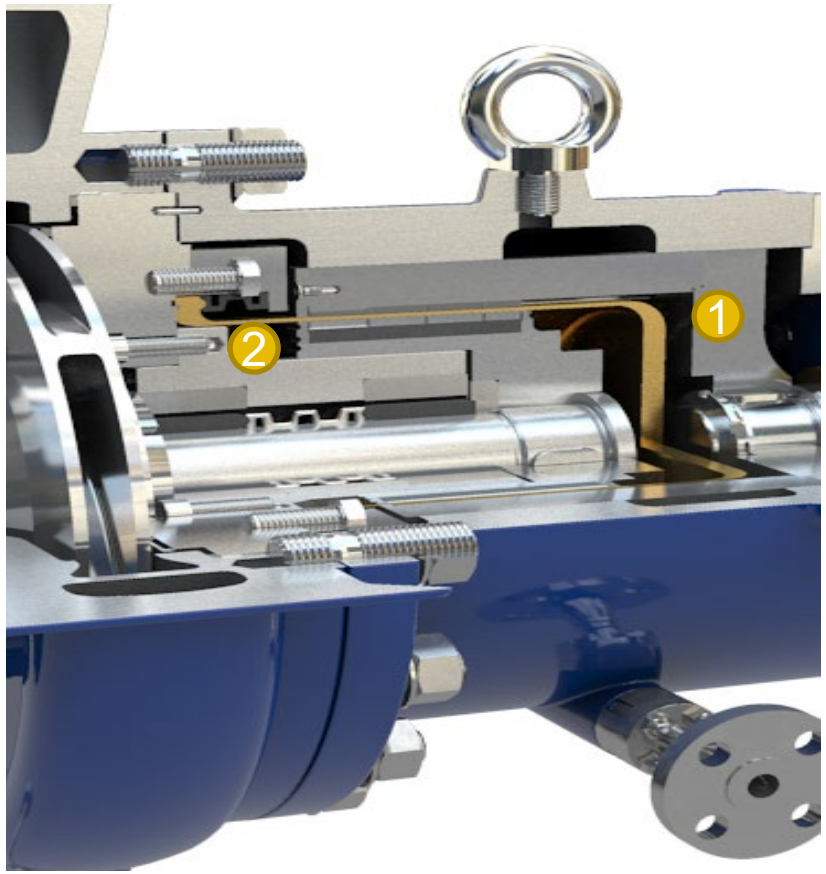


1. In addition to the internal standard containment shell a secondary containment shell is supplied in order to provide full secondary containment

1. Each containment shell has the same pressure rating and wall thickness

2. A monitoring system can be used to monitor the integrity of both the internal and external shell for damage

Ceramic Containment Shell



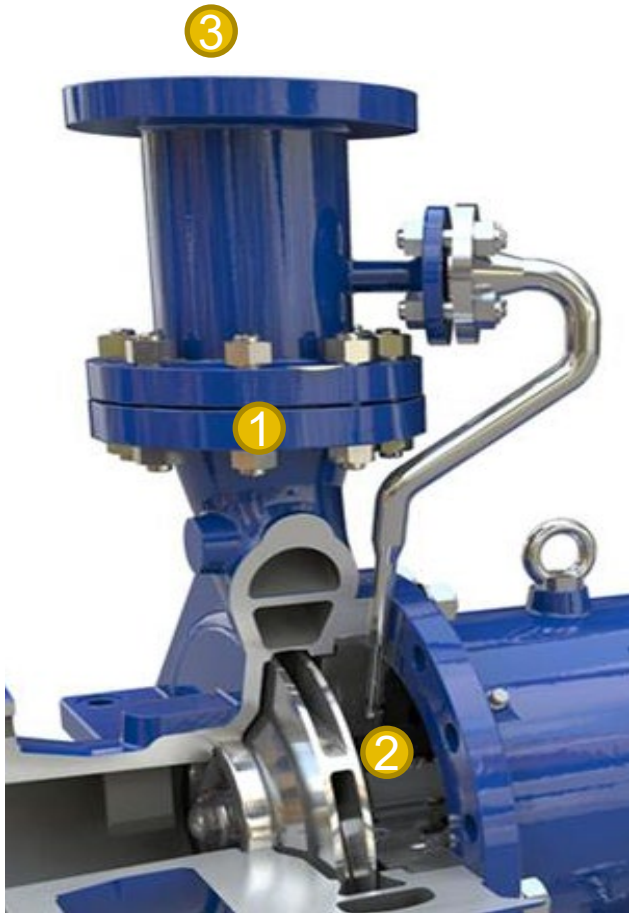
1. Made of Zirconium Oxide

   Magnetic losses are eliminated and efficiency is increased significantly

   The pump has effectively the same efficiency as a mechanical seal pump.

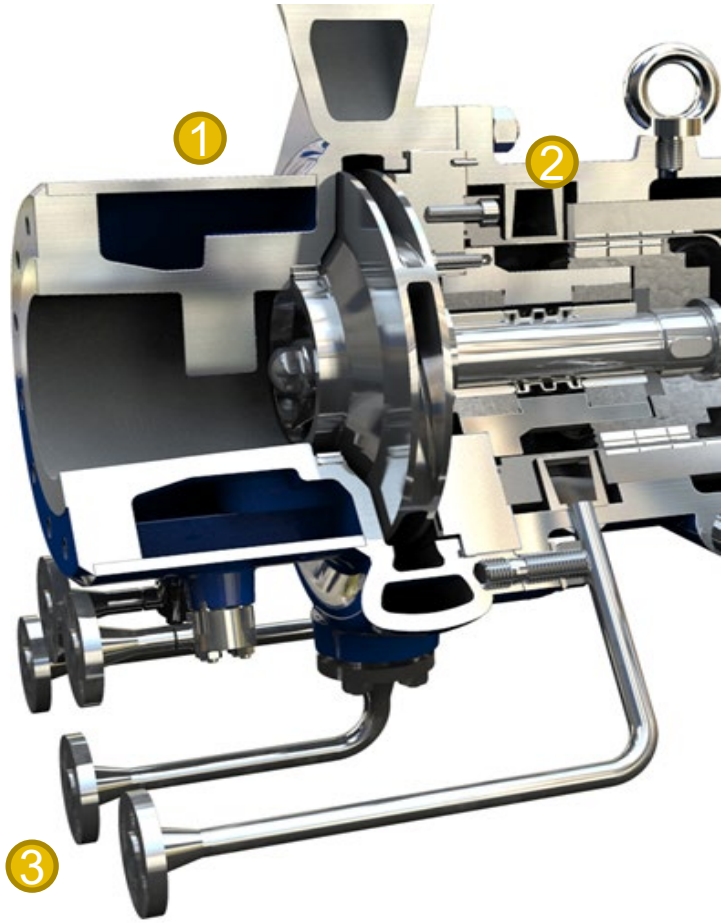
2. The fastening is via a locking ring that guarantees easy assembly and disassembly

Main Stream Filter



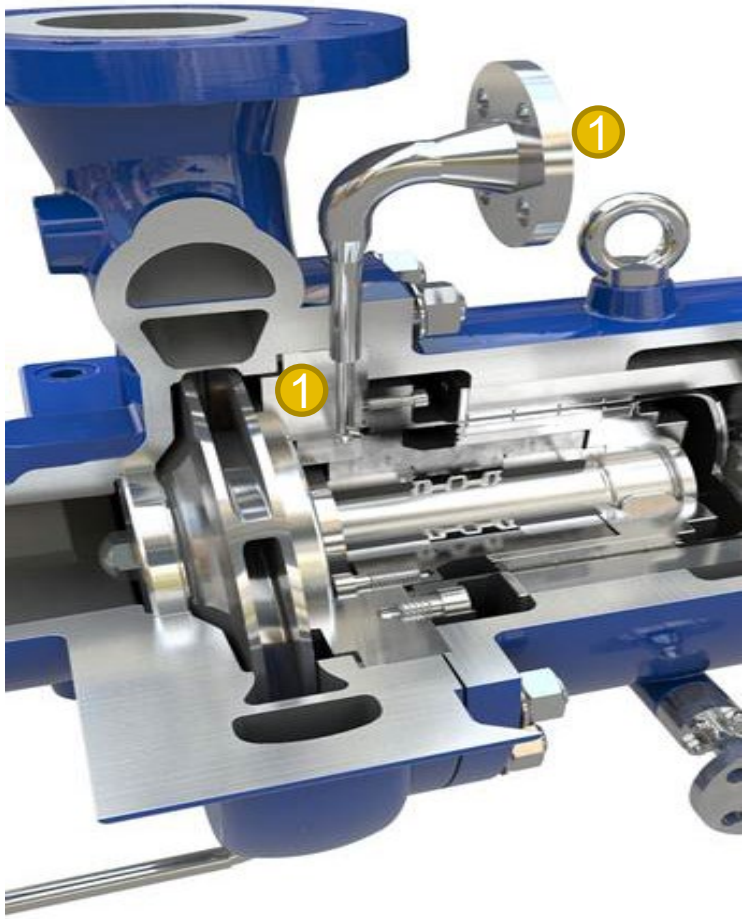
1. Assembled on the discharge flange of the pump
2. In case of solids in the process, clean fluid is provided to the journal bearings and the magnetic drive for lubrication and cooling
3. The main stream filter is self cleaning

Casing and Intermediate Lantern Heating and Cooling



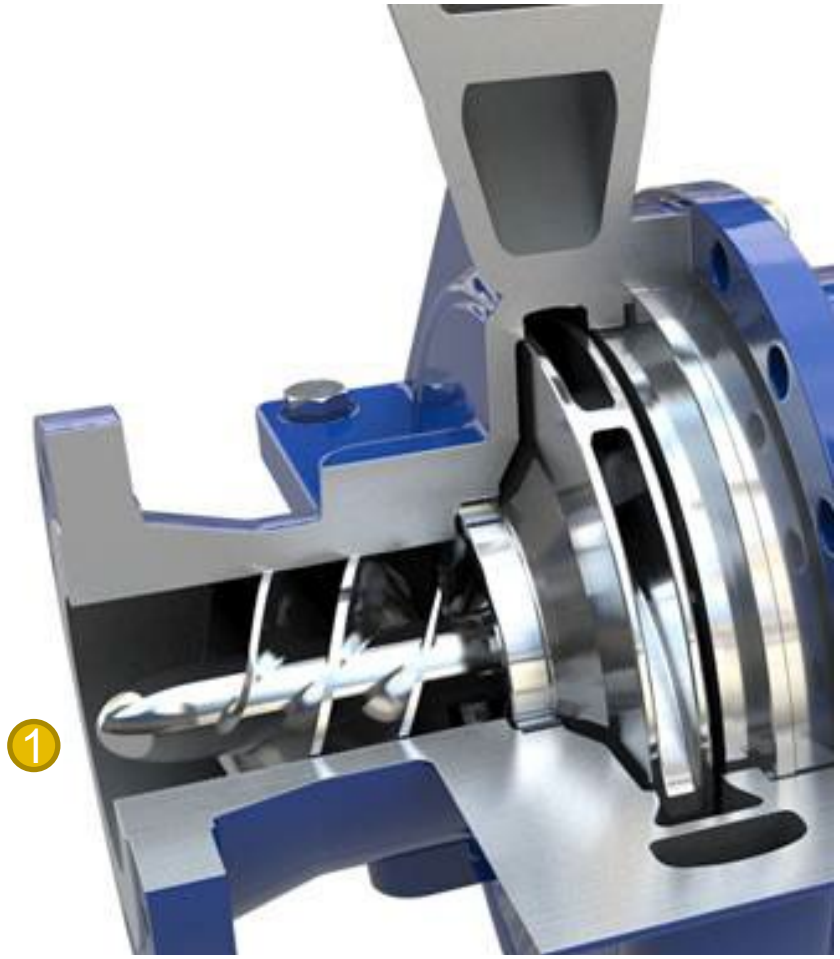
1. The pump can be equipped with a heating or cooling jacket at the casing
2. The pump can also be equipped with a heating or cooling jacket of the intermediate housing
3. Both heated or cooled areas can be operated independently, or in conjunction with each other

External Flushing Lubrication



1. Magnetic drive and the journal bearings can be supplied with clean product for cooling and lubrication

Inducer



1. **NPSHr** of a pump can be significantly reduced by using an inducer

The addition of an inducer will have very little impact on the pump hydraulic characteristic

The addition of an inducer to an existing pump can usually be done without any major modifications to the pump

Animation of Key Features

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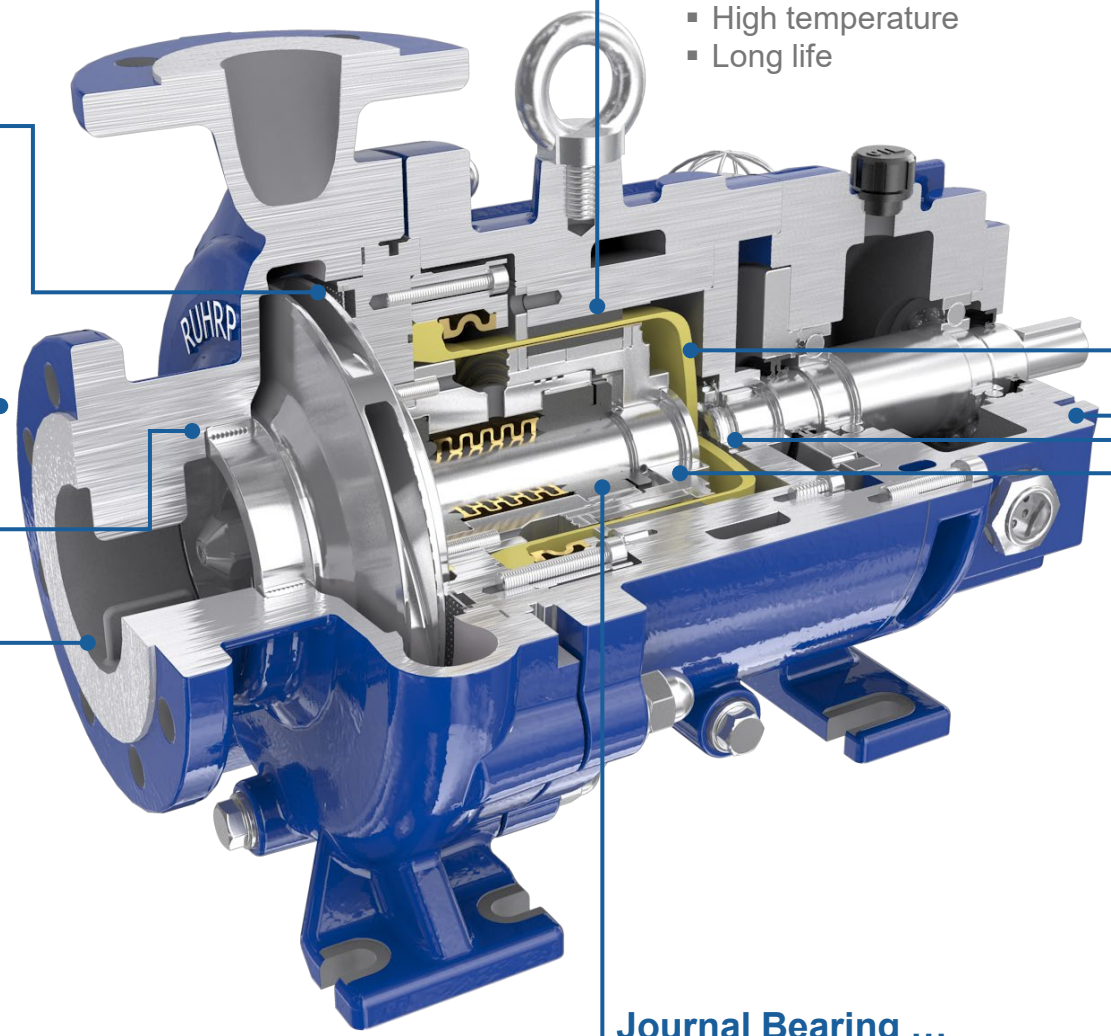
Magnetic Drive Sealless Pumps| Features and Benefits

Pumping Technology for Life…

“Mag-Drive” Creating the Finest Example



Pure Magnet Quality …
- High temperature
- Long life

Various Shell Options …
- Ceramic/Composite for Low Power | High Efficiency
- Inert materials

Free-Flow Filter …
- Self Cleaning
- non-Clogging

Heat Dissipating Bracket …
- Roller Bearings under negligible load

Petrochem Materials …
- Carbon Steels
- Stainless Steel
- Hastelloy

Secondary Containment …
- Leak-activated seals
- Double-wall shell
- Leak Detection Instrumentation

Grooved Wear Rings …
- High Efficiency
- ...Over a life-time
- Replaceable

Low NPSH(r) …
- “High” Vapour pressures
- Inducer options

Journal Bearing …
- Bearing position stability

Internal Flow…
- Balanced flow path
- Bearing lubrication
- Internal cooling

Benefits of a Magnetic Drive Pump

- No leakage of product
- Zero emissions
- No mechanical seal or seal support system
- Reduced installation cost
- Complete fluid containment
- Improved operator safety
- Protection of the environment

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Magnetic Drive Sealless Pumps| Industrial Standards

Pumping Technology for Life…

Industrial Standards

- ISO Hydraulics
- ASME Hydraulics
- API Hydraulics

2x1x8	3x1.5x8	4x1.5x12	4x3x7.5	6x3x16	6x4x11.5	6x6x9
3x1x9.5	3x1.5x9	4x2x9	4x3x8	6x3x19	6x4x12	6x6x11
3x1x10	3x1.5x10	4x2x11.5	4x3x11	6x4x7	6x4x13	6x6x12
3x1x11	3x1.5x11	4x2x14	4x3x12.5	6x4x8.5	6x4x14	8x6x10.5
3x1x12	3x1.5x11.5	4x2x15	4x4x7.5	6x4x9	6x4x16	8x6x14
3x1.5x7	3x2x7	4x2x17	6x2x16	6x4x10	6x4x19	
3x1.5x7.5	3x2x11	4x3x7	6x3x9	6x4x11	6x4x21	

1.5x1x6
1.5x1x8
2x1x10
3x1.5x6
3x1.5x8
3x1.5x10
3x1.5x13
3x2x6
3x2x8
3x2x10
3x2x13
4x3x8
4x3x10
4x3x13
6x4x10
6x4x13
6x4x15
6x4x17
8x6x13
8x6x15

040-025-125
040-025-160
040-025-200
050-032-125
050-032-160
050-032-200
050-032-250
065-040-125
065-040-160
065-040-200
065-040-250
065-040-315
080-050-125
080-050-160
080-050-200
080-050-250
080-050-315
100-065-125
100-065-160
100-065-200
100-065-250
100-065-315
125-080-160
125-080-200
125-080-250
125-080-315
125-100-200
125-100-250
125-100-315
125-100-400
150-125-250
150-125-315
150-125-400
200-150-250
200-150-315
200-150-400

The pump designation follows these rules:

CRP-M 080-050-200-125-040 F1

- Construction designs
- Magnet system length
- Magnet drive size
- Nominal impeller diameter
- Pump discharge nozzle - nomial width
- Pump suction nozzle - nominal width
- Series

Industrial Standards

- ISO Hydraulics
- ASME Hydraulics
- API Hydraulics

API

- **API 685 - Sealless Centrifugal Pumps (Petroleum, Petrochemical, and Gas Industry Process)**

- Centerline Mounted.
- Stringent design and construction rules (pressure, nozzle loads, clearance checks, etc.)
- Materials.
- Testing.

ASME

- **ASME B73.3 – Sealless Horizontal End Suction Pumps (for Chemical Process)**

- Imperial general process pump.
- Dimensionally constrained.

ISO

- ISO 2858 – Hydraulics and dimensions.
- ISO 5199 – Technical Requirements / specifications (Single/Multi-stage, horizontal and vertical).
- **ISO 15783 – Technical requirements / specifications (Sealless).**

- Metric general process pump.
- Dimensionally constrained.

Industrial Standards

- ISO Hydraulics
- ASME Hydraulics
- API Hydraulics

Typical Differences:

	API	ASME		ISO
Pressure ratings	40 Bar	18.9 Bar		16 Bar
Wear Rings	Both Casing and Impeller	Casing ONLY (Maximum)		
Mounting	Centerline	Foot (as standard)		
Dimensional	NO standard	B73.3	ISO 2858	
Testing and Inspection	Mandatory	Optional		

RP has been building Mag Drive Pumps since 2012

In that time we have manufactured 675 pumps

Here are some interesting statistics.

The RP range of pump sizes is similar to the other big players in the market so I think these statistics can be applied across the industry.

- 80% are < 10kW
- 90% are < 20kW
- 7% are between 20 & 50kW
- 3% are > 50kW
- 10% are API build
- 90% ANSI / ISO build
- The largest power we have built is 160kW

Coming Attractions ☺

"Mechanical Seals and Sealing Systems"

Thur 21st September – 08.00 (UK GMT+1) (Eastern Hemisphere) & 17.00 (UK GMT+1) (Western Hemisphere)

Aimed at Process and Mechanical Engineers and Consultant Engineers specifying pumping equipment as well as Applications & Sales Engineers selecting and quoting them. Develop an understanding of the fundamentals of sealing technology, the types of seals available and their associated sealing support systems (piping plans).

Future sessions :

– Understanding System Curves

– NPSH

RUHRPUMPEN

Specialist for Pumping Technology

Q & A

info@short-courses.ruhrpumpen.com


RUHRPUMPEN AT A GLANCE
VERTICAL INTEGRATION
SALES OFFICES IN +35 COUNTRIES
MANUFACTURING FACILITIES IN 10 COUNTRIES
+70 YEARS OF EXPERIENCE
+2,000 EMPLOYEES
15 SERVICE CENTERS
+70,000 PUMPING SOLUTIONS INSTALLED WORLDWIDE

A GLOBAL COMPANY

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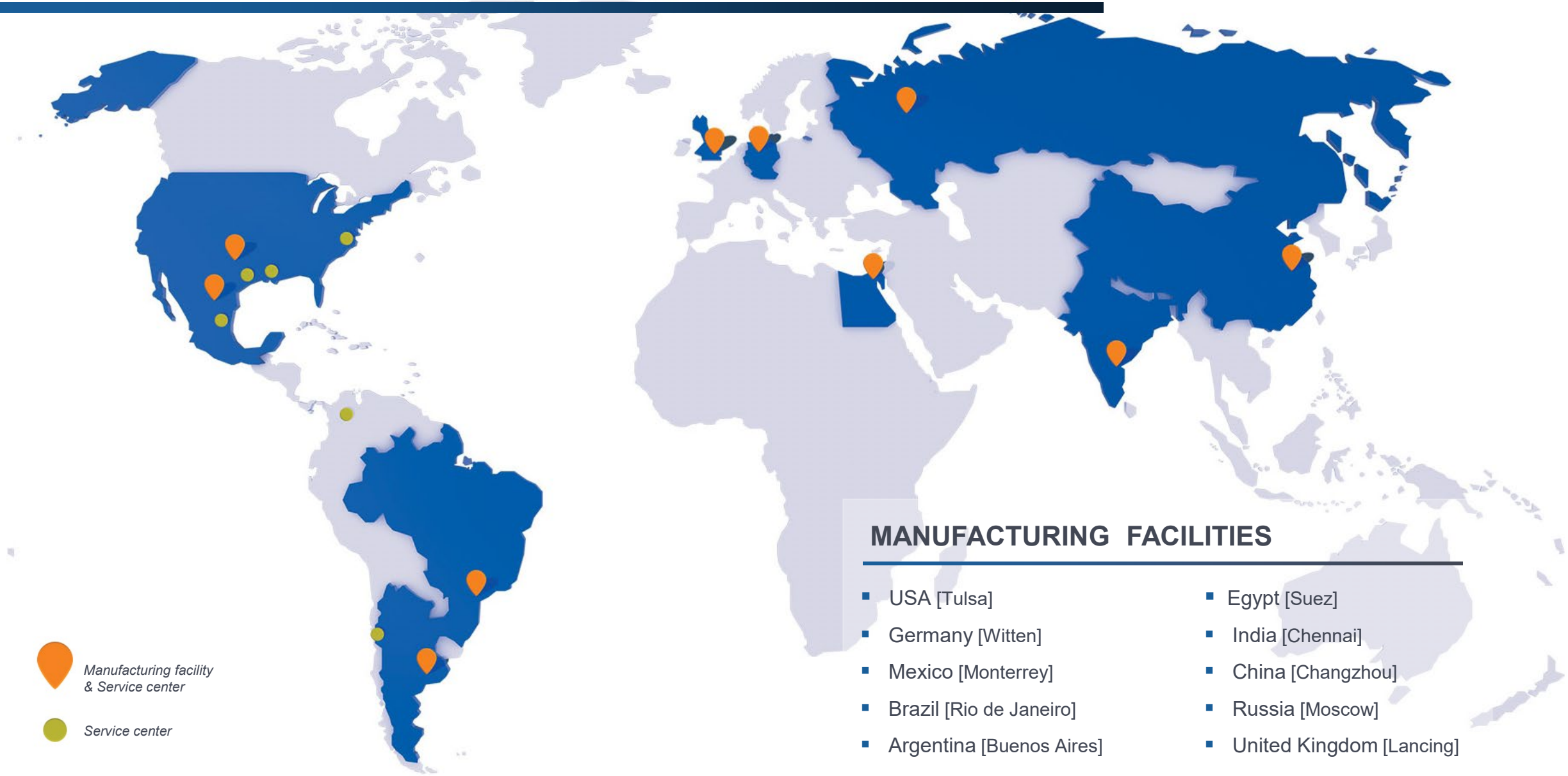


MANUFACTURING FACILITIES

- USA [Tulsa]
- Germany [Witten]
- Mexico [Monterrey]
- Brazil [Rio de Janeiro]
- Argentina [Buenos Aires]
- Egypt [Suez]
- India [Chennai]
- China [Changzhou]
- Russia [Moscow]
- United Kingdom [Lancing]

MARKETS WE SERVE

Our commitment to create innovations that offer reliable solutions to our customers allow us to provide a complete range of pump systems to support **core markets** as:

RUHRPUMPEN

OUR PUMP LINES

Ruhrpumpen offers a broad range of highly engineered and standard pumping products that meet and exceed the requirements of the most demanding quality specifications and industry standards.

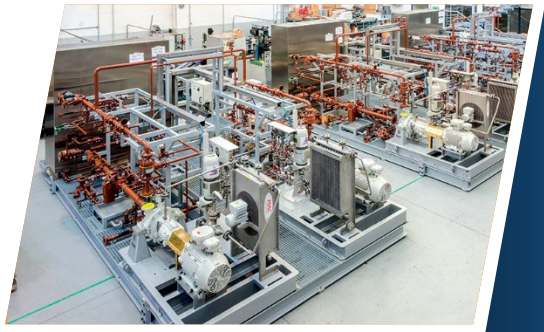
Our pumps can handle head requirements as high as 13,000 ft (4,000 m) and capacities up to 300,000 gpm (68,000 m^3/hr). Moreover, our pump designs cover temperatures from cryogenic temperatures of -310 °F (-196 °C) up to 752 °F (400 °C).

Products include:

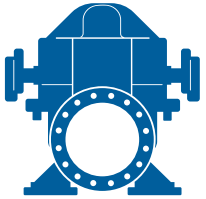
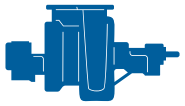
- Single Stage Overhung Pumps
- Between Bearings Pumps
- Horizontal Multi-Stage Pumps
- Vertical Multi-Stage Pumps
- Vertical Mixed Flow & Axial Flow Pumps
- Positive Displacement Pumps
- Full Range of Industrial Pumps
- Submersible Pumps
- Magnetic Drive Pumps
- Decoking Systems
- Packaged Systems
- Fire Systems

OVERHUNG PUMPS

CATEGORY	RP MODEL	DESIGN STANDARD
Sealless Magnetic Drive Pumps	**CRP-M / CRP-M-CC**	ISO 2858 & 15783 HI design (OH11)
	SCE-M	API 685
Foot Mounted OH1 and General End Suction Pumps	**IPP**	HI design (OH1)
	CPP / CPP-L	HI design (OH1) ANSI B73.1
	CPO / CPO-L	HI design (OH1) ANSI B73.1
	CRP	HI design (OH1) ISO 2858 & 5199
	GSD	HI design (OH0)
	SHD / ESK / SK / SKO SKV / ST / STV	HI design (OH1)
	SWP	HI design (OH3A)
Centerline Mounted	**SCE**	API 610 (OH2)
Vertical In-Line Pumps	**SPI**	API 610 (OH3)
	IVP / IVP-CC	HI design (OH4 / OH5)
	IIL	HI design (OH5) Dimensionally compliant with ANSI B73.2
	SPN	API 610 (OH5)



BETWEEN BEARING PUMPS

CATEGORY		RP MODEL	DESIGN STANDARD	
1 and 2 stage	Axially split	**HSC / HSD / HSL HSR / ZW**	HI design (BB1)	
		HSM	HI design (BB3)	
		ZM / ZMS ZLM / ZME	API design (BB1)	
	Radially split	**HVN / J**	API design (BB2)	
		RON / RON-D	API design (BB2)	
Multi-stage	Axially split	**SM / SM-I**	API design (BB3)	
		JTN	API design (BB3)	
	Radially split *single casing*	**GP**	API design (BB4)	
	Radially split *double casing*	**A LINE**	API design (BB5)	

VERTICAL PUMPS

CATEGORY		RP MODEL	DESIGN STANDARD	
Single casing	Diffuser	**VTP**	HI & API 610 (VS1)	
		VCT	HI & API 610 (VS1)	
		HQ	HI & API 610 (VS1)	
		VLT	HI & API 610 (VS1)	
	Volute	**DSV / DX**	HI & API 610 (VS2)	
	Discharge through column – Axial flow	**VAF**	HI & API 610 (VS3)	
	Separate discharge line	**VSP / VSP-Chem**	HI & API 610 (VS4)	
Double casing	Diffuser	**VLT / VMT**	HI & API 610 (VS6)	
	Volute	**DSV / DX**	HI & API 610 (VS7)	
Submersible pumps		**SMF**	HI design (OH8A)	
		VLT-Sub / VTP-Sub	HI design (VS0)	

SPECIAL SERVICE PUMPS

CATEGORY	RP MODEL	DESIGN STANDARD	
Pitot tube pumps	**COMBITUBE**	HI design	
Reciprocating pumps	**RDP**	API 674 ISO 13710	
Vertical turbine generator	**VTG**	HI design (VS6)	
Barge	**LS BARGE**	HI design	
Floating dock pumps	**ZVZ**	HI design	
	LVZ	HI design	
Cryogenic pumps	**SVNV**	-	
	VTG Cryogenic	-	
	VLT Cryogenic VLTV	-	
Pre-packaged fire pump systems	Fire systems incorporate pumps, drivers, control systems and pipework in a single container. They can be skid mounted, with or without enclosure and supplied with electric motor or diesel engine.	**NFPA-20-850** UL and FM approved components