EFRC Training Workshop

Basic Training of Reciprocating Compressor Systems

Auxiliaries

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St. Gallen, Switzerland

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Table of content

Introduction

- **Reciprocating compressors** and their drivers require a variety of auxiliary equipment to support their operation.
- The equipment for these compressors is described as an overview in this presentation.

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Guidelines & standards for recip. compressors

1. **MFG. / OEM Standard** acc. ATEX and CE
2. **ISO 13631** (former API11P, up & mid stream industry)
3. **API 618, 5th Edition** (downstream, petro & chemical industry)
   - Fig G-1 Cylinder Cooling System
   - Fig G-4 Typ. Self contained CW System for piston rod packing
   - Fig. G-5 Typ. Pressurized Frame Lube Oil System

Guidelines & standards for recip. compressors

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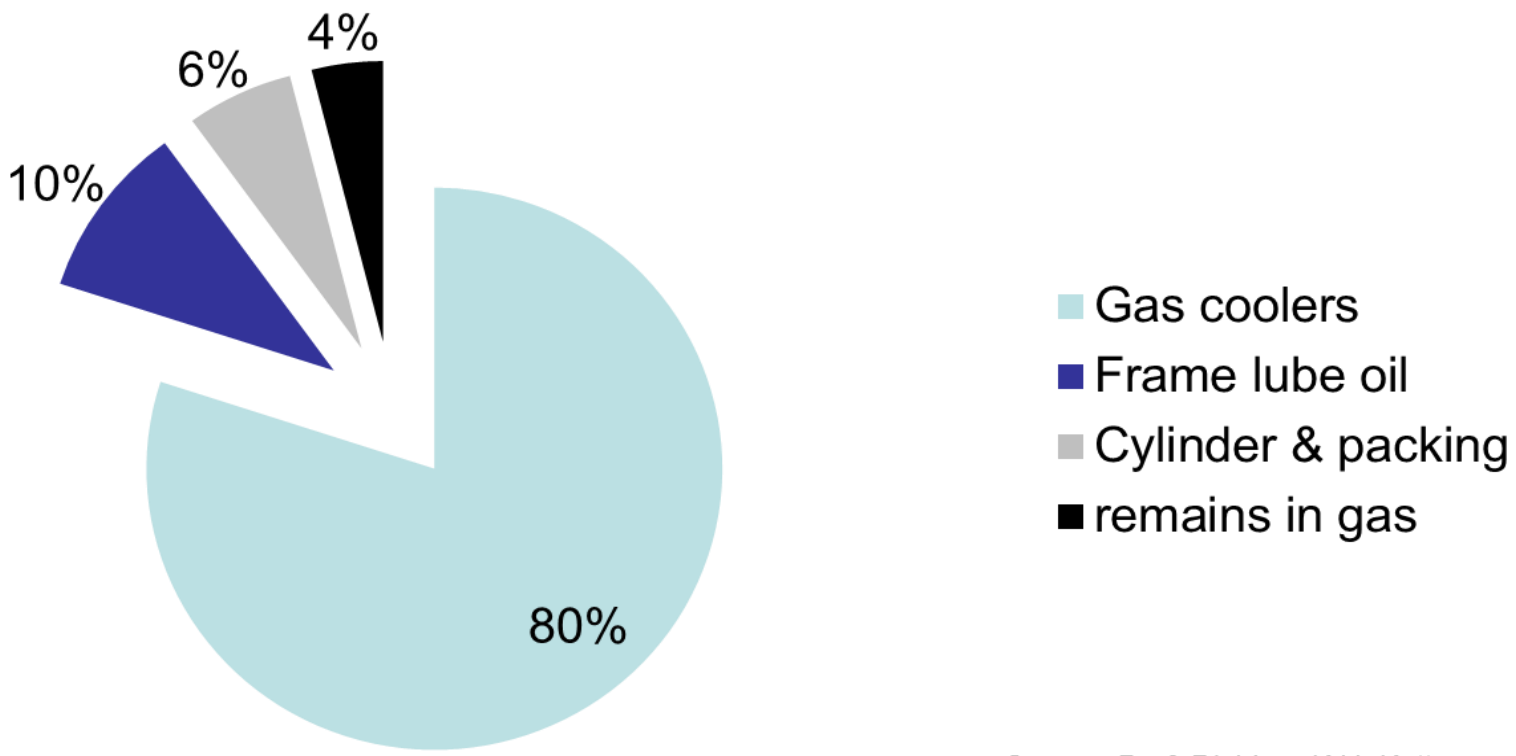
API (AMERICAN PETROLEUM INSTITUTE)

API Standard 610	"Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries"
API Standard 660	"Shell-and-Tube Heat Exchangers for General Refinery Services"
API Standard 661	"Air-Cooled Heat Exchangers for General Refinery Services"

Heat Exchanger



Source: Prof. Dipl-Ing. K.H. Küttner, Kolbenverdichter, Auslegung & Betrieb

Heat Exchanger

How to calculate the heat duty for heat exchangers?

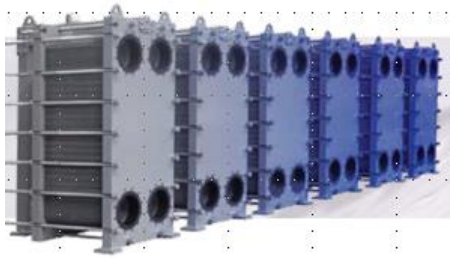
$$Q = M * Cp * \Delta T$$

Where:

- Q – is the heat duty or the total heat transferred. Btu/hr or W
- M – is the Mass flow rate for the fluid (Air, water, oil) undergoing the temperature change. lb/hr or kg/s
- Cp – is the heat capacity of the fluid undergoing the temperature change. Btu/lb.˚F or J/kg.˚K
- ΔT – is the temperature change in fluid normally calculated as the difference between outlet and inlet temperatures. ˚F or ˚K(˚C)

Heat Exchanger

- Shell and tube heat exchanger
  - Process gas, cooling water, lube-oil
- Bolted plate heat exchanger
  - Cooling water and lube-oil
- Air heat exchanger
  - Cooling water &lube-oil,



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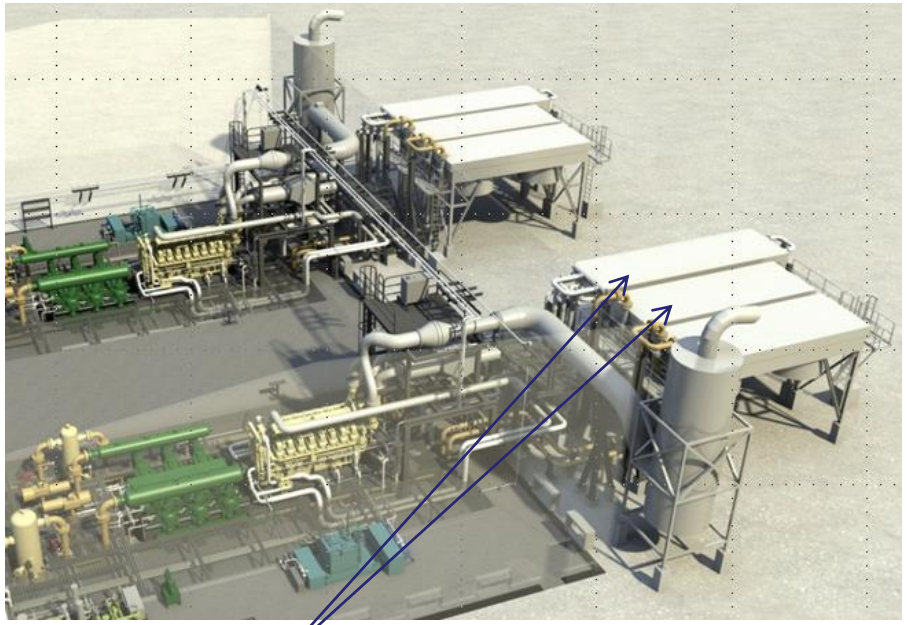
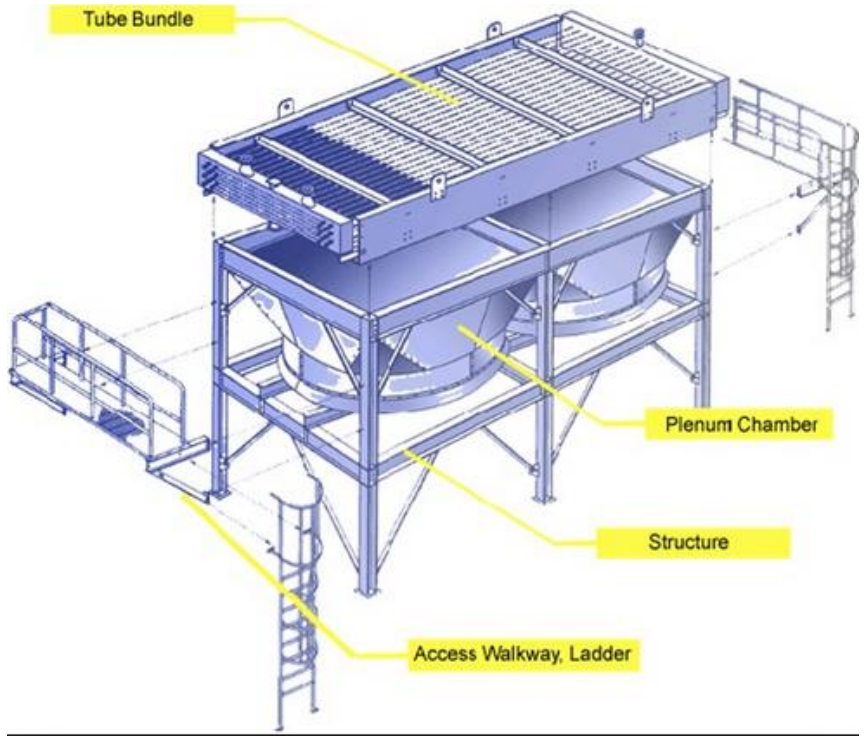
Heat Exchanger

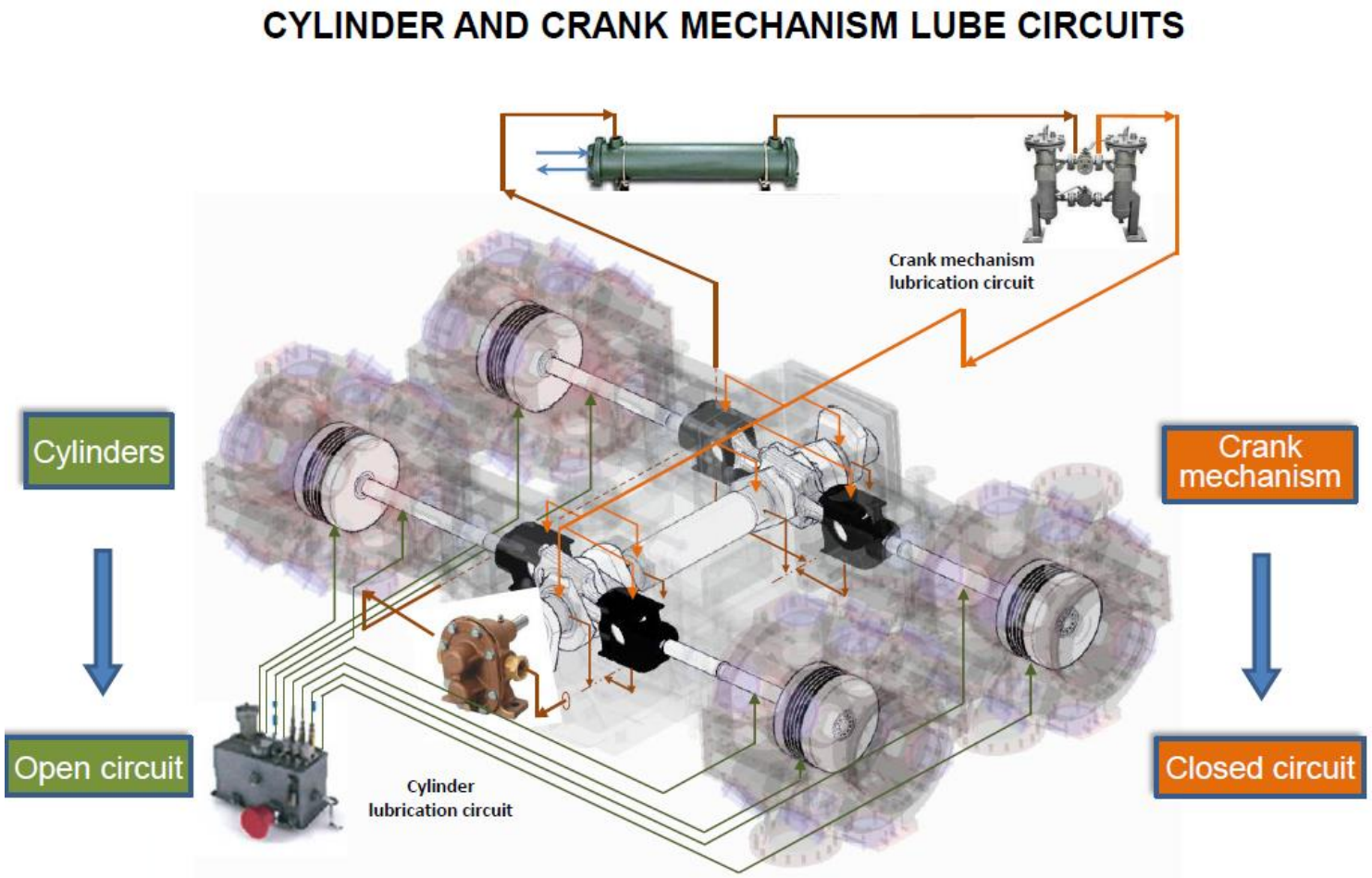
- Air heat exchanger
  - Process gas and / or cooling water,



Combined Design



Lubrication systems



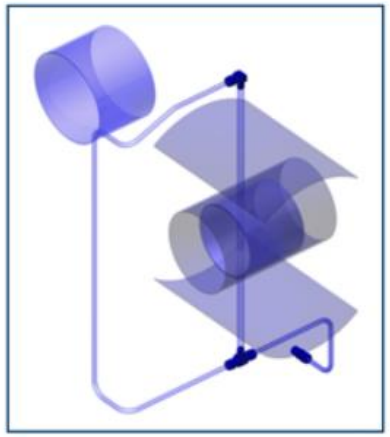
OEM Compressor typical data

Lubrication:

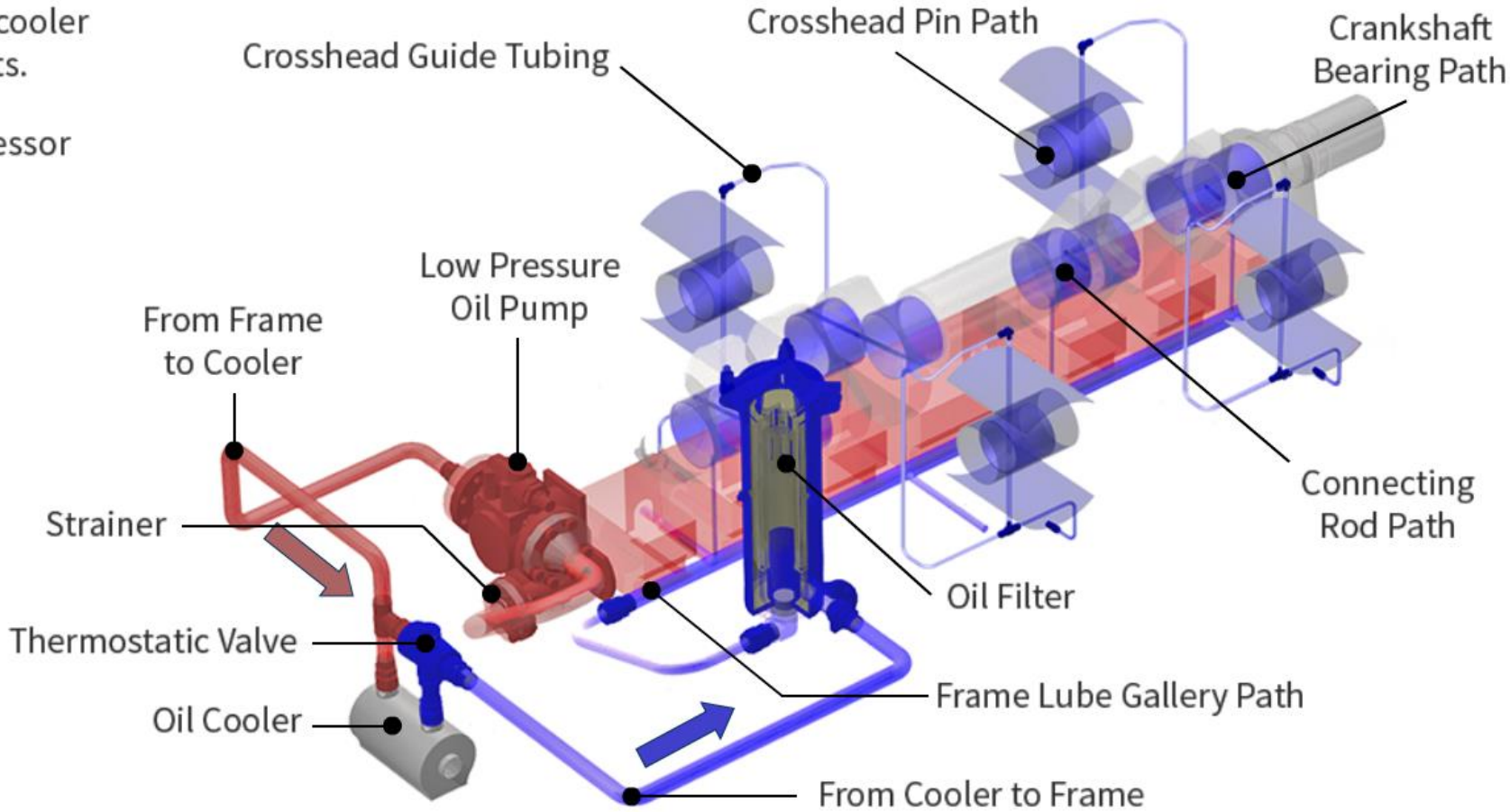
Oil Pump Flow Rate:	45.4 L/min
Oil Sump Capacity:	56.8 l
Oil Heat Rejection:	8.2 KW

Frame lubrication paths

- Cool lubricant flows from the cooler to the compressor components.
- Hot lubricant from the compressor back to the cooler.

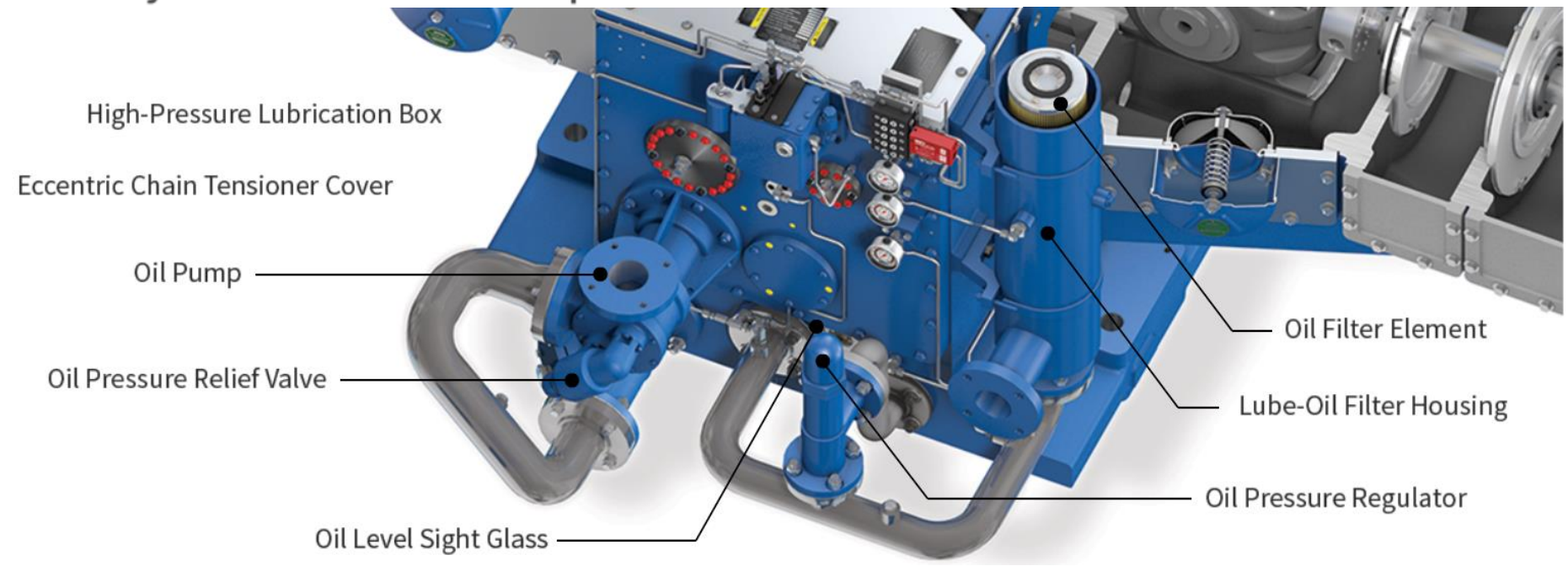


Lubrication from crankshaft to cylinder



Frame lubrication

Auxiliary End Lubrication Components



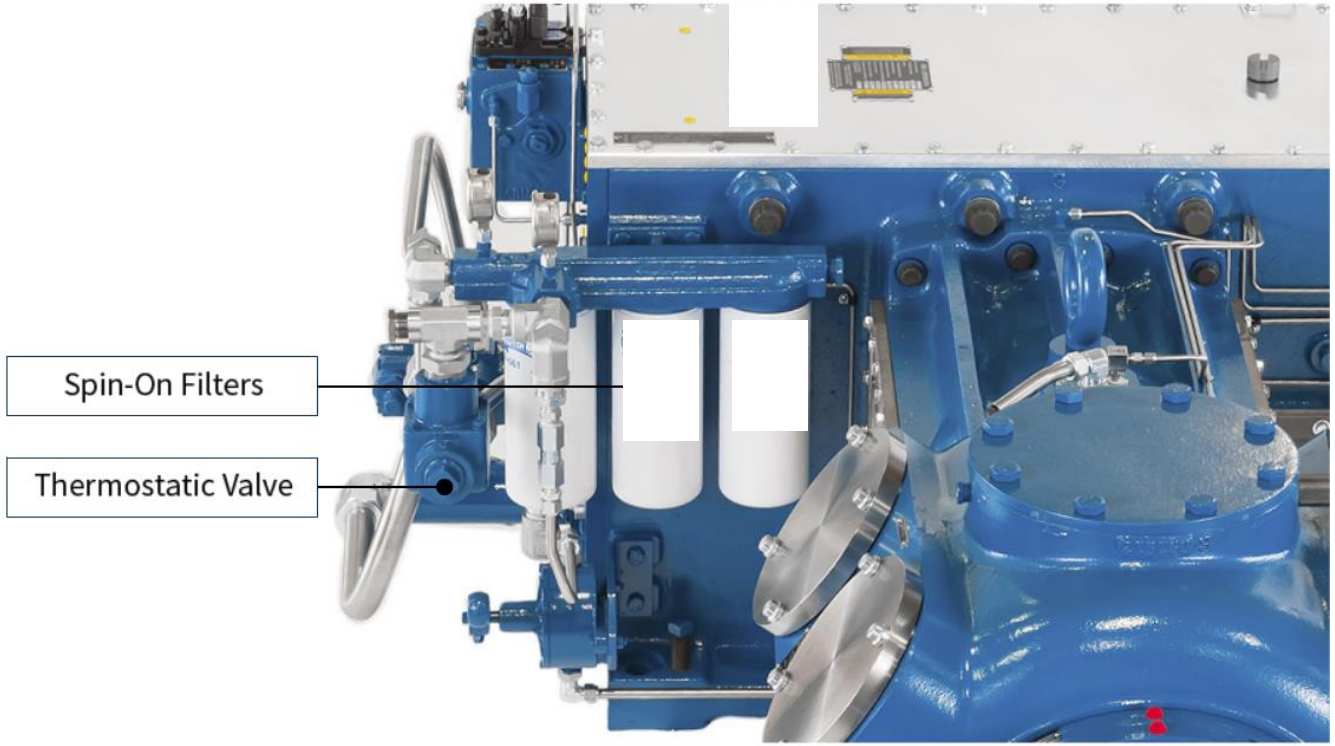
Frame lubrication

Spin-On Oil Filters

Auxiliary End Lubrication Components

Maximum pressure differential for spin-on filters: 10 psid

Oil pressure downstream from filters: 60 psig



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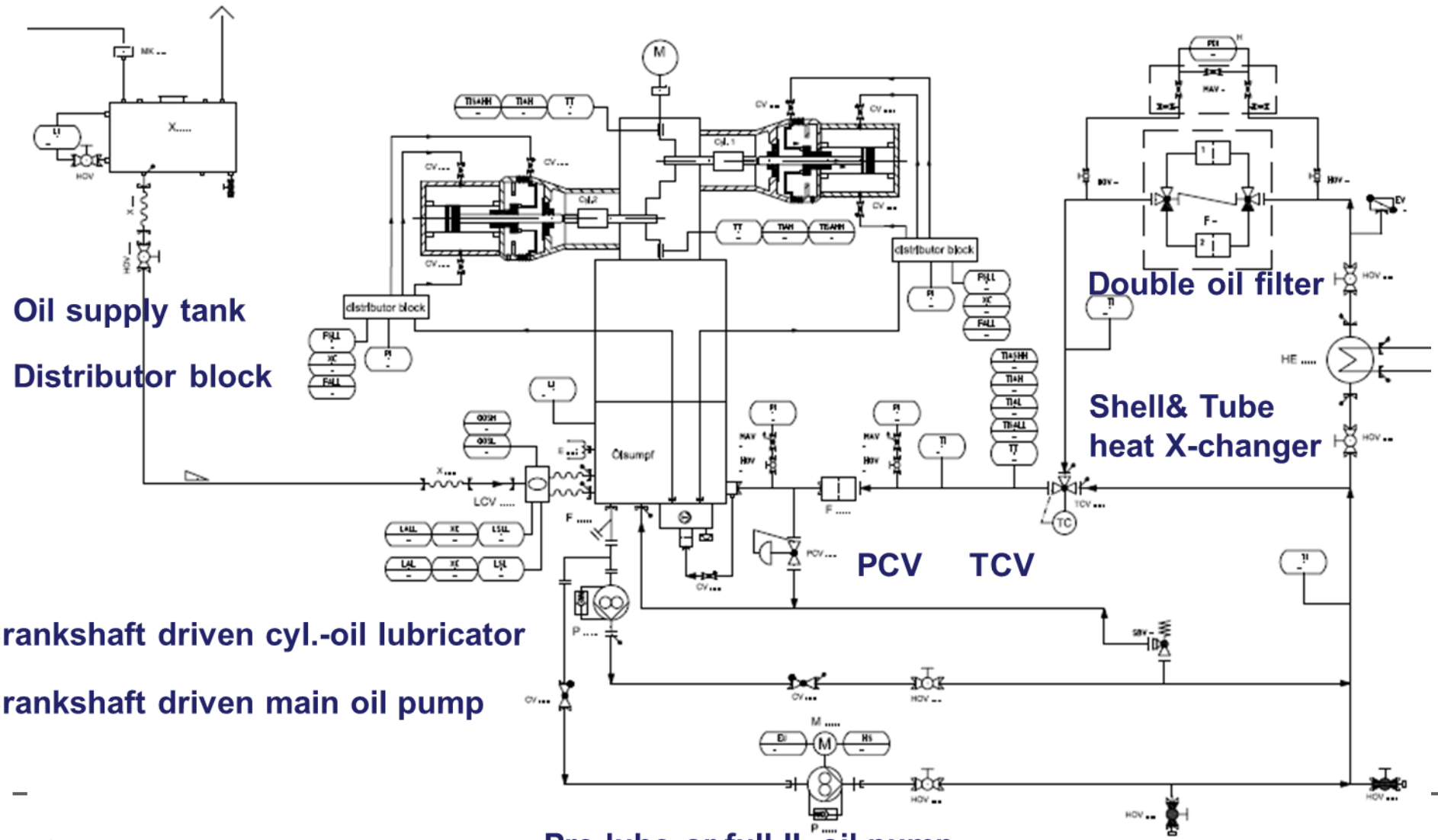
Frame lubrication P&I D



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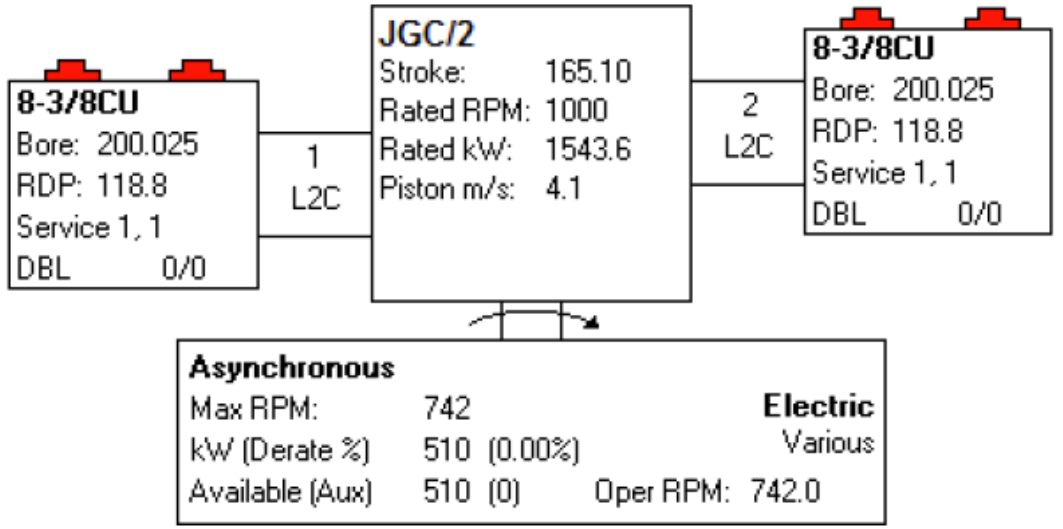
Cylinder & packing lubrication

- 6.12.1 Cylinder lubrication (ISO 13631)

- Either block-distribution lubrication systems or
- pump-to-point lubrication systems shall be furnished for lubrication of compressor cylinder ring travel bore and piston rod packing.
- The force-feed lubricator shall be suited for variable flow.

Cylinder & packing lubrication calculation



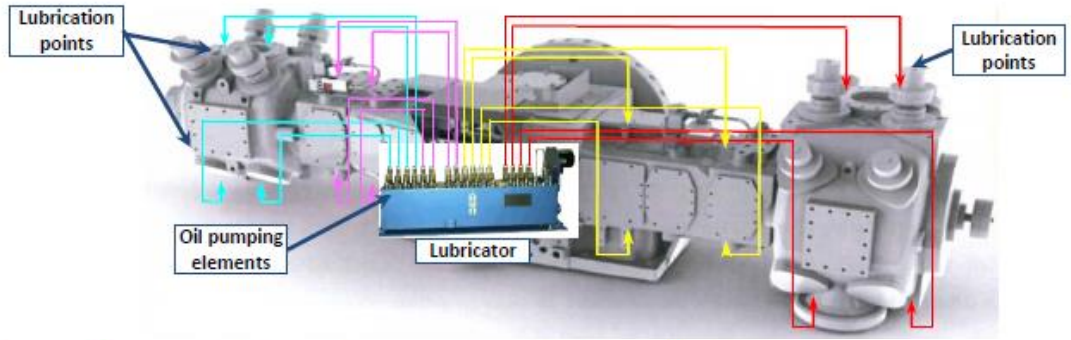
Mineral Oil and Synthetic Oil consumption during normal operation for Applied Speed of 742 RPM

Minimum Recommended Mineral Oil ISO Grade and Type		Recommended Liters/day Packing	Cylinder	Total
Throw 1	SAE 50-60 wt (ISO 220-320) or SAE 40 wt (ISO 150) w/ Compounding	1.76	2.07	3.83
Throw 2	SAE 50-60 wt (ISO 220-320) or SAE 40 wt (ISO 150) w/ Compounding	1.76	2.07	3.83
			Normal:	7.66
			Break-In*:	13.78

Cylinder & packing lubrication

PtP System
(Pump-to-Point)

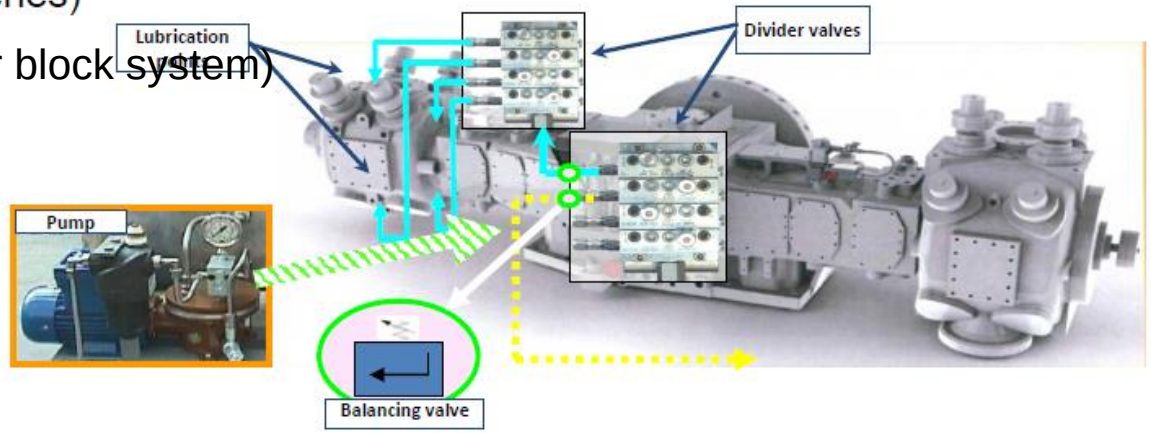
A single pumping element for each lubrication point



PS System
(Progressive Series)

A pumping element with Divider Valves

(Divider block system)



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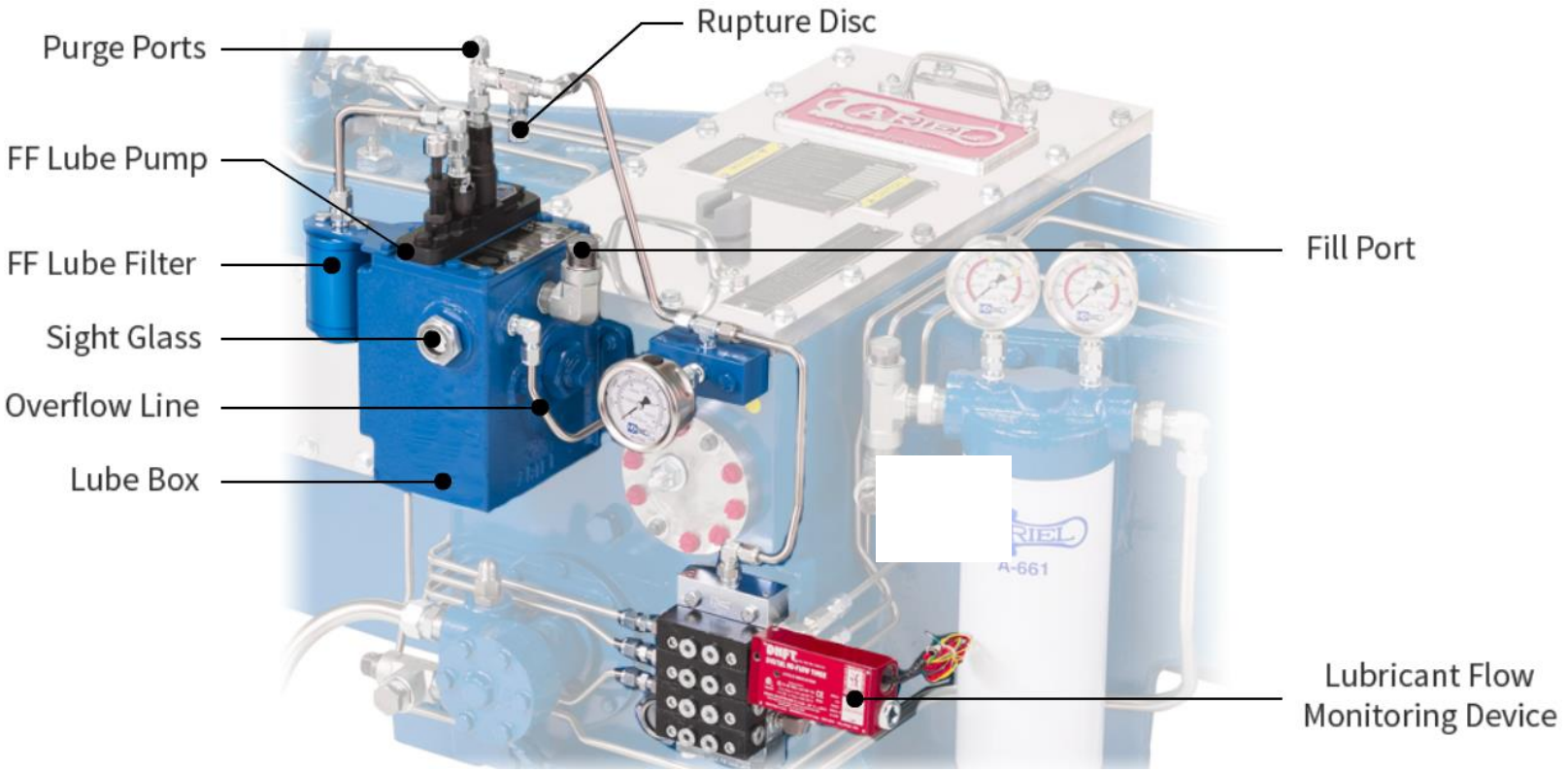
Cylinder & packing lubrication

Force Feed System Components

Force-Feed Pump Components



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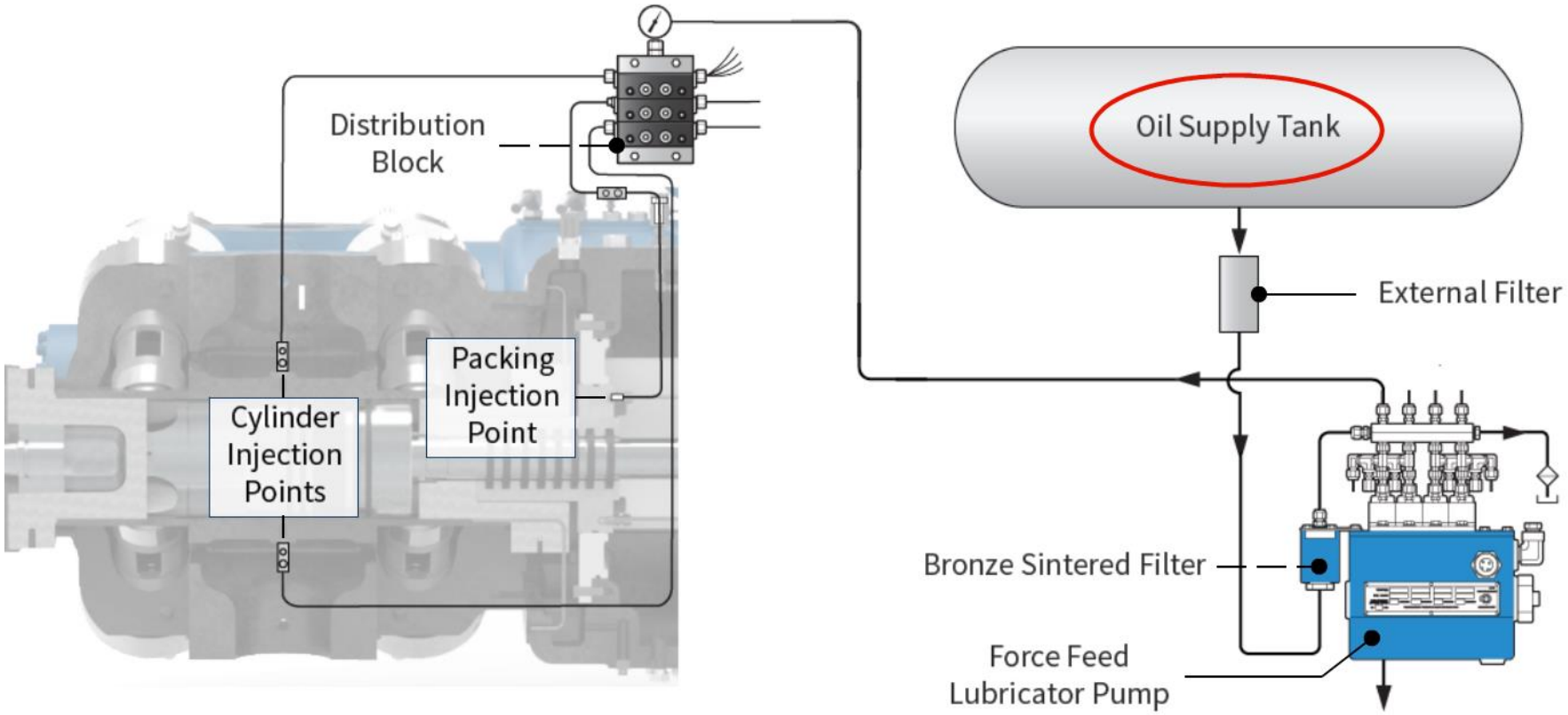
Cylinder & packing lubrication

Separate Oil Supply Force Feed System



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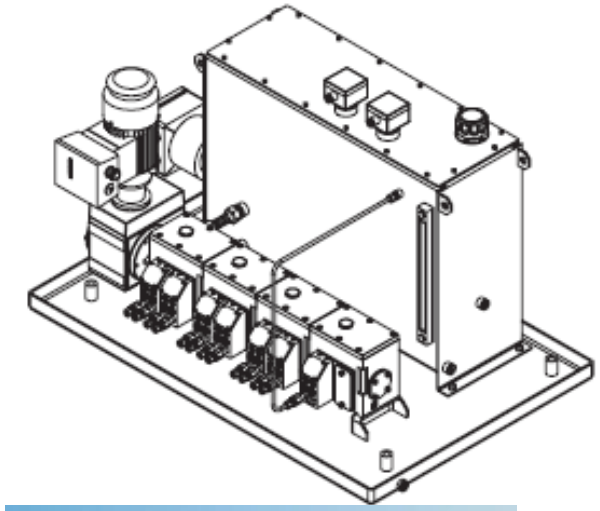
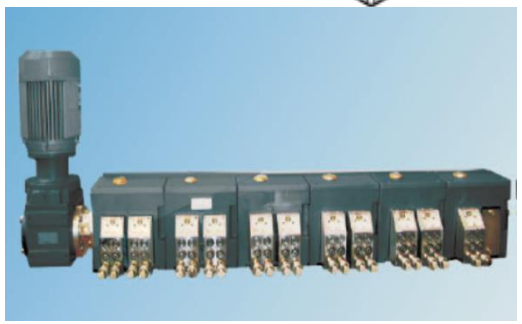
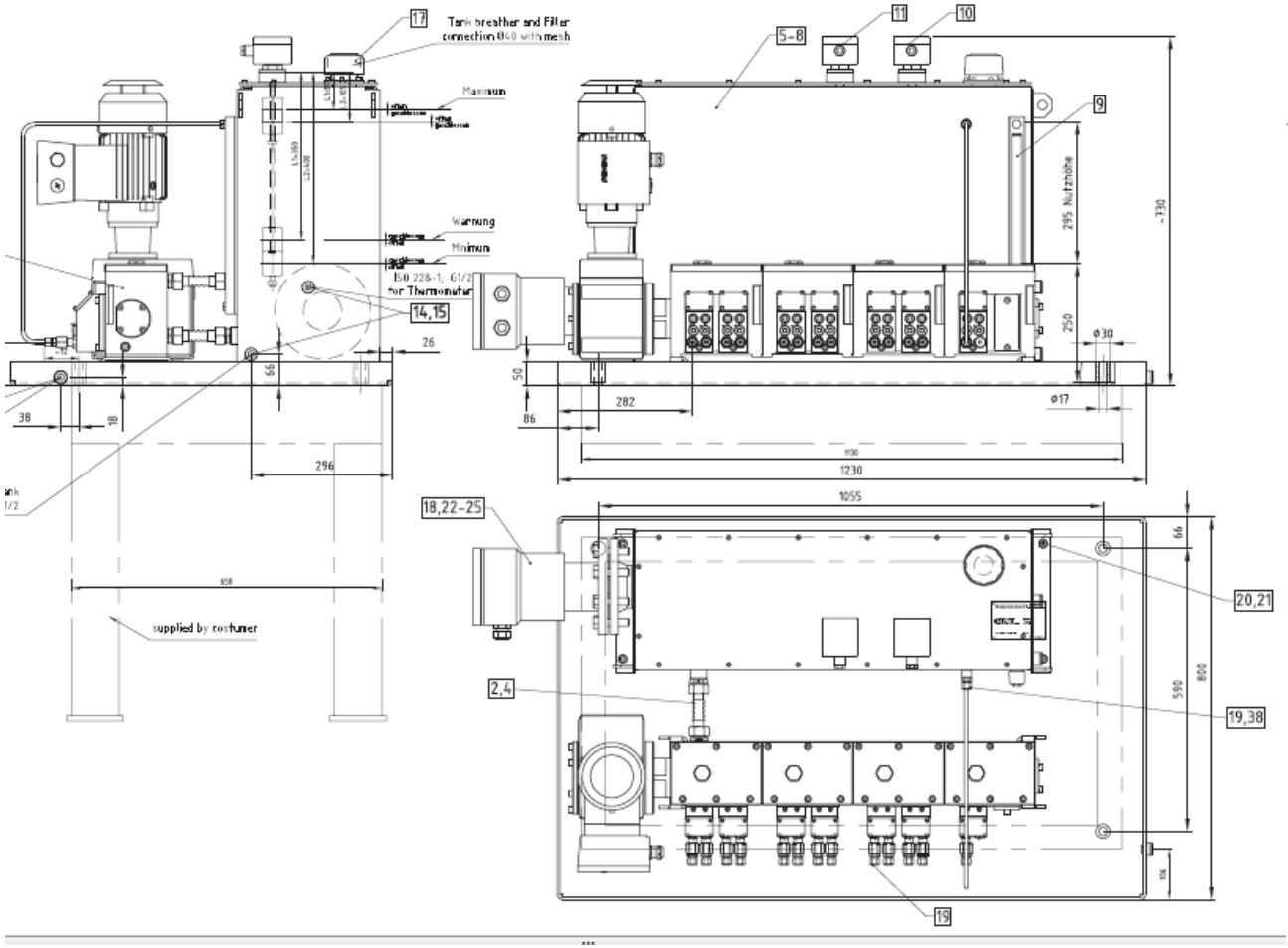
Cylinder & packing lubrication

Point to point lubricator





Fa. SKF Lubrication Systems



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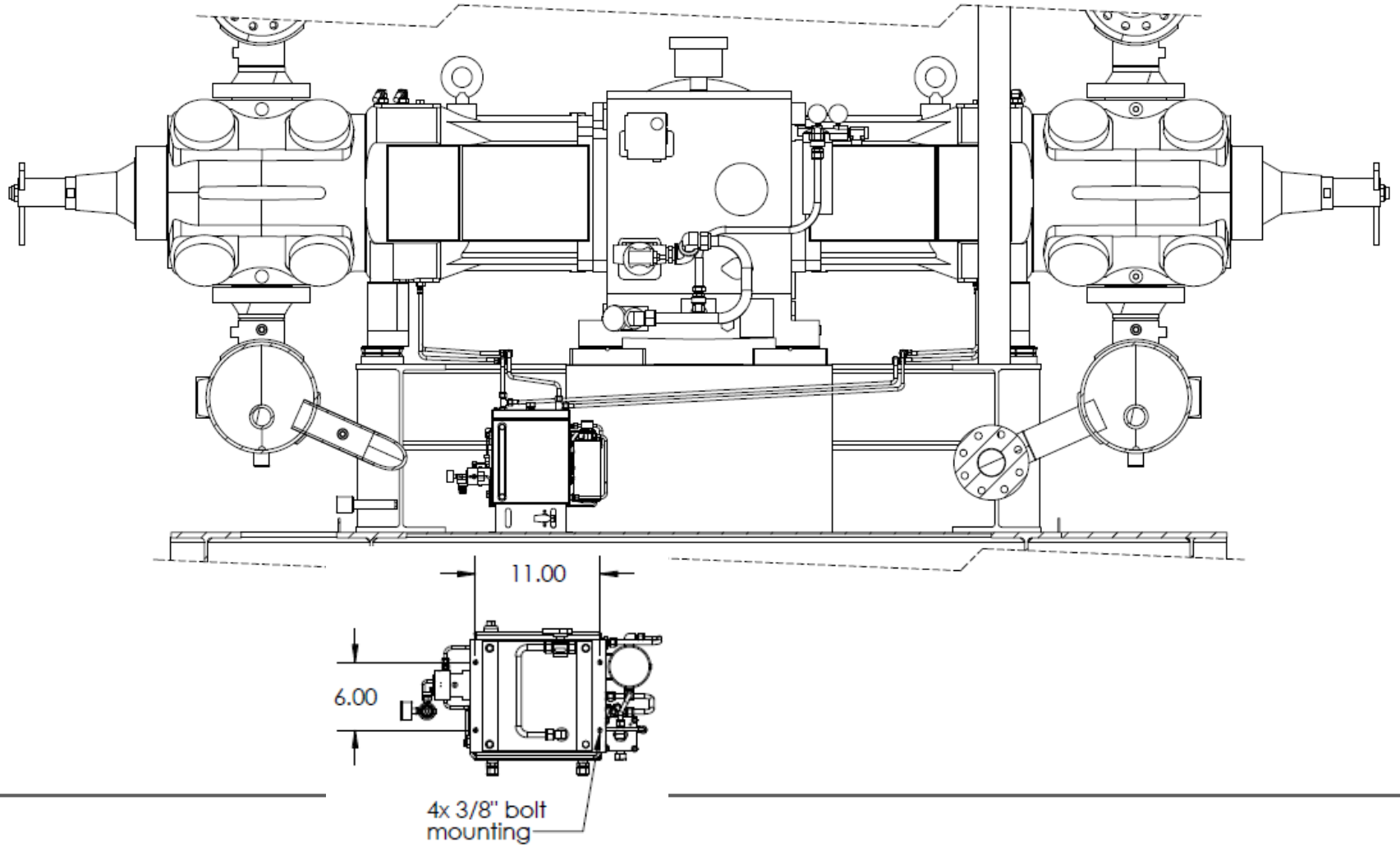
Lube-Oil Recovery System

Oil Recovery System Installation Details



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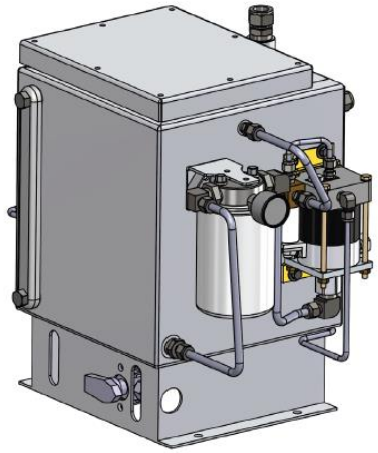
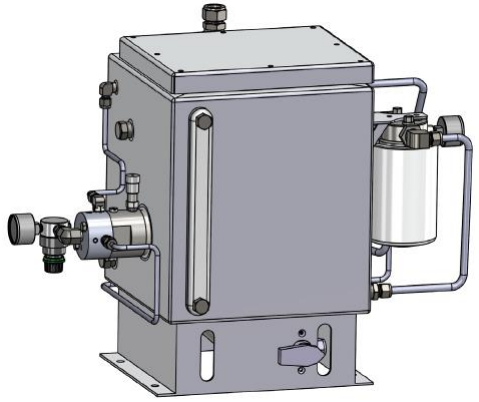
Lube-Oil Recovery System

The oil recovery system is designed to automate the recovery and reuse or disposal of oil from distance piece and packing

- Recovers oil from packing and distance piece drain lines
- Reuse oil by returning to suppy, or send to existing waste tank
- 20-40% potential oil reuse on typical compressor packages
- Eliminates mistakes made when manually venting storage vessels
- Vent to atmosphere, VRU, or flare system
- 5 gallon tank capacity, powder coated inside and out
- Instrument gas or air operated, up to 300 PSI supply, integrated regulator
- Integrated float control in tank, 2.75 gallon “swing”
- Slow speed piston pump, low air or gas usage





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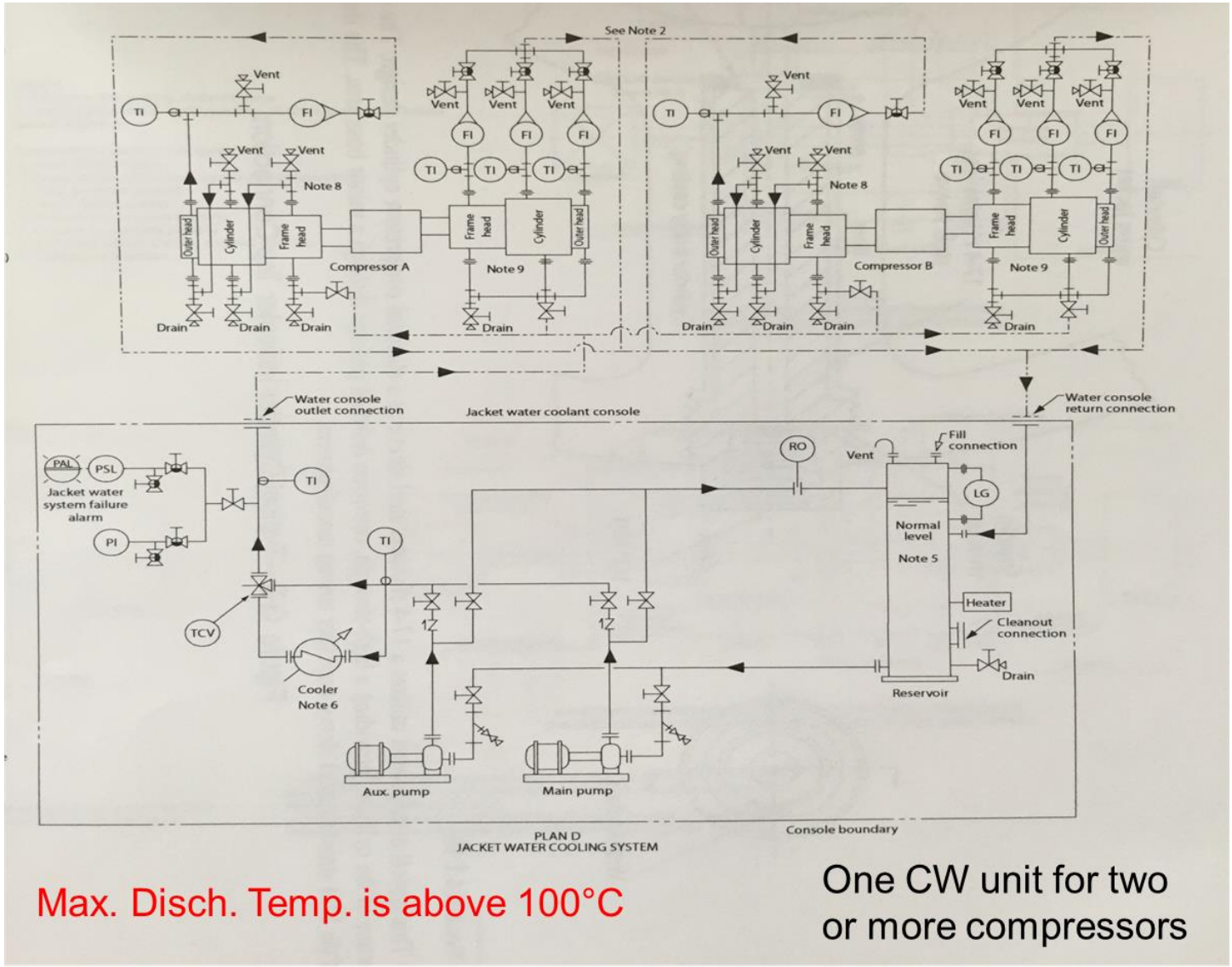
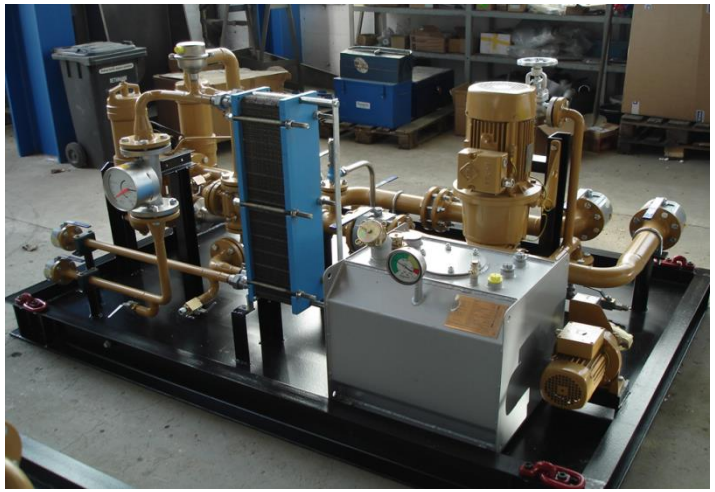


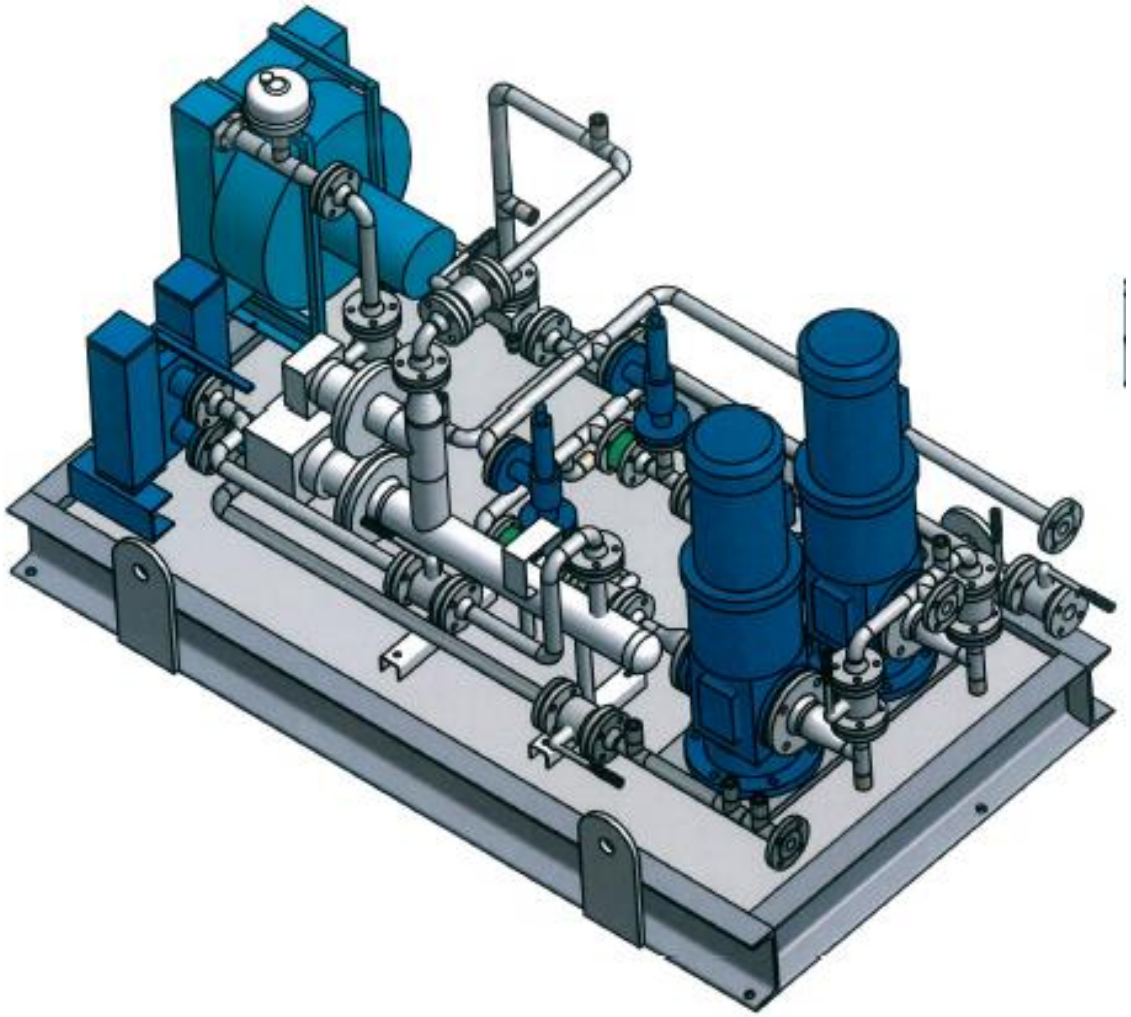
Max. Disch. Temp. is above 100°C

One CW unit for two or more compressors

Cooling water unit, API 618, D

Cooling water unit, API 618, D





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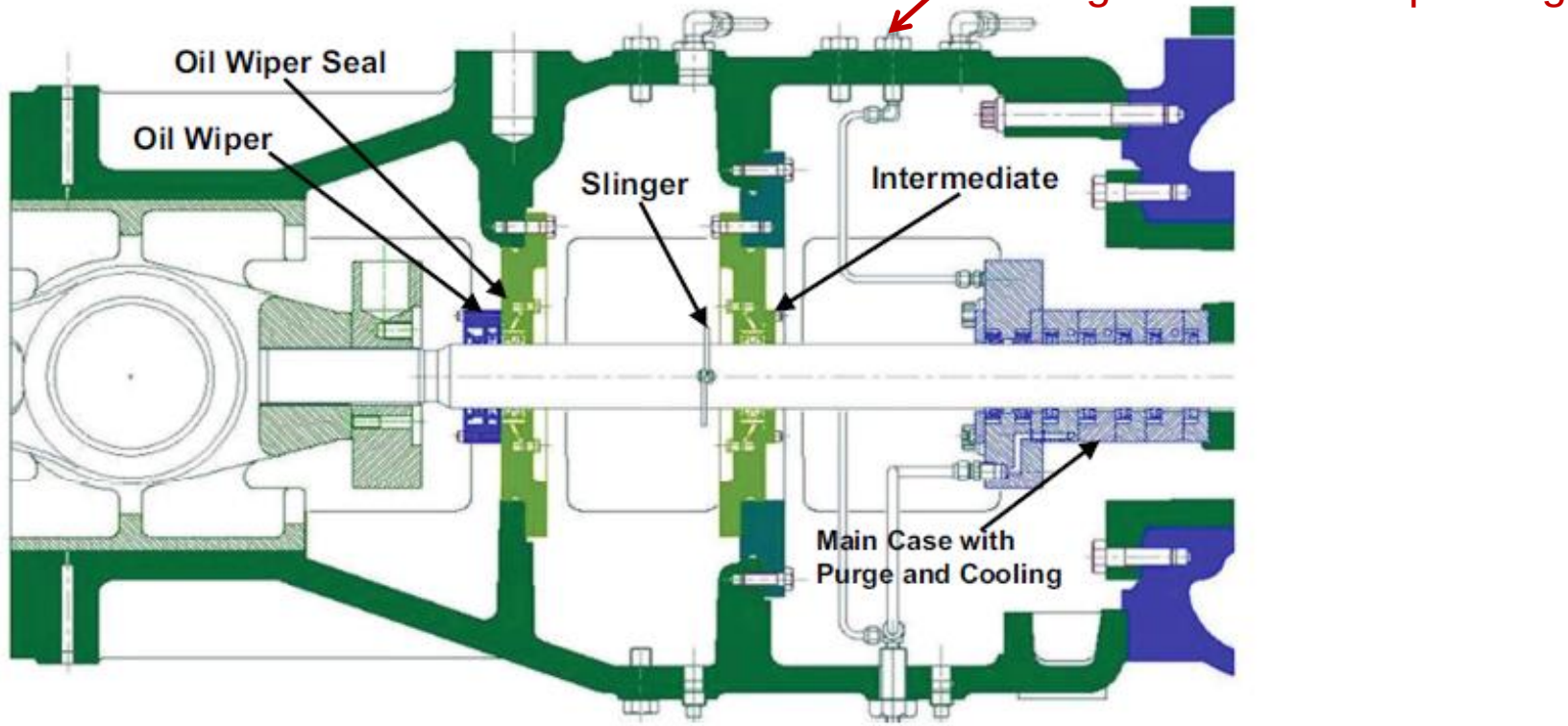
Leak gas recovery systems

- In the natural gas industry, compressors are used for various applications. Natural gas leakages from these compressors represent a major source of methane emission. In the methane emission reduction field sometimes local regulations and End Users ask for the recovery of leaks to achieve **“ZERO EMISSION”**
- When the re-injection in the compressor suction is not possible a leak recovery system is recommended. Seal gas recovery units use special oil-free compressors specially designed for continuous operation.

Leak gas recovery systems

API 618 Type C Distance Piece



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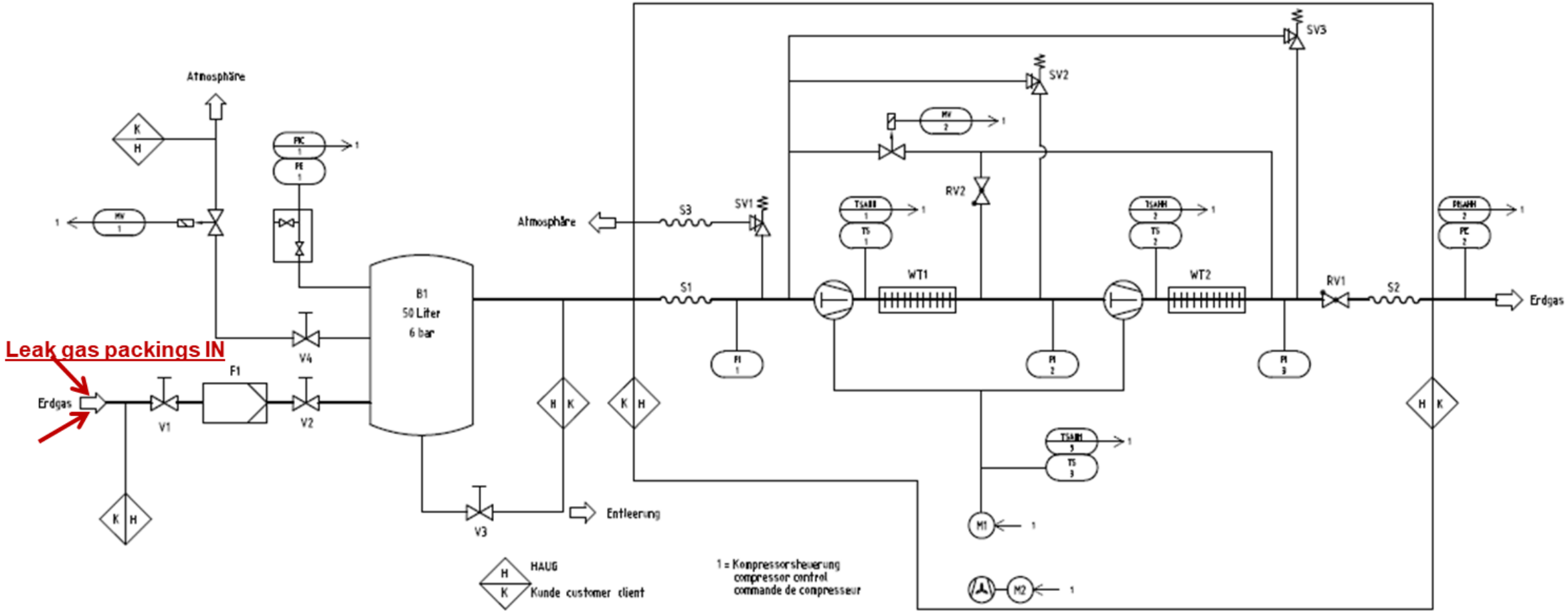
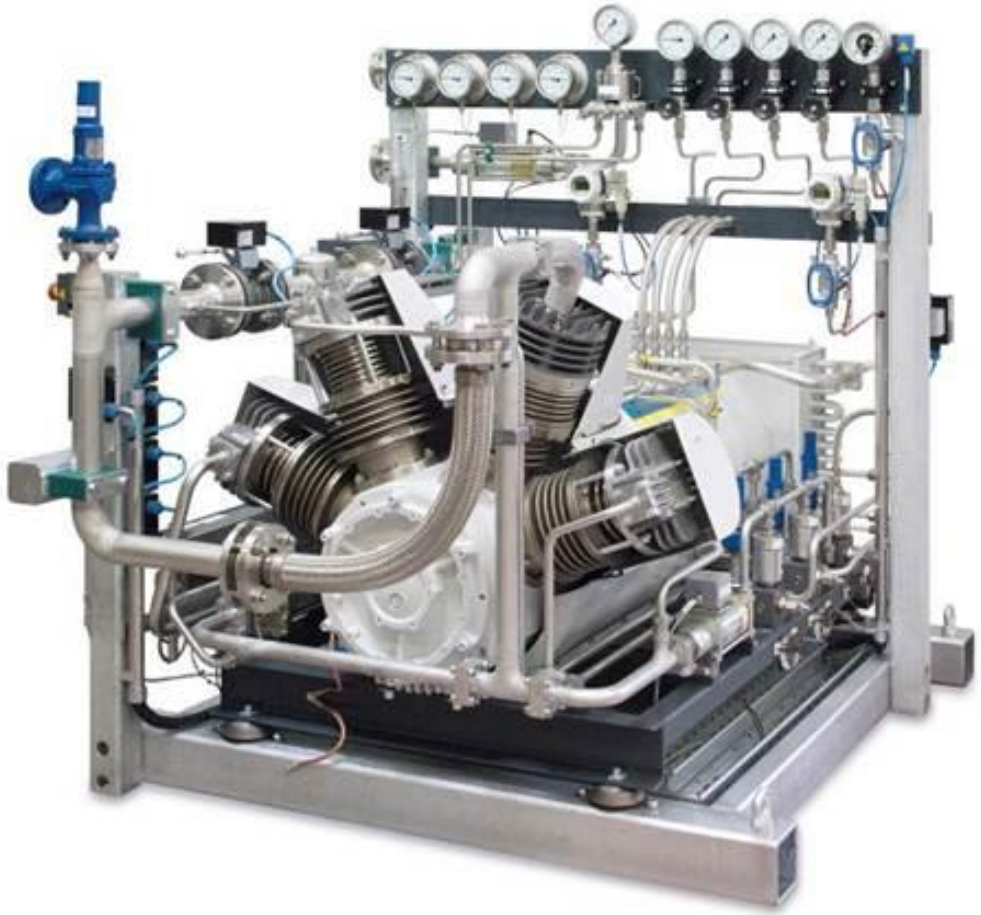
Leak gas recovery systems



Leak gas recovery systems



Compressor-Data		min.	max.
Compressor housing over pressure max.	bar(abs)		3,5
Suction pressure p1	bar(abs)	1	2,5
Discharge pressure p2	bar(abs)		91
Suction temperature	°C	0	35
Ambient temperature	°C	0	40

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Conclusions

- All process, compressor and ambient related conditions must be available for sizing the related equipment
- Selection of good engineered auxiliary systems is essential for the trouble free, long term operation of the reciprocating compression sytems.
- Regular maintenance according to the operation instructions is mandatory to maintain high availability and reliabilty of the auxiliary sytems

Keep the pistons running !!

Good luck ☺

Thank you