EFRC Training Workshop

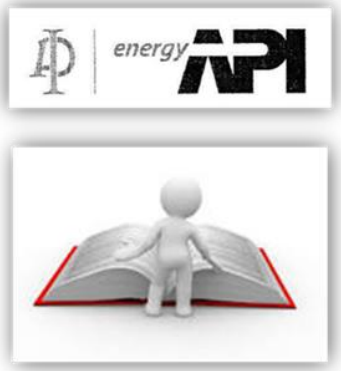
“Lubrication and Wear”

Frame Lubrication

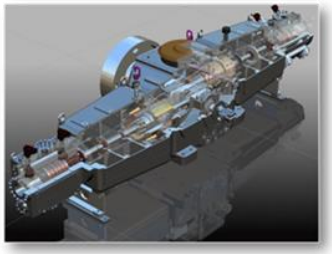
Harry Lankenau – NEAC

Agenda

- Introduction
- API 618 (5th Edition) Requirements – § 6.14



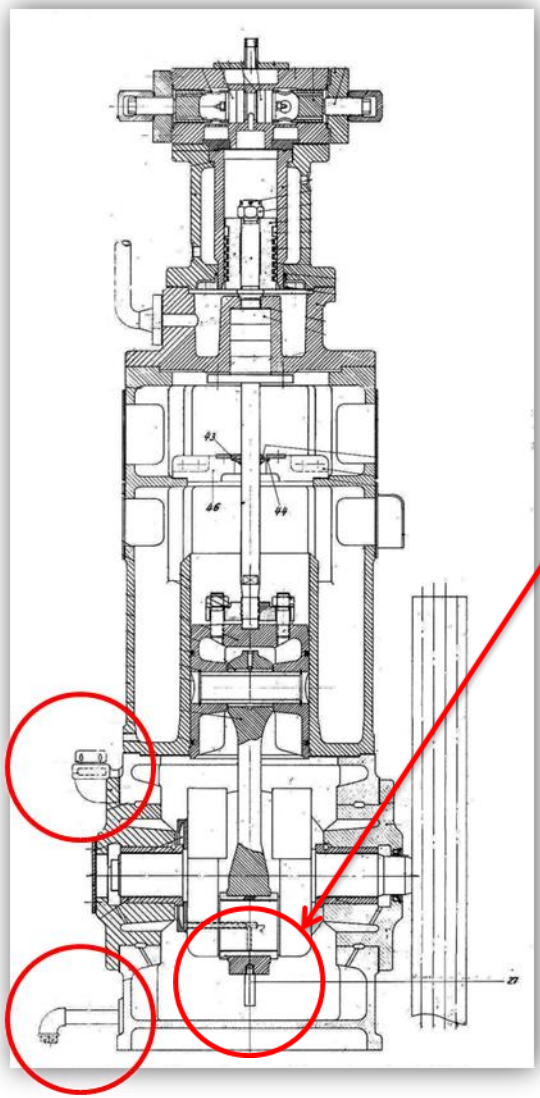
- Aspects of Slide Bearing Lubrication
- Lubrication Points & Oil Path



- Oil Lubrication Unit Devices & Instrumentation

- Operational Issues

Introduction – Oldtimer Oil Lubrication

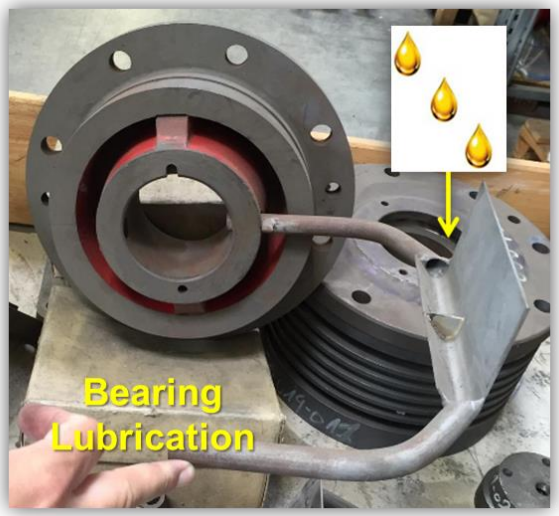


Do you see the Oil Unit ?

No ?

There is None !

An Oil Splashing Pin is the Oil Supply



API 618 (5th Edition) Requirements – § 6.14

6.14.2.1.4 The basic oil system, in accordance with 6.14.2.1.2, shall contain, as a minimum, the following components:

a. reservoir—typically the compressor crankcase;
b. main oil pump—(materials in accordance with 6.14.2.1.5) which may be shaft-driven or motor driven;
c. auxiliary pump, when required, in accordance with 6.14.2.2;
d. single cooler (see 6.14.2.3);
e. dual filters (see 6.14.2.4);
f. heater—when required (see 6.14.2.5);
g. pressure relief valve for each pump (see 6.14.2.6);
h. single regulator for control of delivered oil pressure (separate from relief valves);
i. single regulator for oil temperature control (see 6.14.2.7);
j. valves—material shall be carbon steel with stainless steel trim;
k. oil piping—shall be stainless steel pipe and fittings (with the exception of cast-in-frame lines or passages); or stainless steel tubing and fittings (see 6.14.2.1.8);
l. The following instruments:

- one pressure indicator;
- two temperature indicators;
- one level indicator (on the crankcase or reservoir) (see 6.14.2.1.9);
- one pressure transmitter for low pressure alarm and auxiliary pump start;
- one low frame oil level transmitter for alarm;
- one filter high differential pressure transmitter for alarm;
- one pressure transmitter for low pressure shutdown.

See Figure G-5 for a typical schematic drawing of a lube-oil system.

API 618 (5th Edition) Requirements – § 6.14

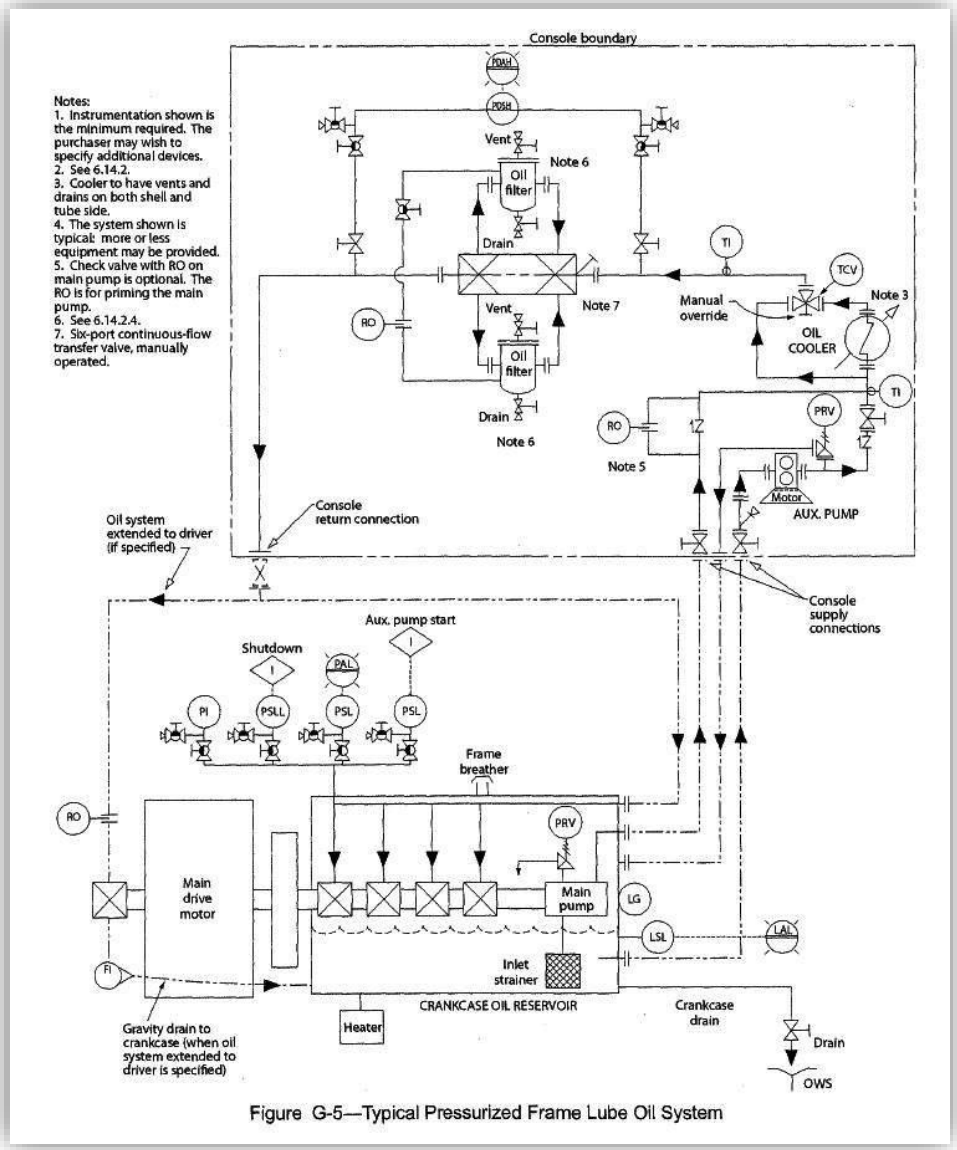


Figure G-5—Typical Pressurized Frame Lube Oil System

Oil Filter

Oil Cooler – with Temperature Control & Bypass

Auxiliary Pump

Instrumentation with Control & Monitoring

Oil Reservoir Crankcase

Main Pump

Aspects of Slide Bearing Lubrication

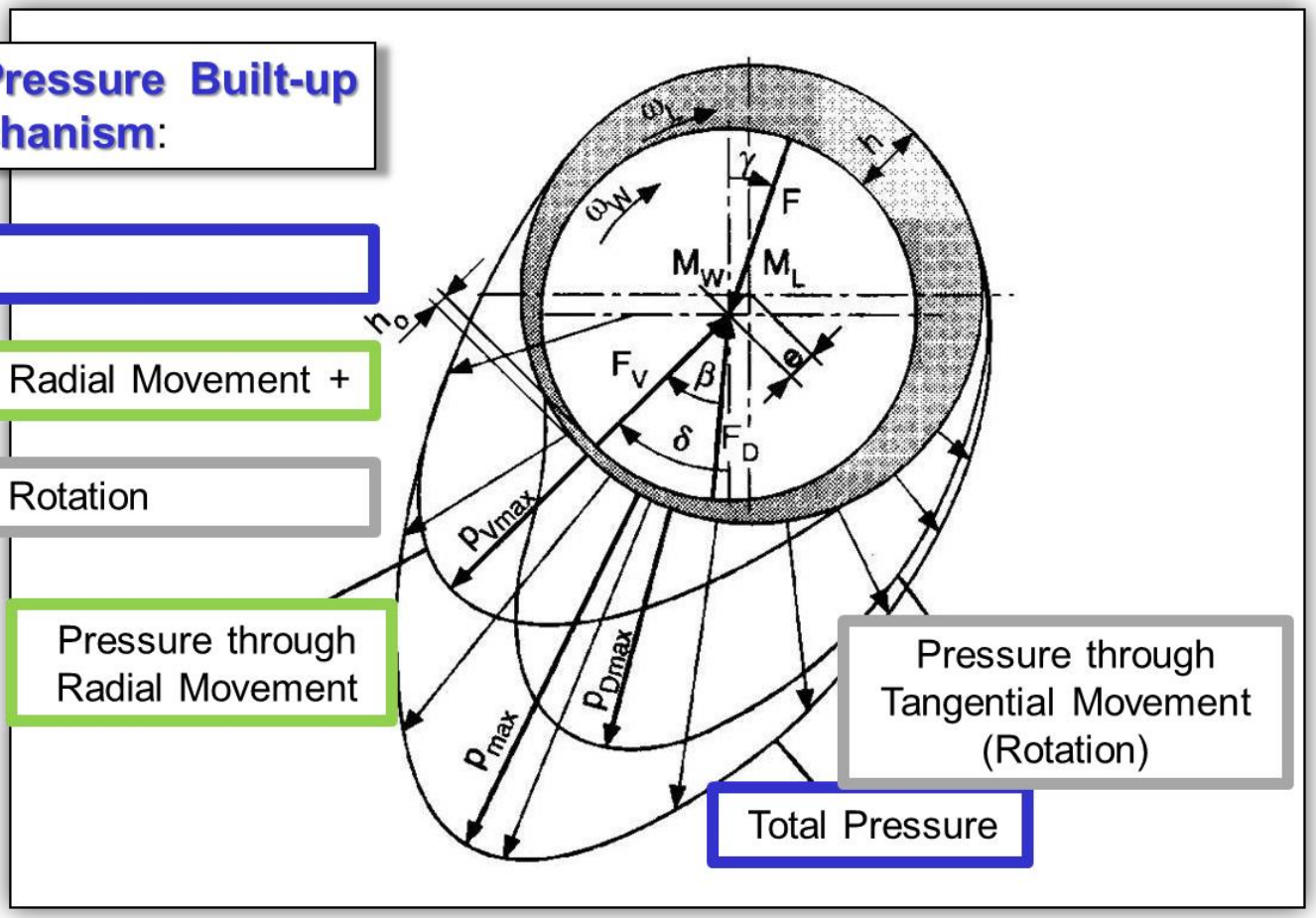
Main Bearing & Crank Pin Bearing – Fully Rotating Journals

Hydrodynamic Pressure Built-up through two Mechanism:

Total Pressure =

1. Pressure through Radial Movement +
2. Pressure through Rotation

… and only valid for static loads!

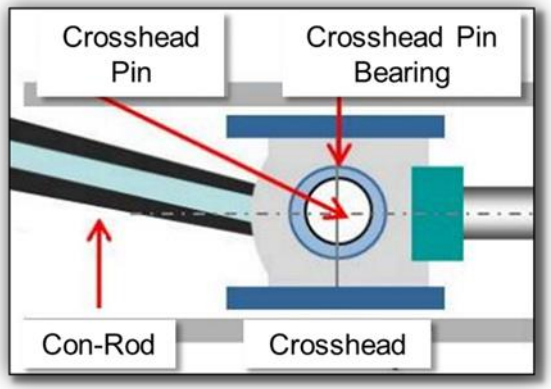


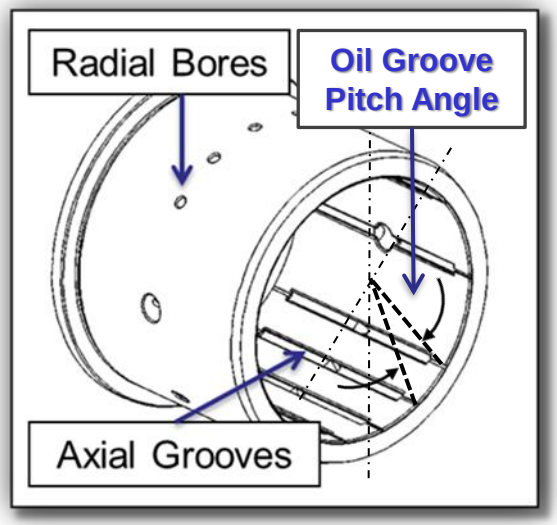
Aspects of Slide Bearing Lubrication

Wristpin Bushing or Crosshead Pin Bearing – Not Fully Rotating Bearing

- The Connecting Rod Angular Movement is like a Pendulum Movement rather than a Journal Rotation.
- The typical Bearing Calculation Methods are not valid !
- Important:
  - Rod Reversal vs. Bearing Load
  - Time for Oil Filling (Function of Speed)
  - Number of Grooves
  - Oil Viscosity
- Rule of Thumb (for very 1st Assessment):

  The Oil Groove Pitch Angle is recommended to be 85% to 90% of the Connecting Rod Angular Movement.





Aspects of Slide Bearing Lubrication

Oil Quality & Viscosity Selection

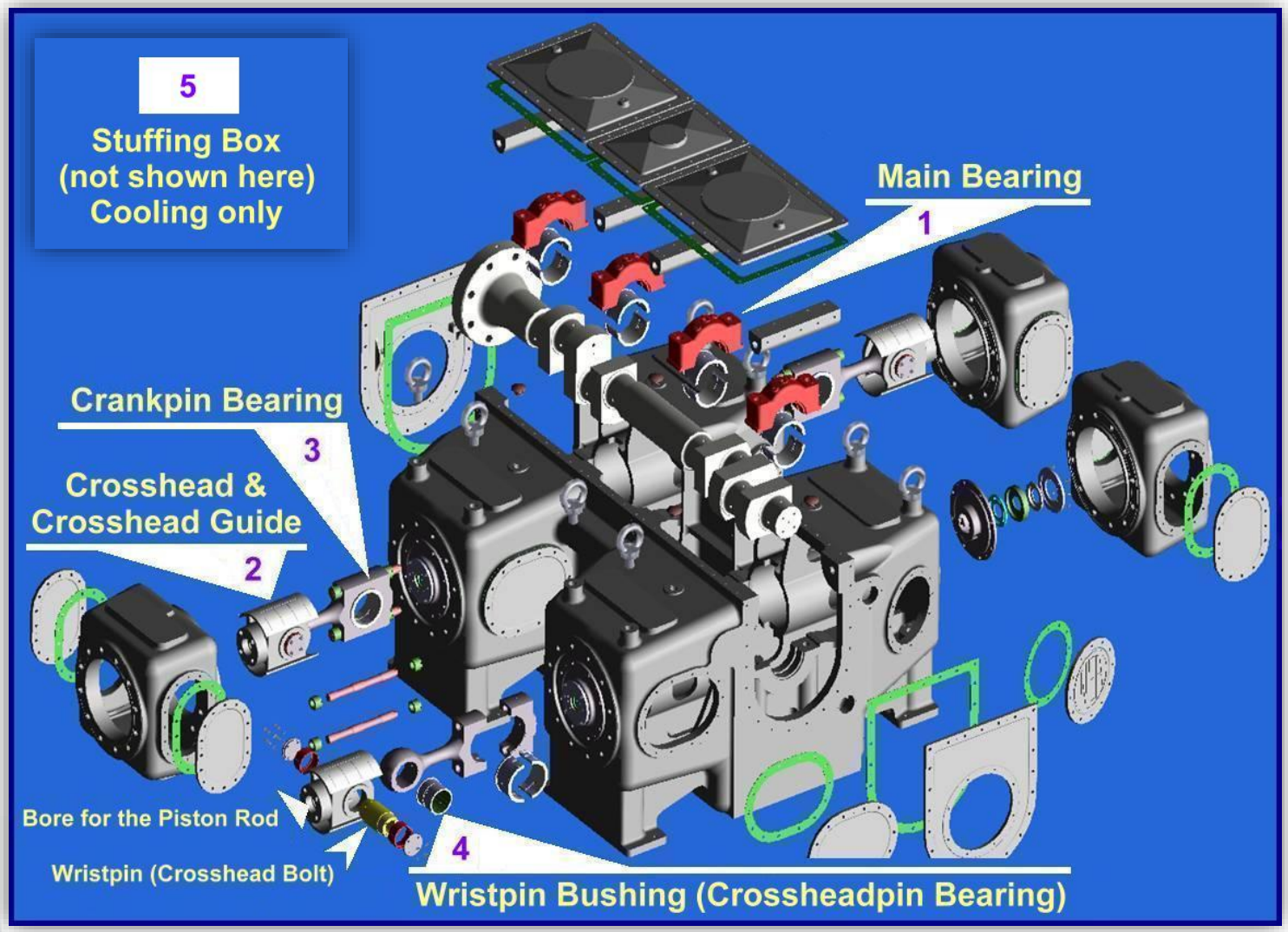
Alloyed as well as unalloyed oils on mineral oil basis are used as lubricants for compressor driving mechanisms and cylinders. The following table provides information on typical characteristics and required selection criteria resp.
Synthetic hydro carbons belong to the same chemical family like mineral oils. Thus these can be mixed with them and show the same characteristics with regard to sealings and colours. So these oils can be used, too.
Polyglycoles are not compatible with mineral oils. Colours and sealings must be adapted to it. Polyglycoles must only be used under special conditions and after consultation with the compressor manufacturer.

		max. oil inlet temp. °C				For driving mechanism extr. 38	norm 50	extr. 60			
Viskositätsklasse Viscosity classification	ISO 3448 DIN 51 519	15	22	32	46	68	100	150	220	320	460
Konematische Viskosität Kinematic viscosity bei/at 40°C mm²/s	DIN EN ISO 3104	15	22	32	46	68	100	150	220	320	460
bei/at 100°C * mm²/s		3.1	4.35	5.45	6.8	8.7	11.2	14.3	18.2	23.6	32

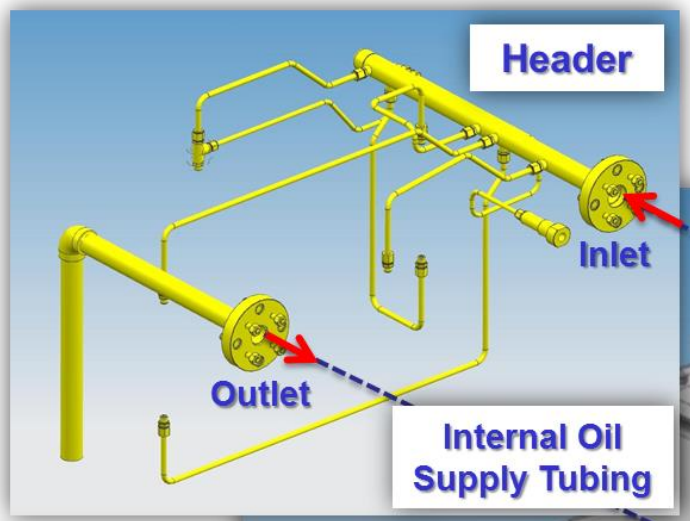
These Days preferred Oil Viscosity for Normal Operation

Typical for Hyper Compressors

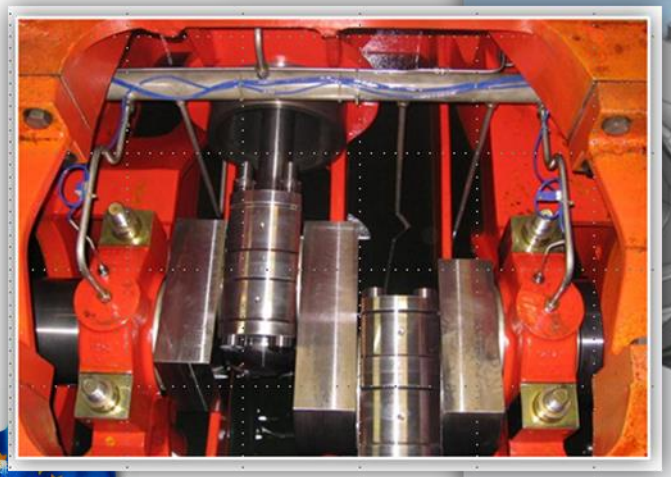
Lubrication Points & Oil Path

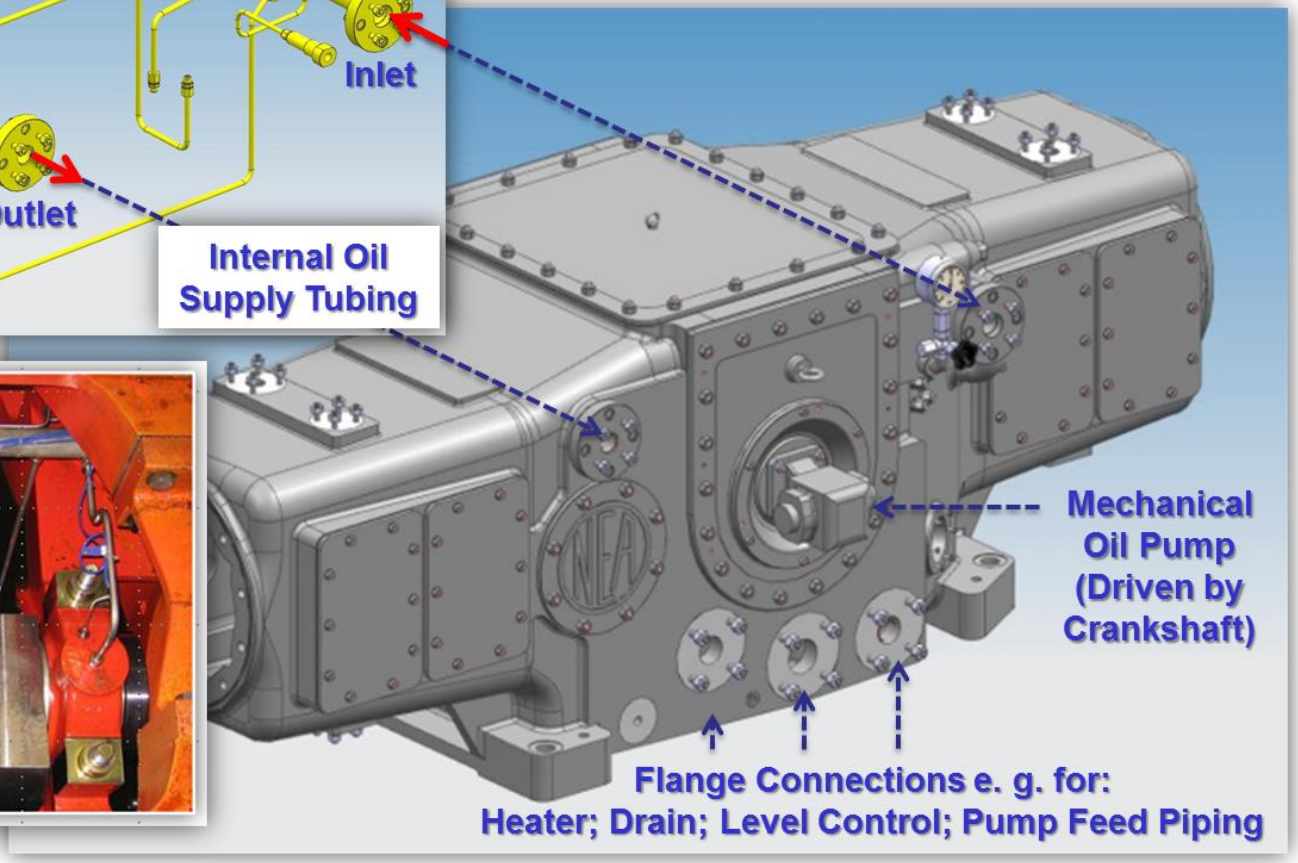


Lubrication Points & Oil Path

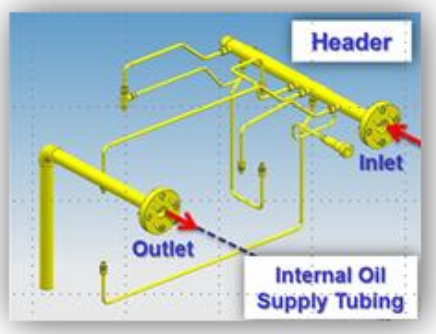


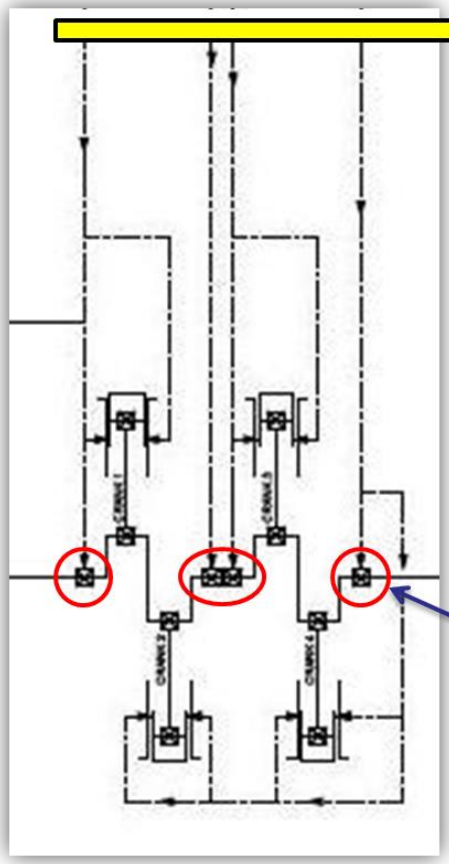
Typical Medium Size Two Throw Horizontal Compressor Frame



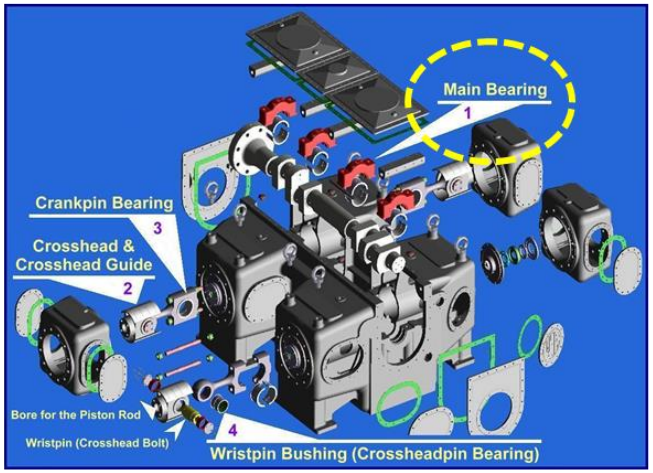


Lubrication Points & Oil Path



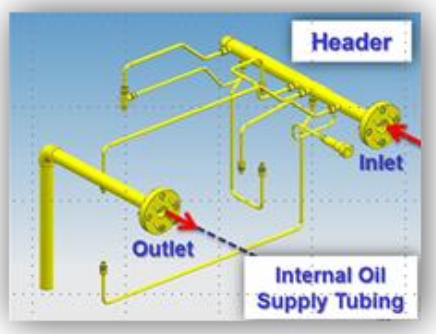


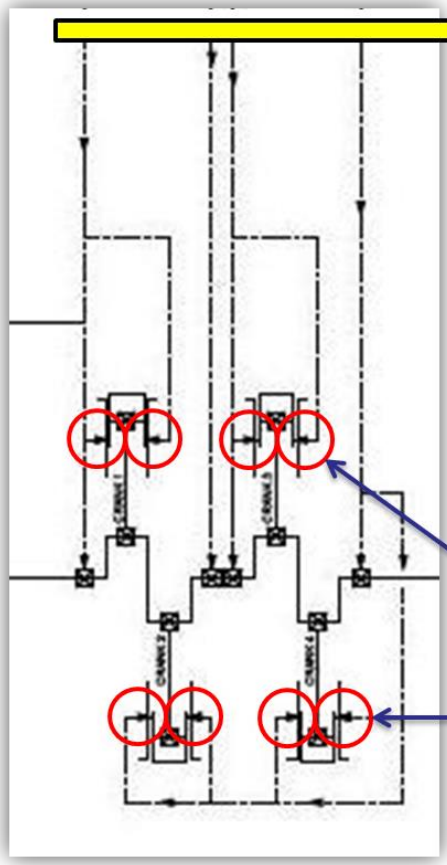
Crankcase Oil Feed Header



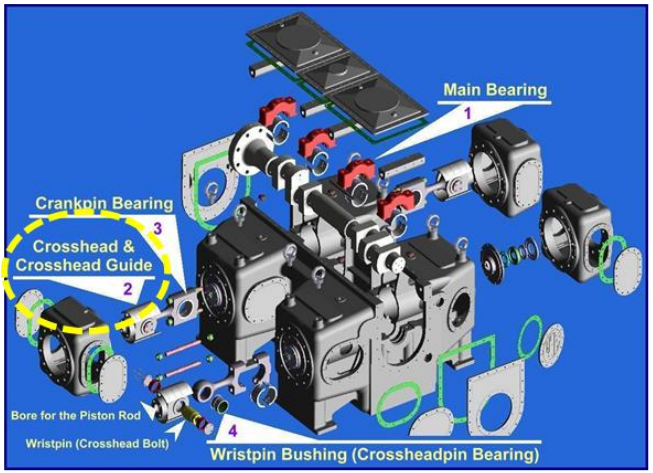
1. Main Bearing
   - ✓ Feed from Header

Lubrication Points & Oil Path



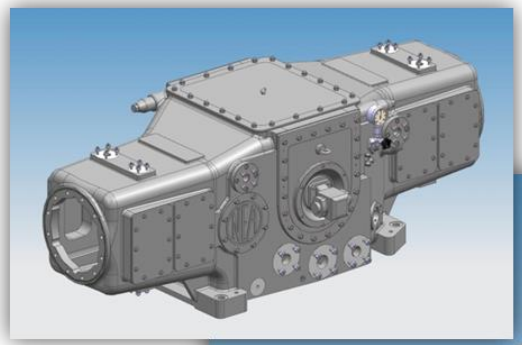


Crankcase Oil Feed Header

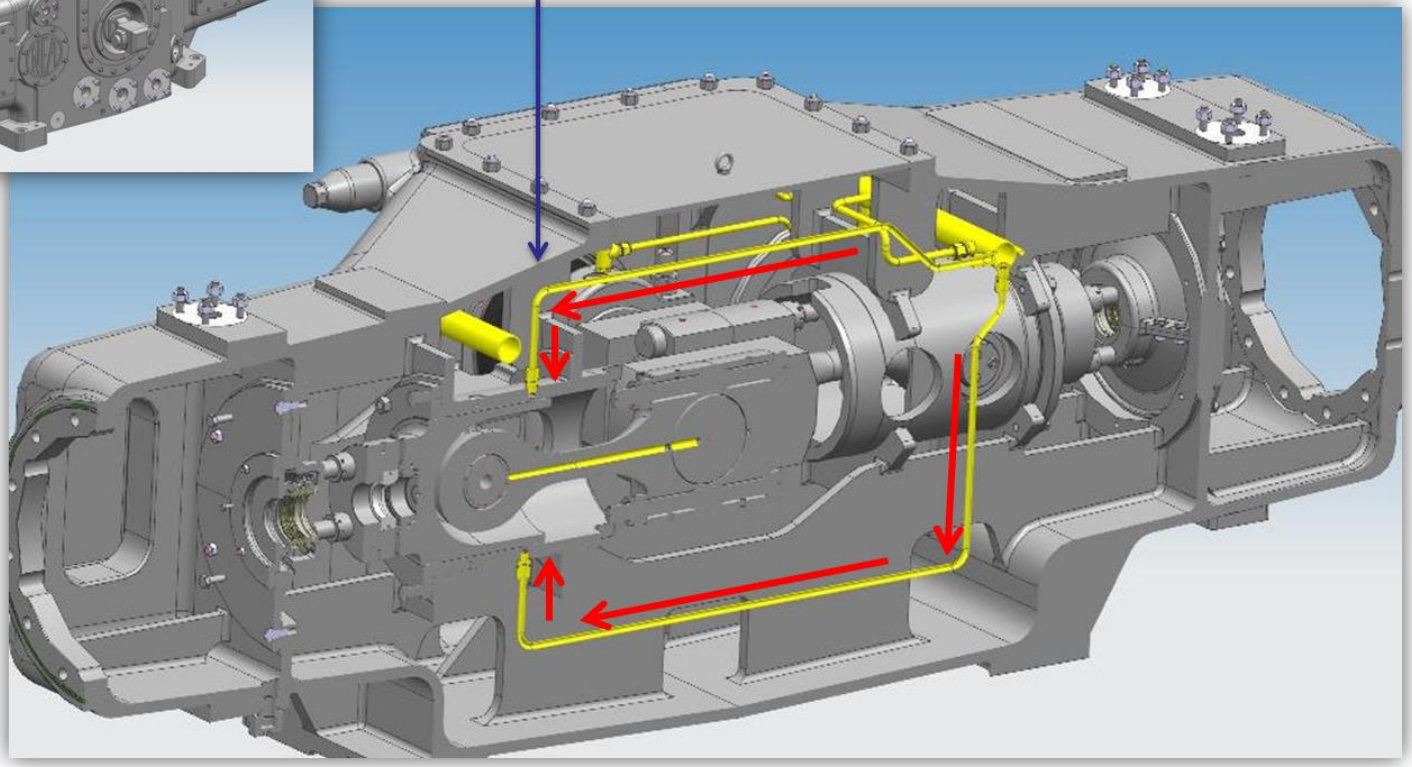


2. Crosshead Guide
✓ Feed from Header

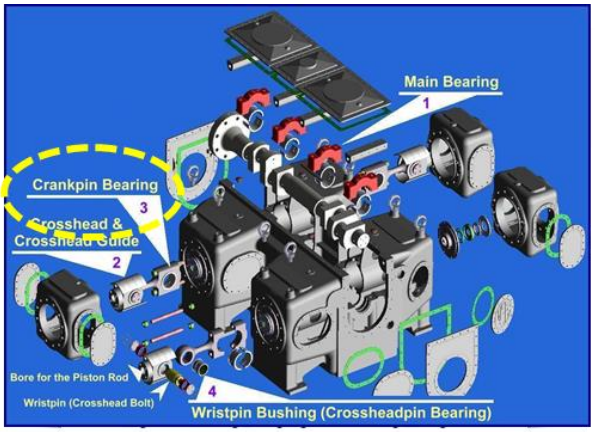
Lubrication Points & Oil Path

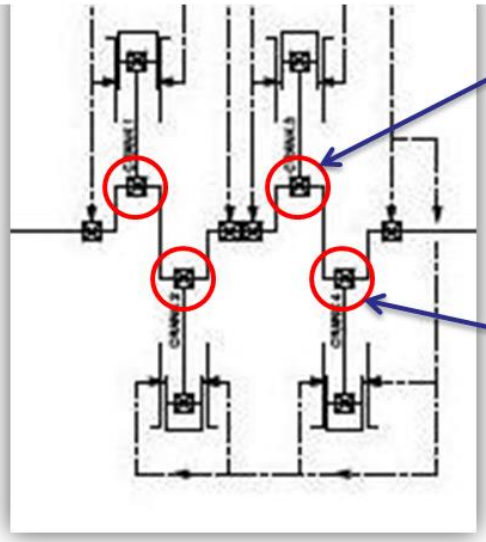


Crosshead Guide (Top & Bottom) Oil Feed from Main Oil Feed Header



Lubrication Points & Oil Path

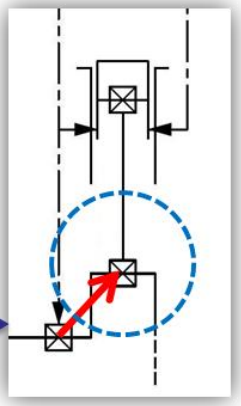




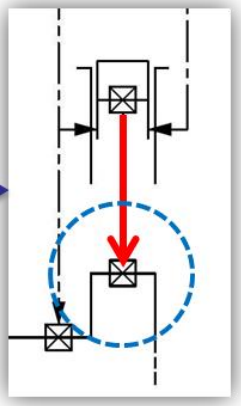
3. Crankpin Bearing

Two Options:

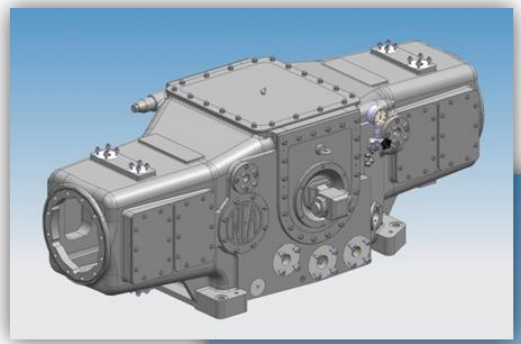
1. **Feed from Main Bearing through Crankshaft**



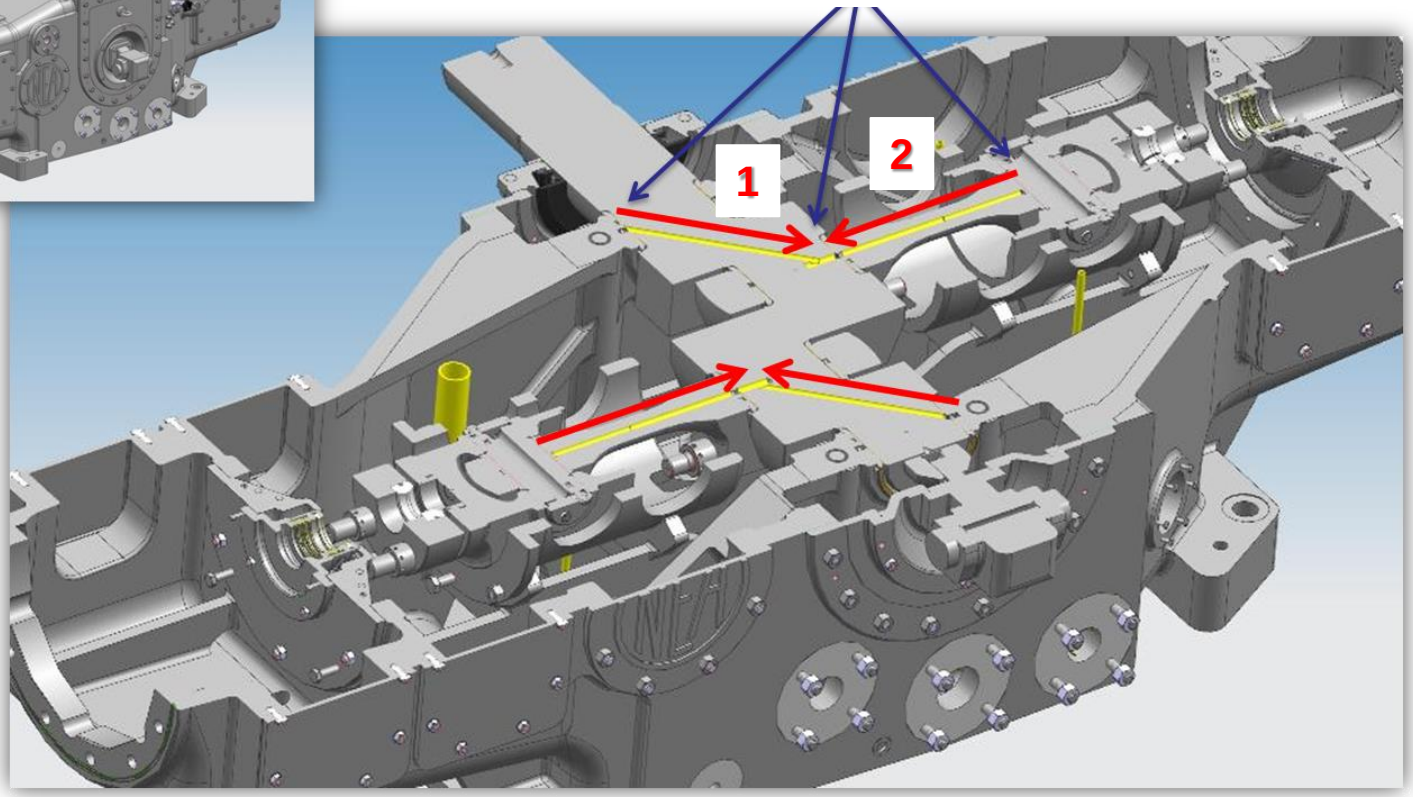
2. **Feed from Crosshead through Con-Rod**



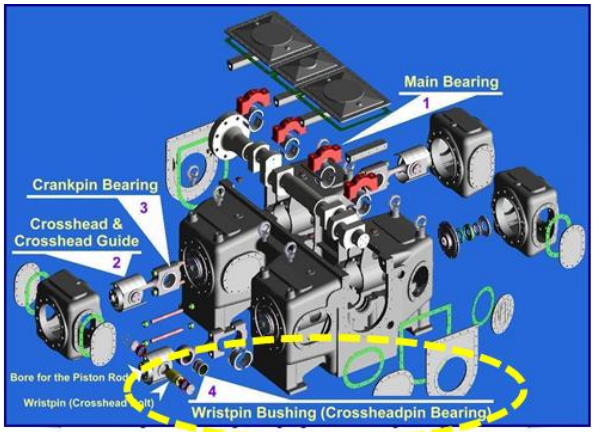
Lubrication Points & Oil Path

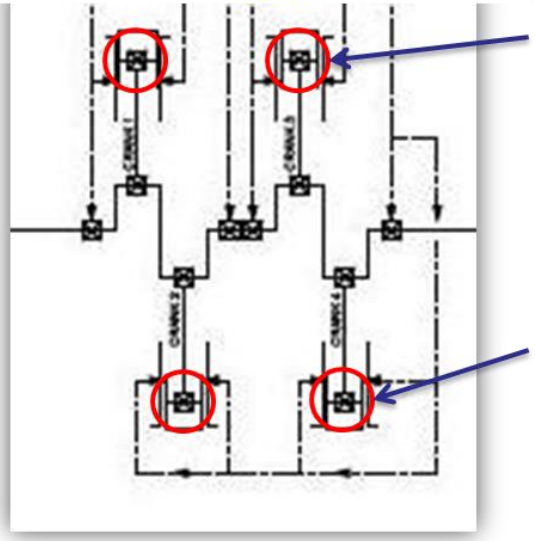


Crank Pin Bearing Oil Feed (1) from Main Bearing through Crankshaft – or (2) from Crosshead through the Connecting Rod



Lubrication Points & Oil Path

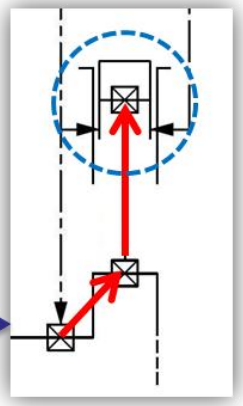




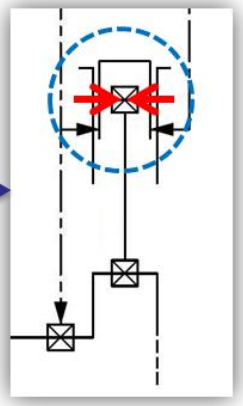
4. Wristpin Bushing
(Crosshead Pin Bearing)

Two Options:

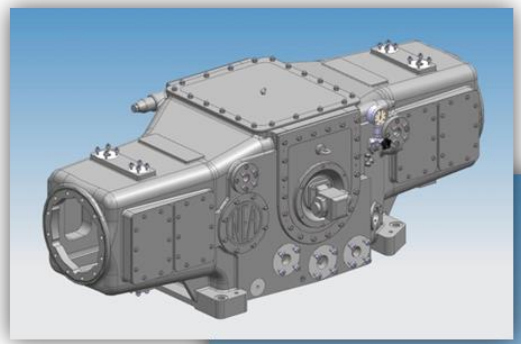
1. **Feed from Crankpin Bearing through Con-Rod**



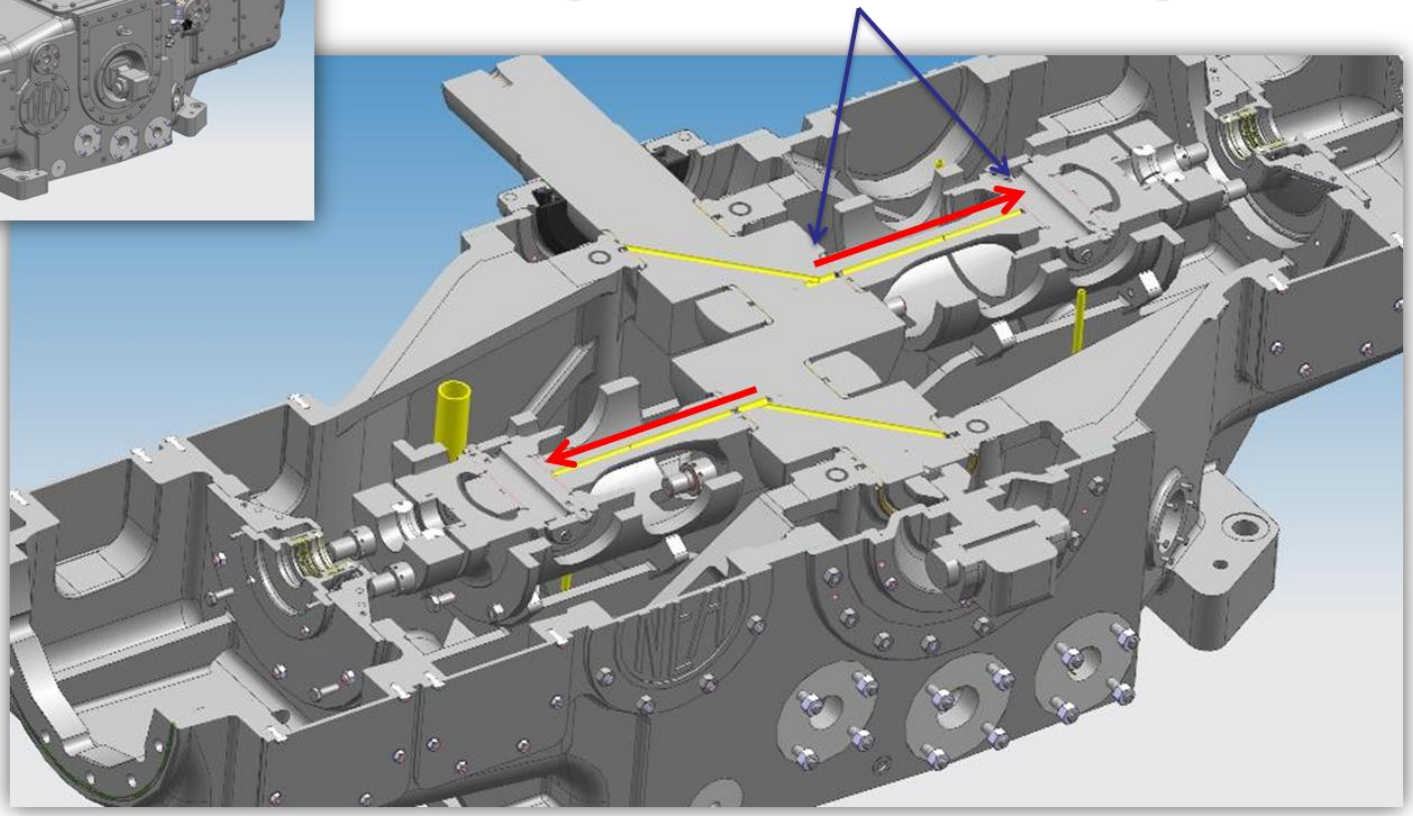
2. **Feed from Crosshead Guide through Crosshead**



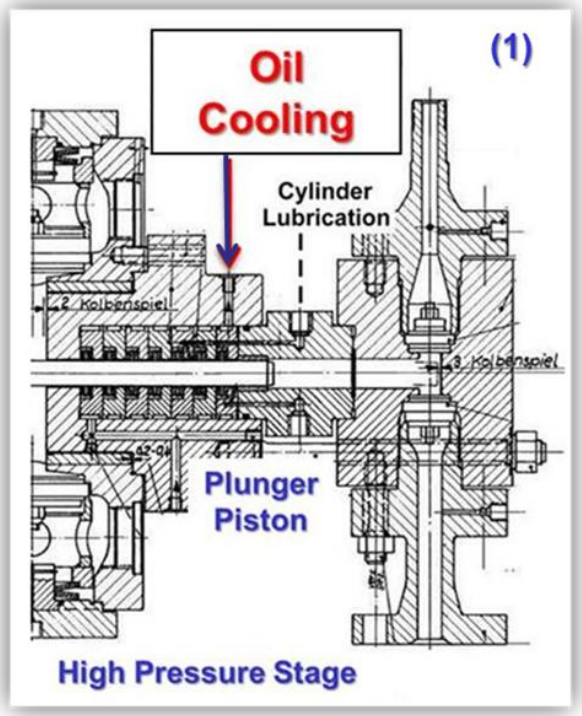
Lubrication Points & Oil Path



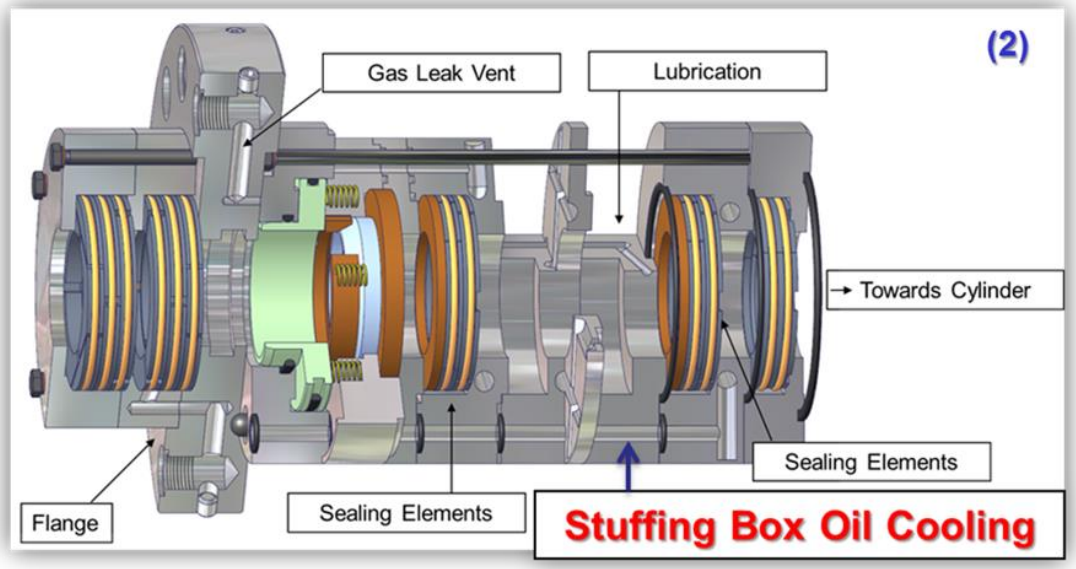
Wristpin Bushing Oil Feed from Crank Pin Bearing through Crankshaft and Connecting Rod



Lubrication Points & Oil Path



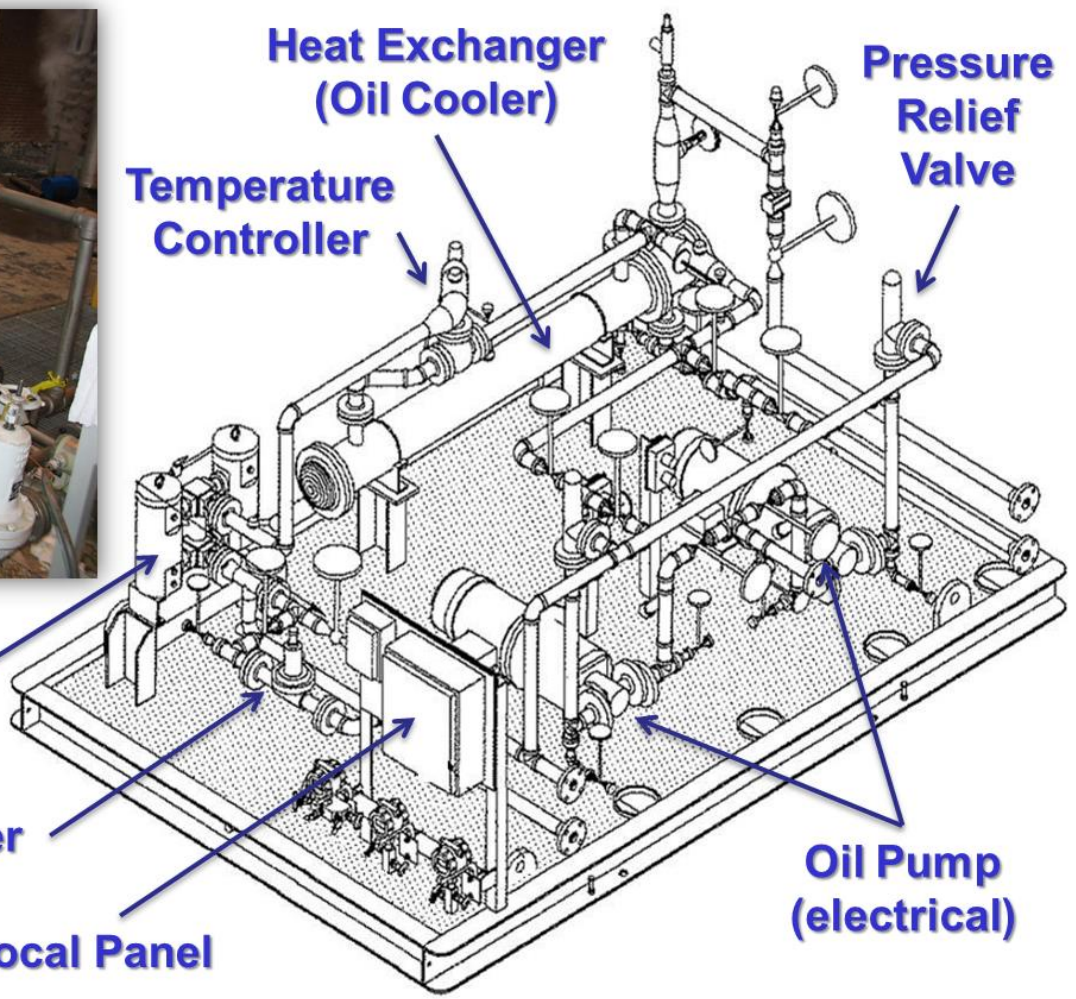
5 Stuffing Box Oil Flow – Cooling only



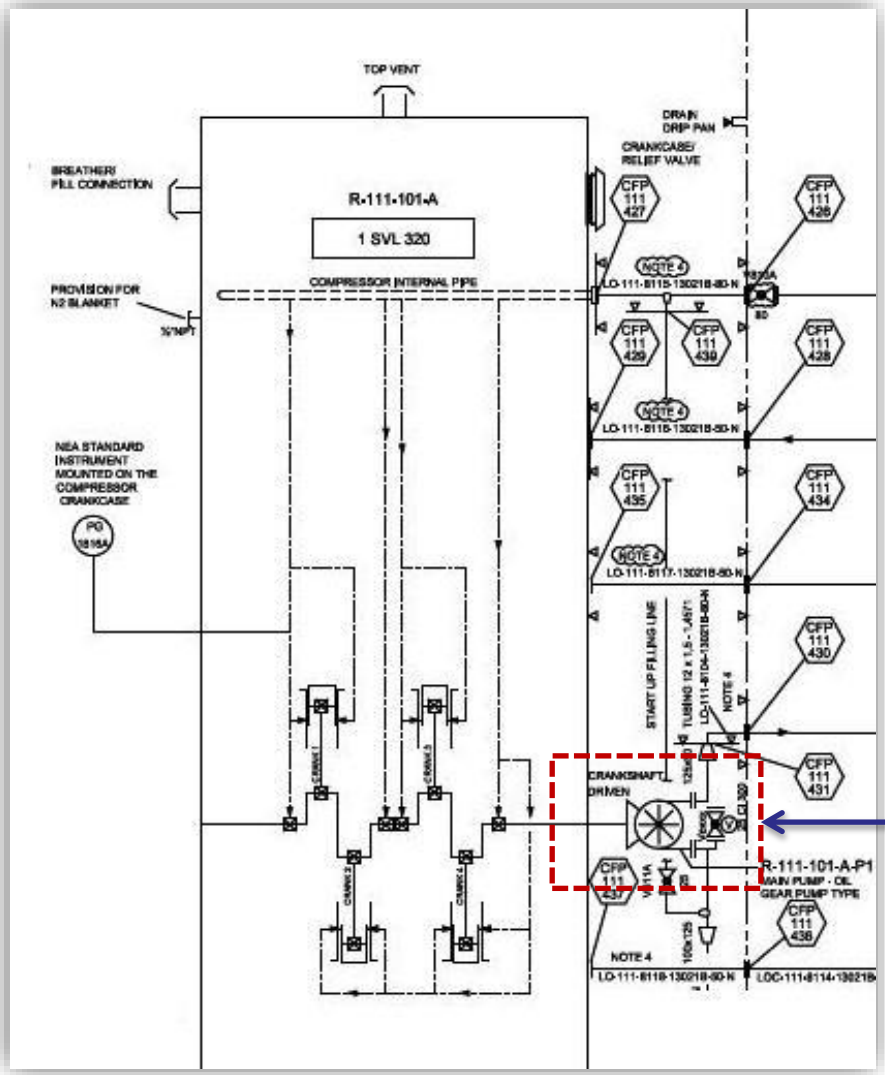
- **"Cooling" may under Circumstances also be a "Warming"**
- **Oil Branch-Off from Frame Lubrication System**

Oil Lubrication Unit Devices & Instrumentation

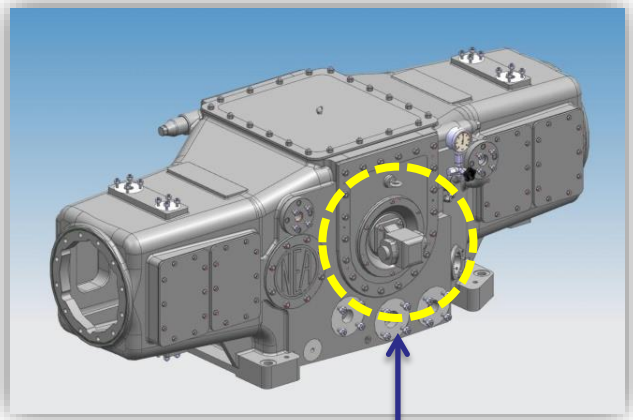
Oil Lubrication Unit Devices & Instrumentation



Oil Lubrication Unit Devices & Instrumentation



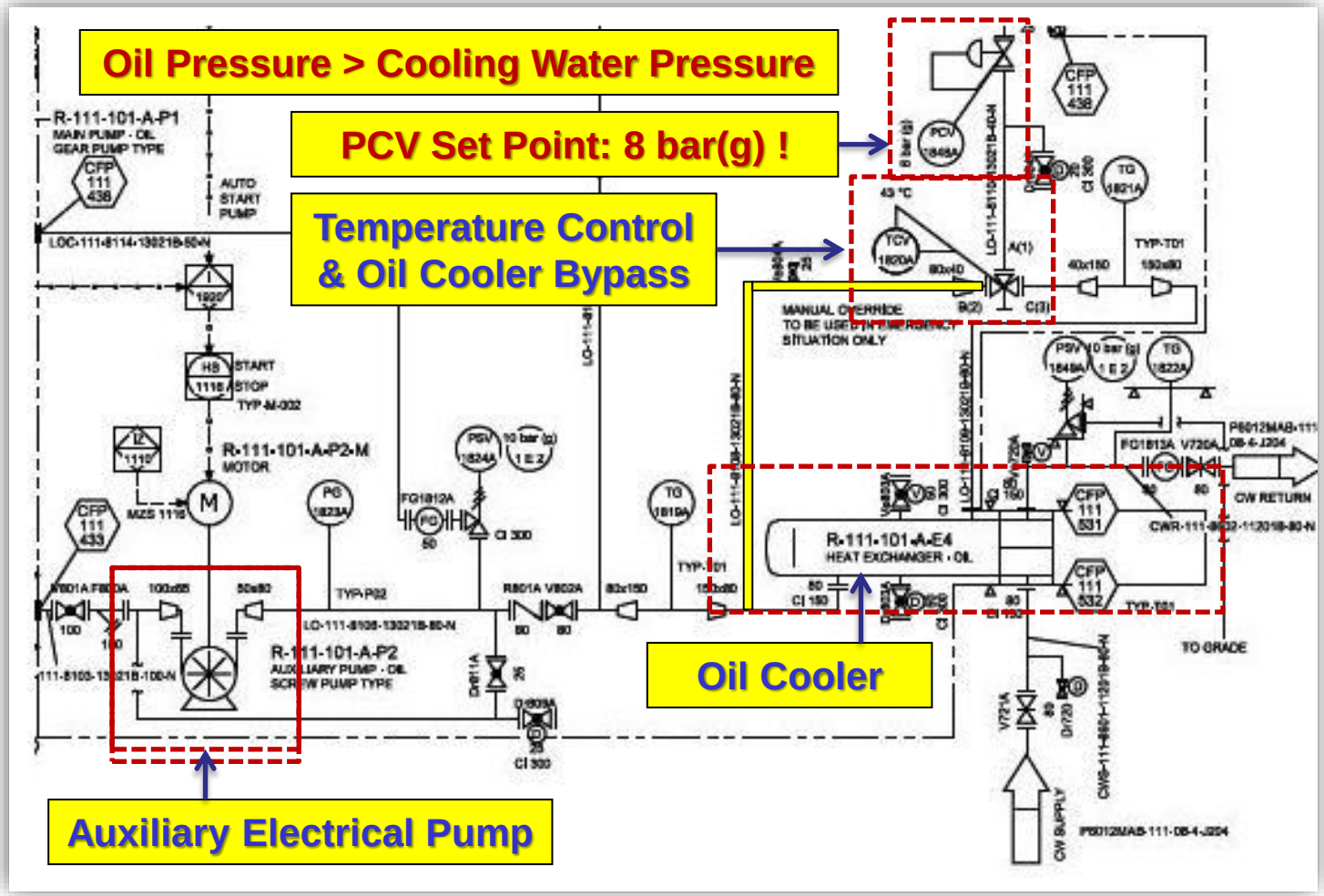
Crankcase



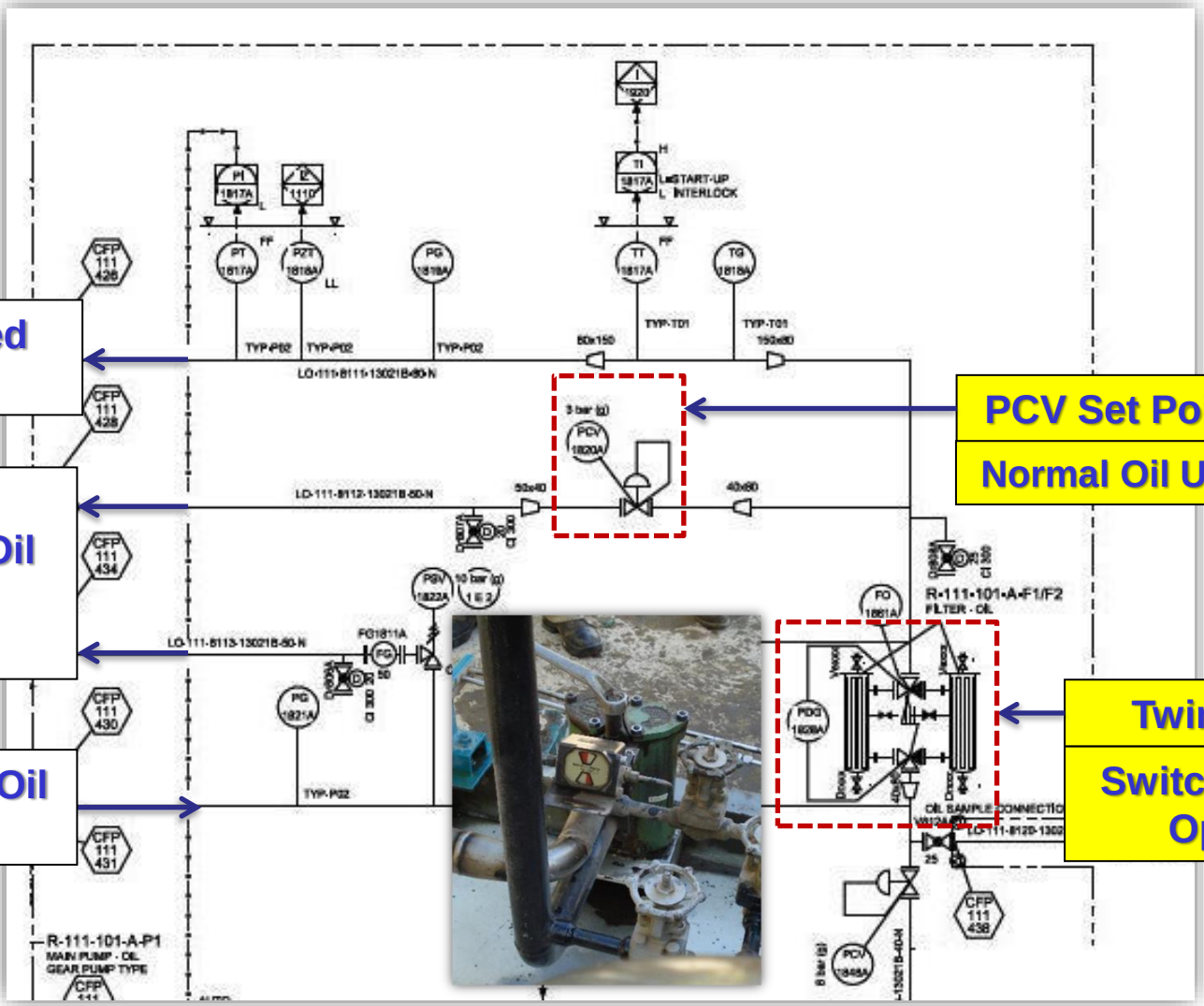
Main Mechanical Pump

Alternative: Electrical Pump

Oil Lubrication Unit Devices & Instrumentation

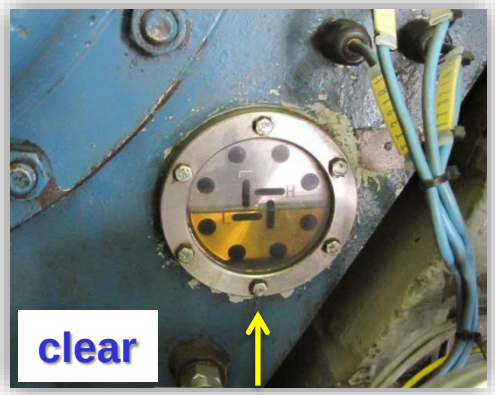


Oil Lubrication Unit Devices & Instrumentation



Operational Issues

Oil Foam Creation Inside Frame

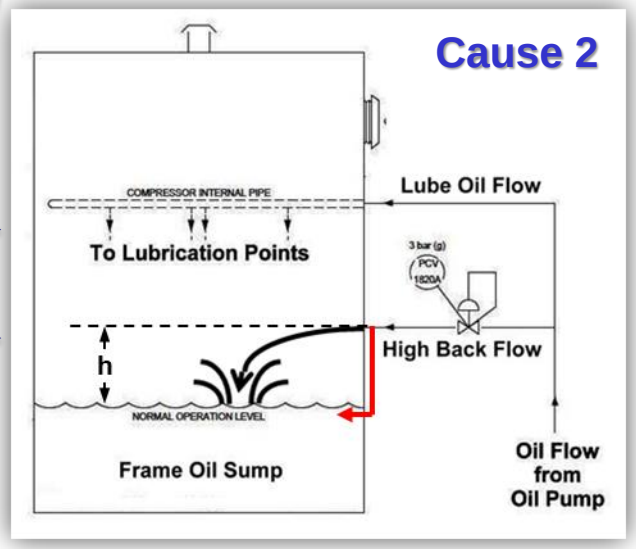


1. Crank Web or Counter Weights punching into Oil Sump (Rarely the Case for correct Oil Level)

2. a) High Back Flow from Pressure Controller Flushing large Amount of Oil into Oil Sump

   b) High Elevation (**h**) of Inlet Pipe above Oil Level

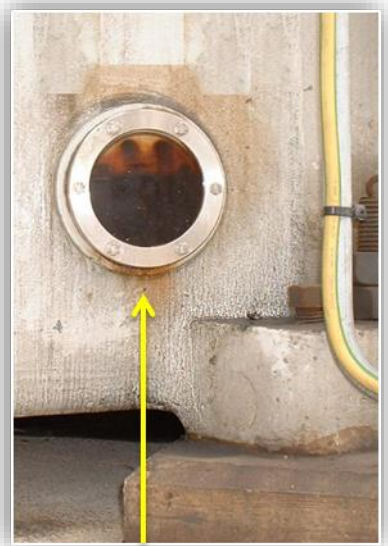
Remedy for (a) and (b): Move Backflow Pipe Outlet below Oil Level



Operational Issues

Oil Contamination

- **Process Gas penetrating into Frame with consequential Oil Quality Degradation and Crankshaft Journal Wear**

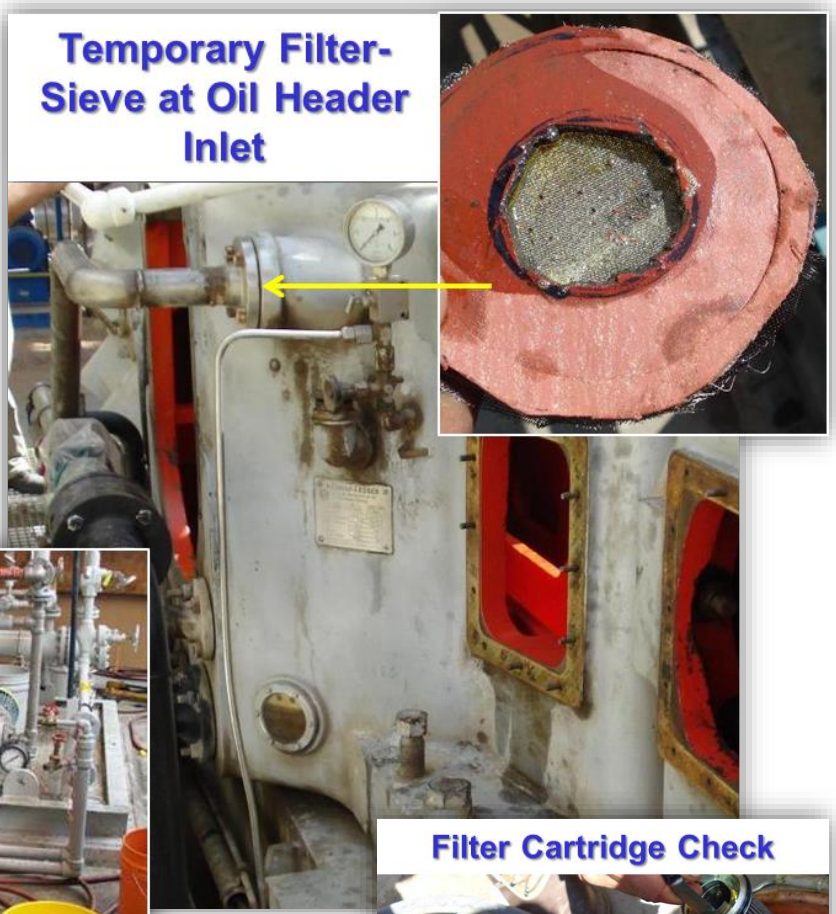


- **Oil Heater Defect – Oil Cracking from Heater Hot Spots ⇔ Black Oil**

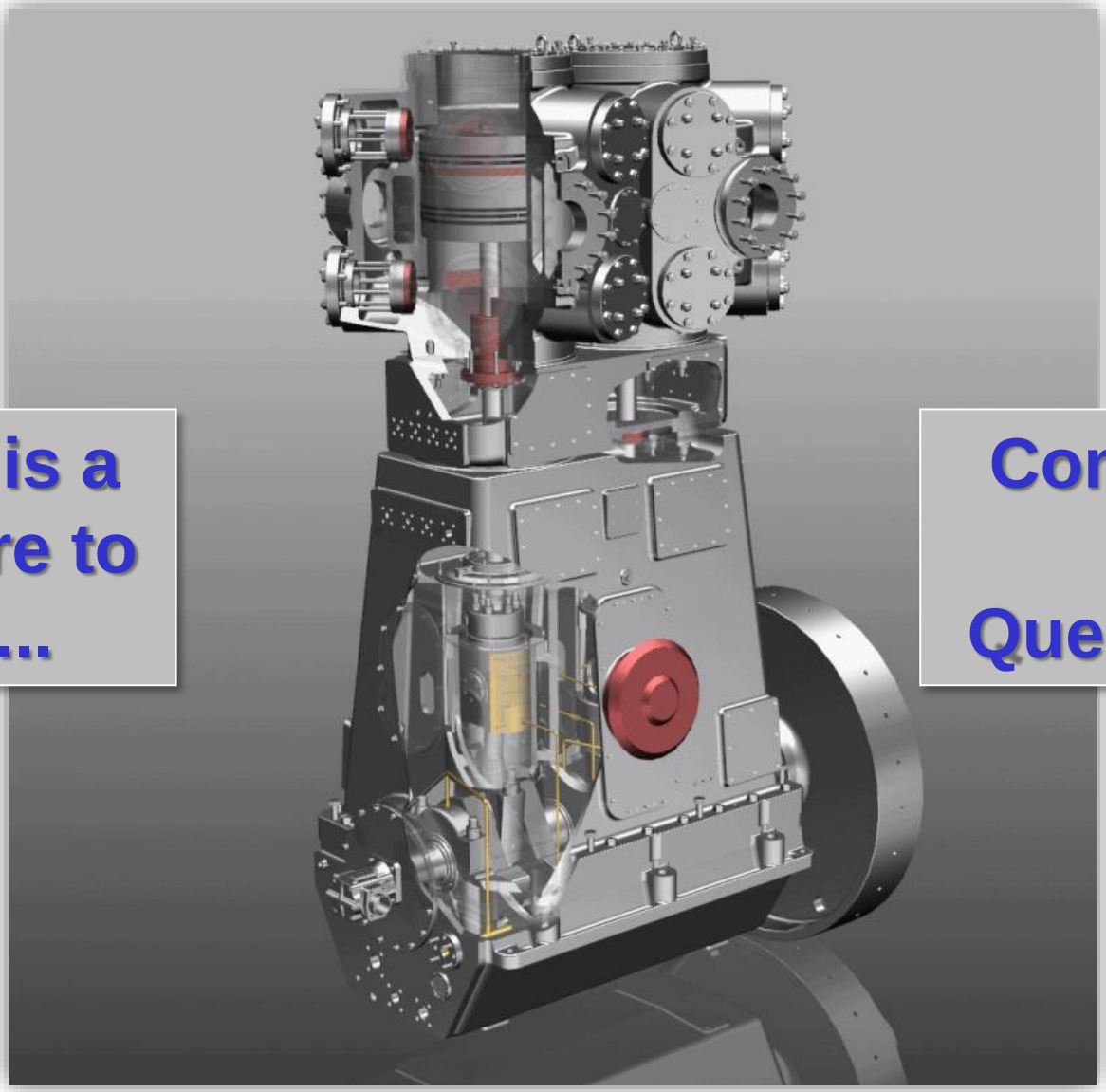
- **Milky Oil from Water mixing with Oil; e. g. from Oil Cooler Leak if Water Pressure > Oil Pressure (no Picture)**

Operational Issues

Oil Unit Commissioning & Cleaning



Oil Unit Flushing with Outlet at lowest Point !



There is a lot more to say ...

Comments and Questions ?