

# Cooling of server rooms with CO2

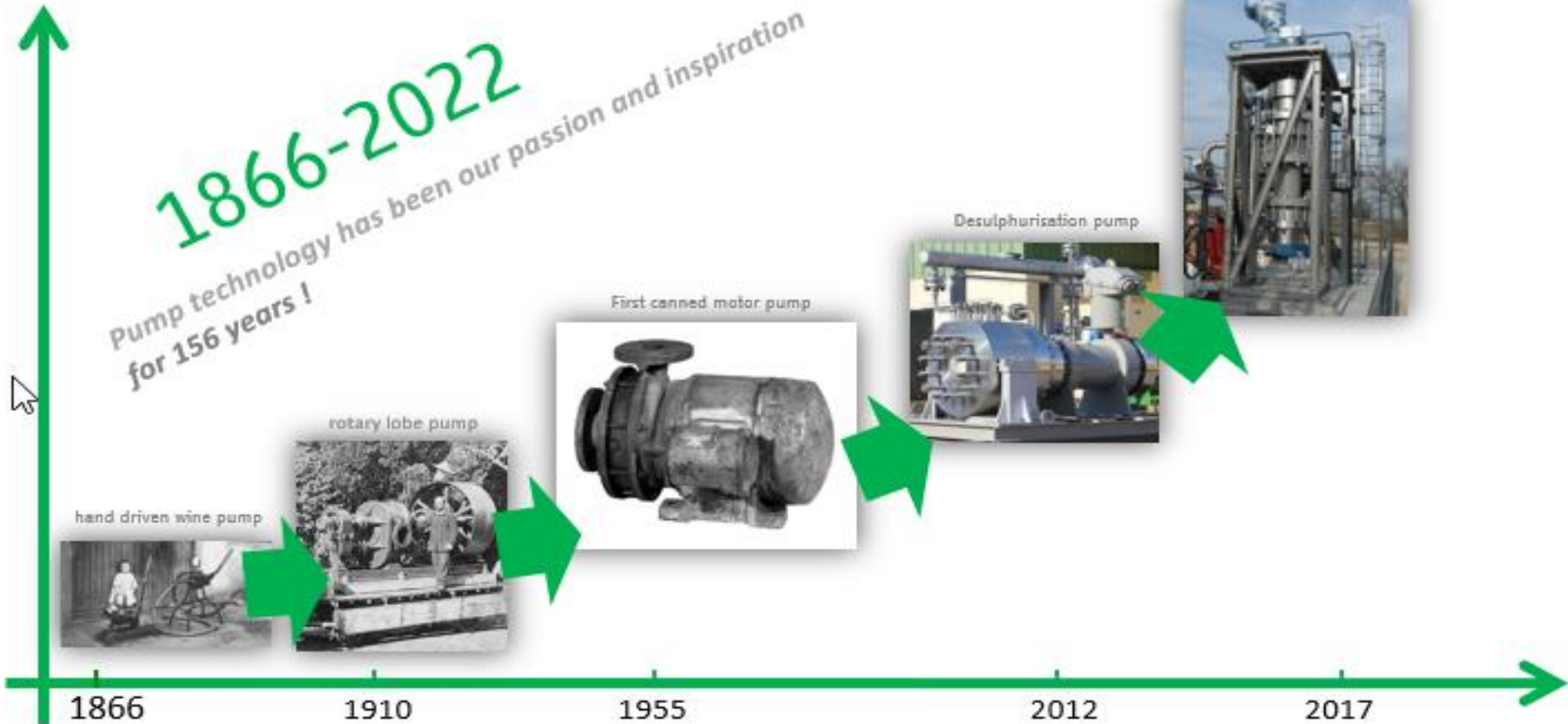
Christoph Galli

euramm<sup>on</sup> Symposium, DATE

# HERMETIC-Company



# ADVANCED TECHNOLOGY



# Agenda

- CO2 as natural refrigerant – short introduction
- Cooling of server room with CO2 – solution
- Finding the right pumping solution
- Summary



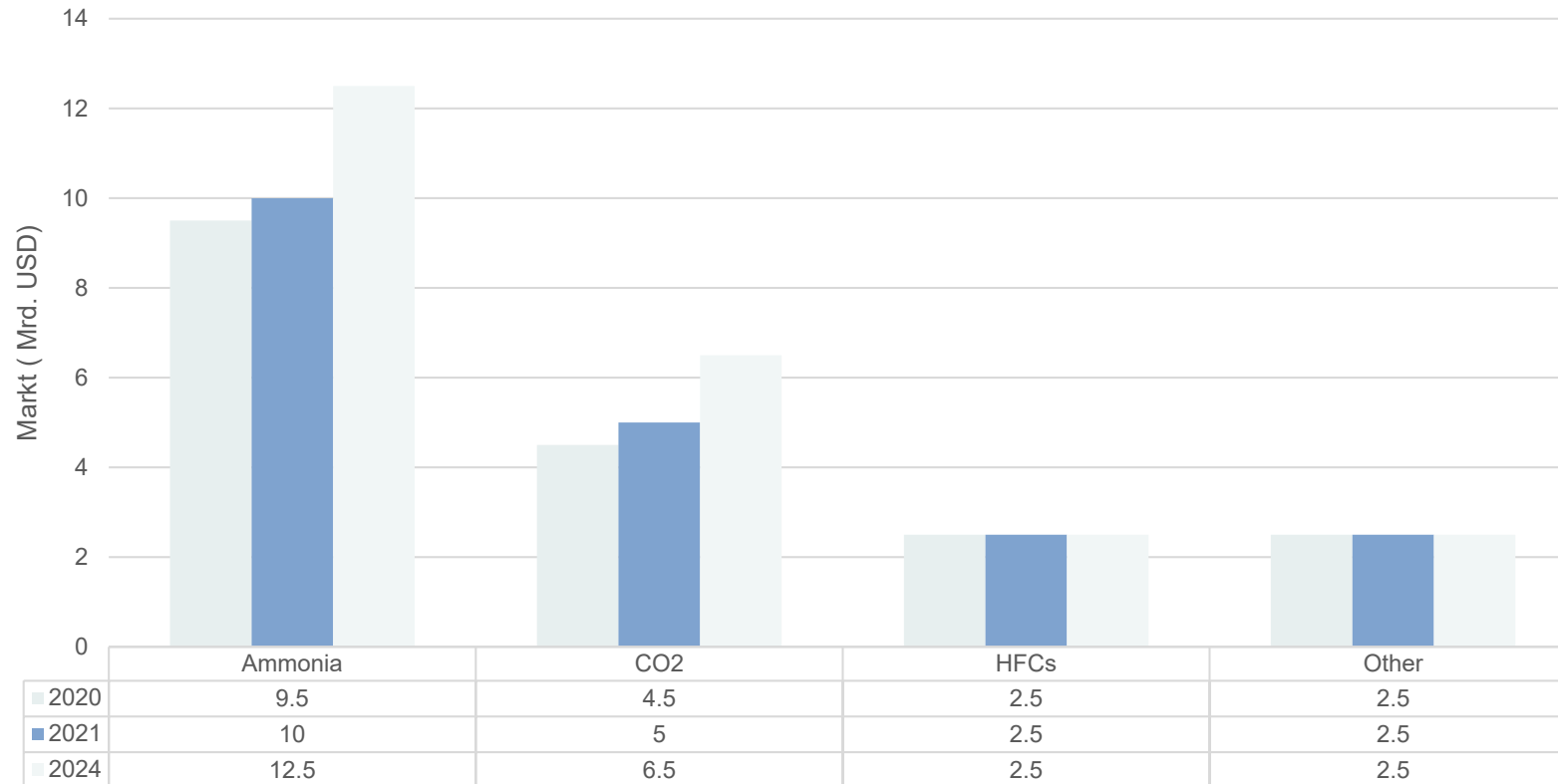
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# Market Outlook – Expectations for different refrigerants

Marktentwicklung



Largest growth for CO2 (appr. 7%/per year until 2024)

# CO2 – As natural refrigerant

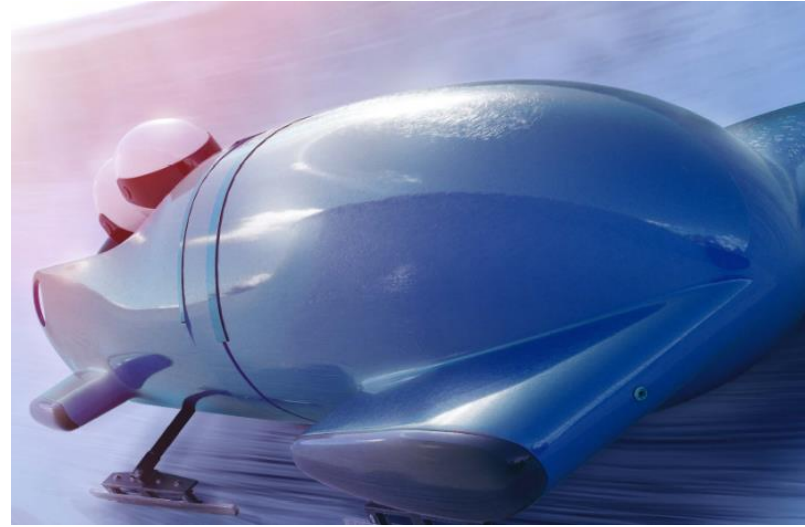
## Properties CO2:

- R744
- Global Warming Potential (GWP) = 1
- Density (0°C) = 927.4 kg/m<sup>3</sup>
- Spec. heat(0°C) = 2.542 kJ/kgK
- Vapor pressure (0°C) = 3.485 Mpa / 500 psia



Advantages	Disadvantages
+ Low global warming potential	- High pressure installations
+ Not hazardous to product in case of contact	- Expensive installation
+ Low pressure/compression ratio	- Operating conditions can be close to critical (triple) point
+ Low cost	

# Typical installations of CO2





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# Cooling server rooms with CO2

## Main advantages of CO2

- Less space
- Lower volumetric flow (12m<sup>3</sup>/h) – instead of 100m<sup>3</sup>/h water / 5000 m<sup>3</sup>/h air
- No water damages to server

## Requirements

- Nominal pressure: 75 bars
- Operating temperature: +15°C
- Delivery rate: 12 m<sup>3</sup>/h
- Pumping head: 45 m



# Pump solution

- Pump type: CAM 30/3+0
- Nominal pressure: PN75
- Motor output: 3kW
- Position: Vertical

## Advantages:

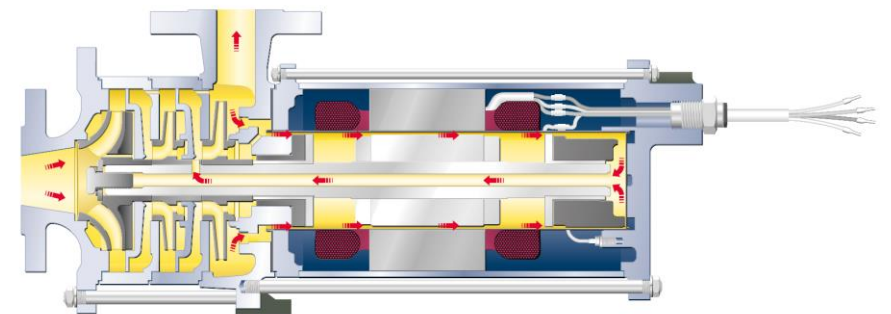
- CO2 leakage rate less than 1g/year at 64bar
- Reliability
- Low maintenance



Heat exchanger (CARRIER)

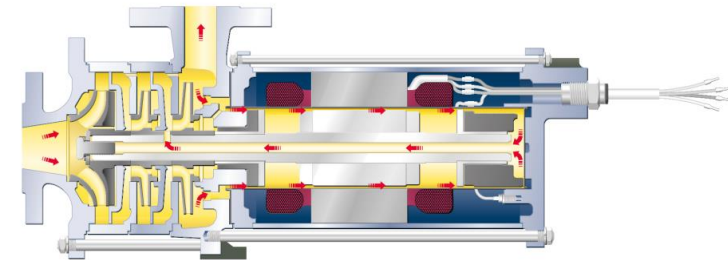
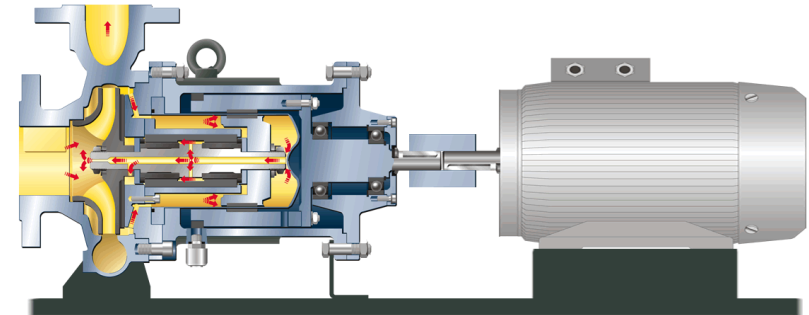
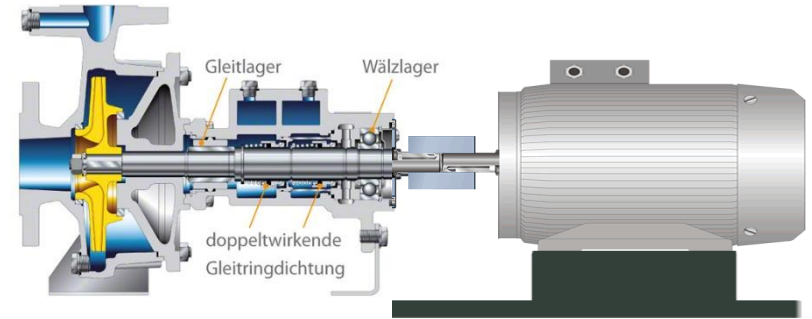
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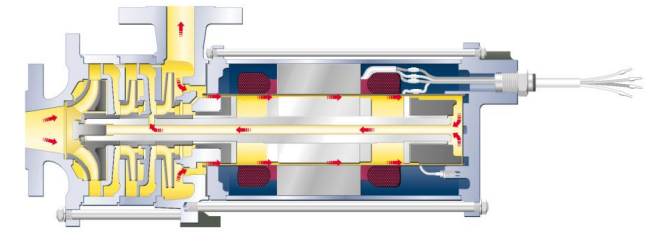
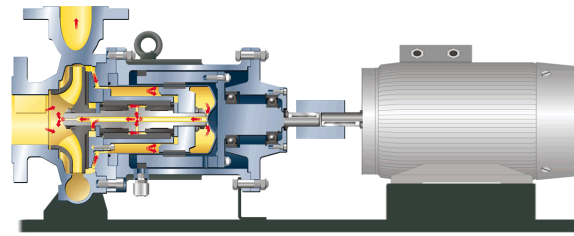
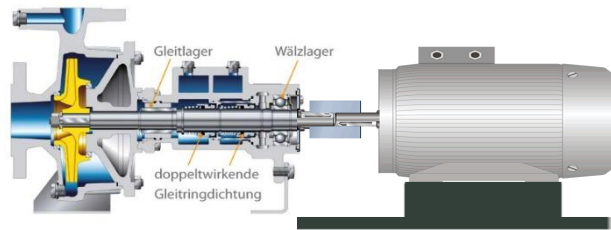


# Centrifugal pump types

- Centrifugal Pumps with double mechanical seal
- Magnetic coupled pumps
- Canned Motor Pumps

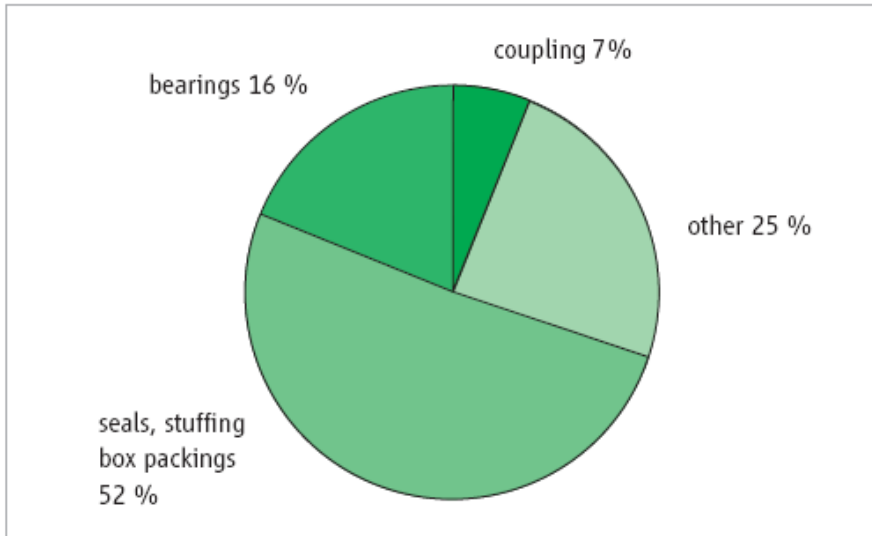


# Comparison of pump types – for natural refrigerants as CO2



	Pump with double mechanical seal	Magnetic coupled pump	Canned motor pump
<b>Benefits</b>	<ul style="list-style-type: none"> <li>+ Initial cost low (without installation)</li> <li>+ Cheap wet end, big selection</li> <li>+ Lowest heat input to liquid (no motor cooling)</li> </ul>	<ul style="list-style-type: none"> <li>+ External motor is cheap</li> <li>+ Cheap change of motor unit</li> <li>+ Increased safety</li> </ul>	<ul style="list-style-type: none"> <li>+ Maximum safety (secondary containment)</li> <li>+ Lowest LCC</li> <li>+ Compactness</li> <li>+ Easiest installation</li> <li>+ Lowest maintenance cost</li> </ul>
<b>Dis-advantages</b>	<ul style="list-style-type: none"> <li>- Highest risk pump for leaks</li> <li>- Highest maintenance cost and efforts</li> <li>- High maintenance cycles</li> <li>- Largest footprint</li> <li>- High installation cost and efforts</li> </ul>	<ul style="list-style-type: none"> <li>- Initial cost and lifecycle costs are between seal and canned motor pumps</li> <li>- Maintenance intervall range between seal and CMP as well</li> <li>- Performance drop through many interfaces</li> <li>- Liquid cooling adds heat to the process</li> </ul>	<ul style="list-style-type: none"> <li>- Highest cost for pump</li> <li>- Losses through can</li> <li>- Liquid cooling adds heat to the process</li> </ul>

# Error analysis



- **Mechanical seals often cause failure (52 %) of conventional centrifugal pumps.**
- **Damage caused by roller bearings and couplings is considerably lower.**

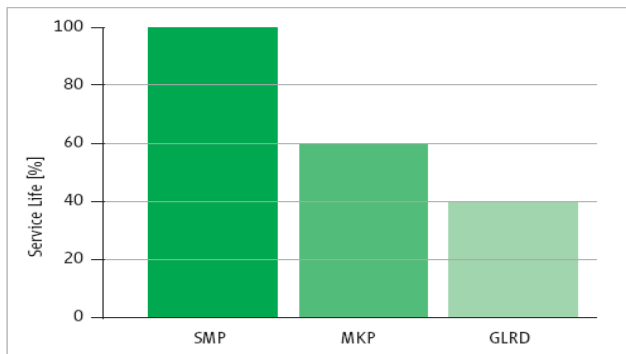


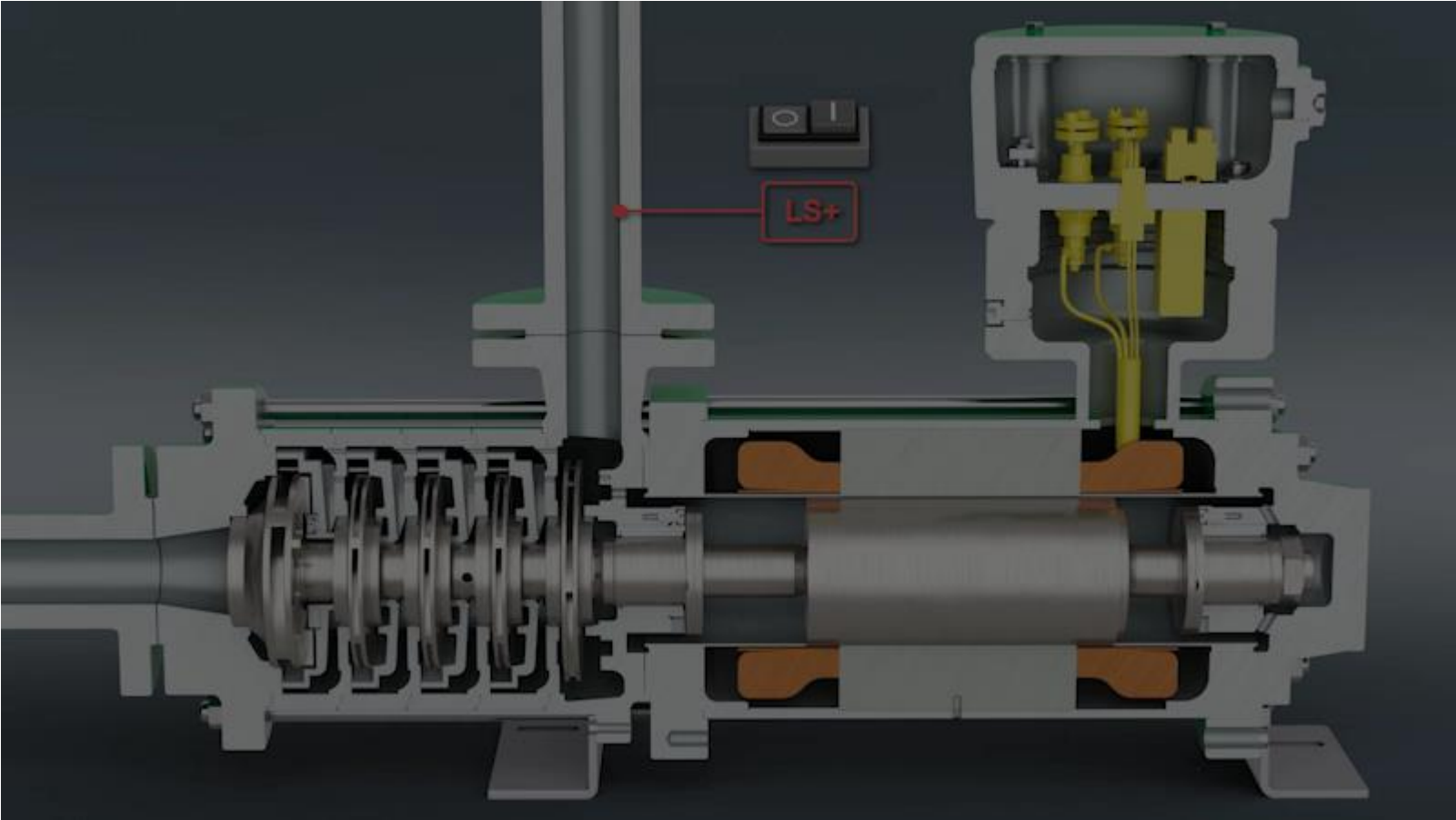
Figure 5: Service lives of various types of centrifugal pumps

SMP canned motor pump  
 MKP magnetically coupled pump  
 GLRD mechanical seal pump



- **Service life of canned motor**
- **CMP has considerable advantages over magnetically coupled pumps (60 %) and conventional pumps (40 %).**

# Canned motor pump in operation





# CAMh / CAMhk - Solution for CO2

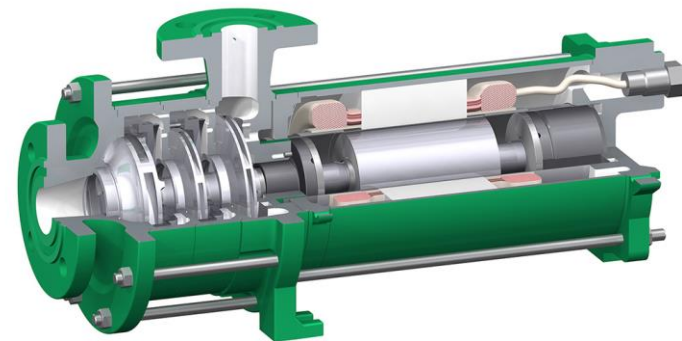
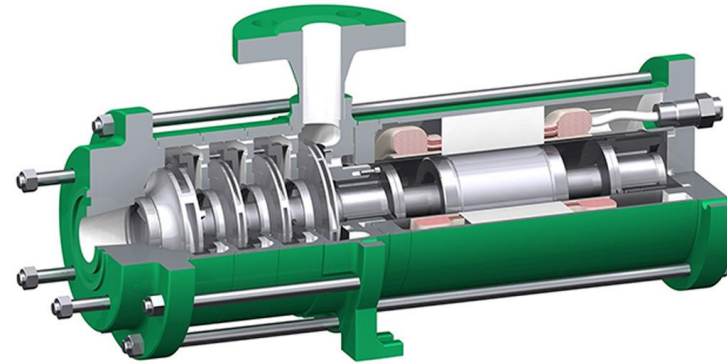
- Normal suction design
- Multistage design – up to 6 stages
- Options: SiC30 or graphite bearings

## Properties:

- Capacity: max. 14 m<sup>3</sup>/h
- Head: max. 85 m
- Op. temperature: -50 °C to +15 °C
- Pressure rating: PN52
- Test pressure: 78 bar

## Options:

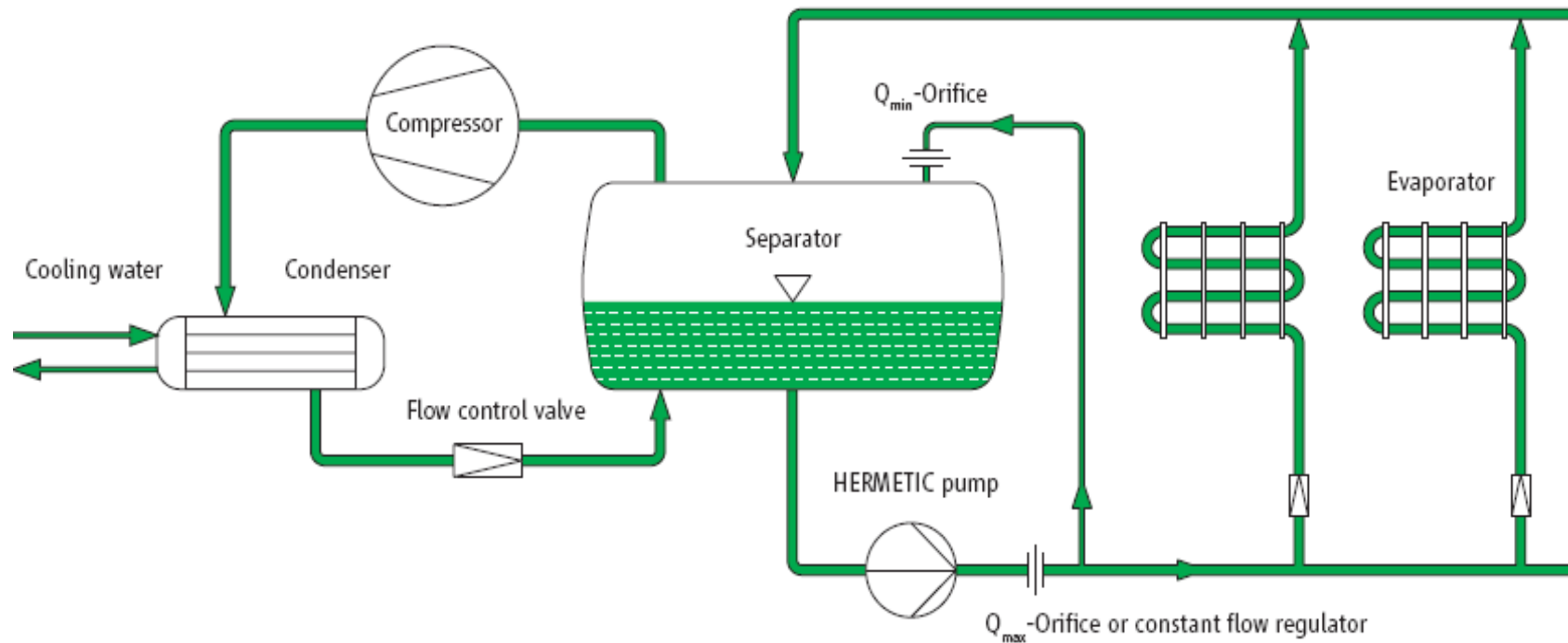
- Drain
- Manometer bores



# Single stage pumps with deviation line



# What to look for at CO2 pumped systems



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# Summary

## CO2 – as natural refrigerant:

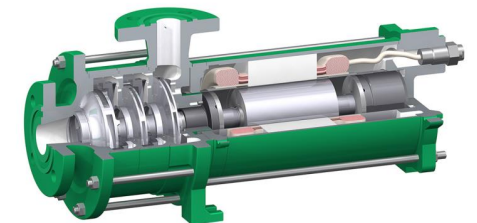
- Low global warming potential
- Low pressure/compression ratio
- High pressure installation

## CO2 for server room cooling:

- Less space
- Not risk for water damages

## Advantages of canned motor pumps with CO2:

- Low CO2 leakage rate
- Reliability
- Low maintenance



# CO2 Supercritical



CO2 hypercritical	
90,0	°C
651,00	kg/m3
0,070	cP
2,000	kJ/kgK

zulässiger Arbeitsbereich			
$Q_{min,ad}$	$Q_r$	$Q_{max,ad}$	
90,0		250,0	m3/h
250,0		190,0	m
		145,00	kW
16,00		12,10	bar
6,00		7,00	m
290			mm
			m
			m
			m
250 bar			bar
			m
285,0	Hydr.Prüfdruck p <sub>test</sub>	425,0	bar
285,0	bar	bei Q <sub>max,ad</sub>	120,0 °C

NH85z-2 1)	
315,0	kW

# Contact

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Additional information to CO2:

- **Whitepaper - CO2**

Information about natural refrigerant

