Implementation of a Condition Monitoring System on a hydraulically-driven Hyper Compressor

Mirko Graf
Innospec Leuna GmbH

- About Innospec
- Hyper Compressor
- Condition Monitoring System
- Resistance Strain Gauges
- Rod Position Sensors
- Standard Sensor Arrangements on Hypers
- Customised Sensor Arrangements on hydraulically-driven Hypers

INNOSPEC – General Information

Plants

Salisbury (NC/US)
High Point (NC/US)
Oklahoma City (OK/US)
Chatsworth (CA/US)
Pleasanton (TX/US)
Midland (TX/US)
Ellesmere Port (UK)
Vernon (FR)
St. Mihiel (FR)
Castiglione (IT)
Barcelona (ES)
Herne (DE)
Leuna (DE)

Representatives

Corporate Headquarter Englewood/Denver (CO/US)

Ellesmere Port (UK)
Madrid (ES)
Milan (IT)
Piraeus (GR)
Limassol (CY)
Everberg (BE)
Karlstad (SE)
Moscow (RU)
Rio de Janeiro, Itajai (BR)
Houston (TX/US)
Cape Town (ZA)
Dubai (UAE)
New Delhi (IN)
Seoul (KR)
Beijing, Guangzhou (CN)
Hong Kong (HK)

Additional Info

Technology Centres

- Pencader (DE/US)
- Salisbury (NC/US)
- Houston (TX/US)
- Millbrook (UK)
- Singapore (SG)
- Castiglione (IT)
- Ellesmere Port (UK)
- Everberg (BE)

Employees: 1,800 (2017)

Turnover: $1.3b (2017)

Fuel Specialties

Oilfield Services

Performance Chemicals

Octane Additives

- EVA Tubular Reactor
- Commissioning in 1968 as Pilot Plant
- Hydraulically-driven Hyper Compressor

EVA FLEXAREN®

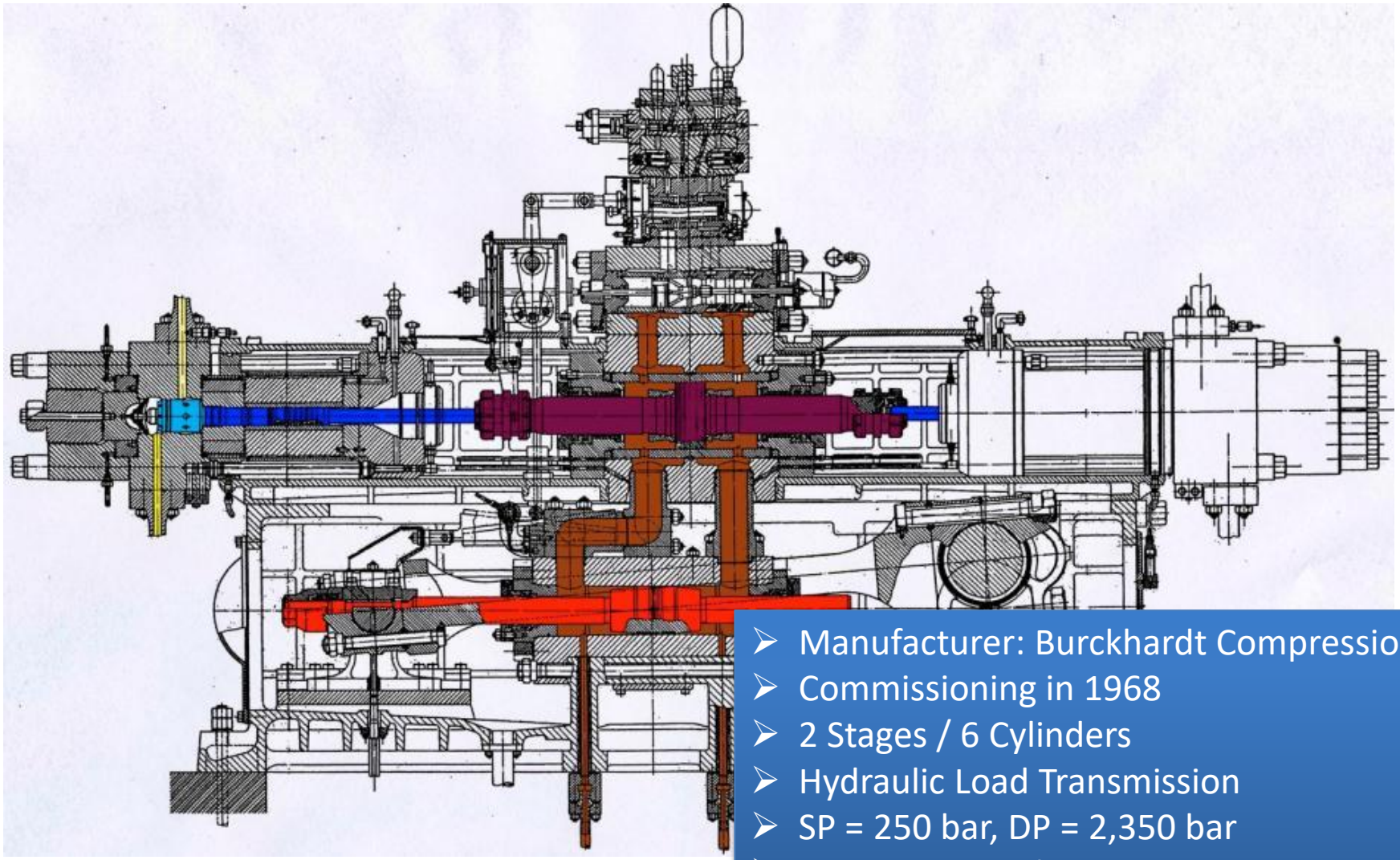
- Injection moulding
- Sheets / profiles
- Flexible hoses
- Films
- Foams
- Carrier material
- Compounds

PE/EVA WAX VISCOWAX®

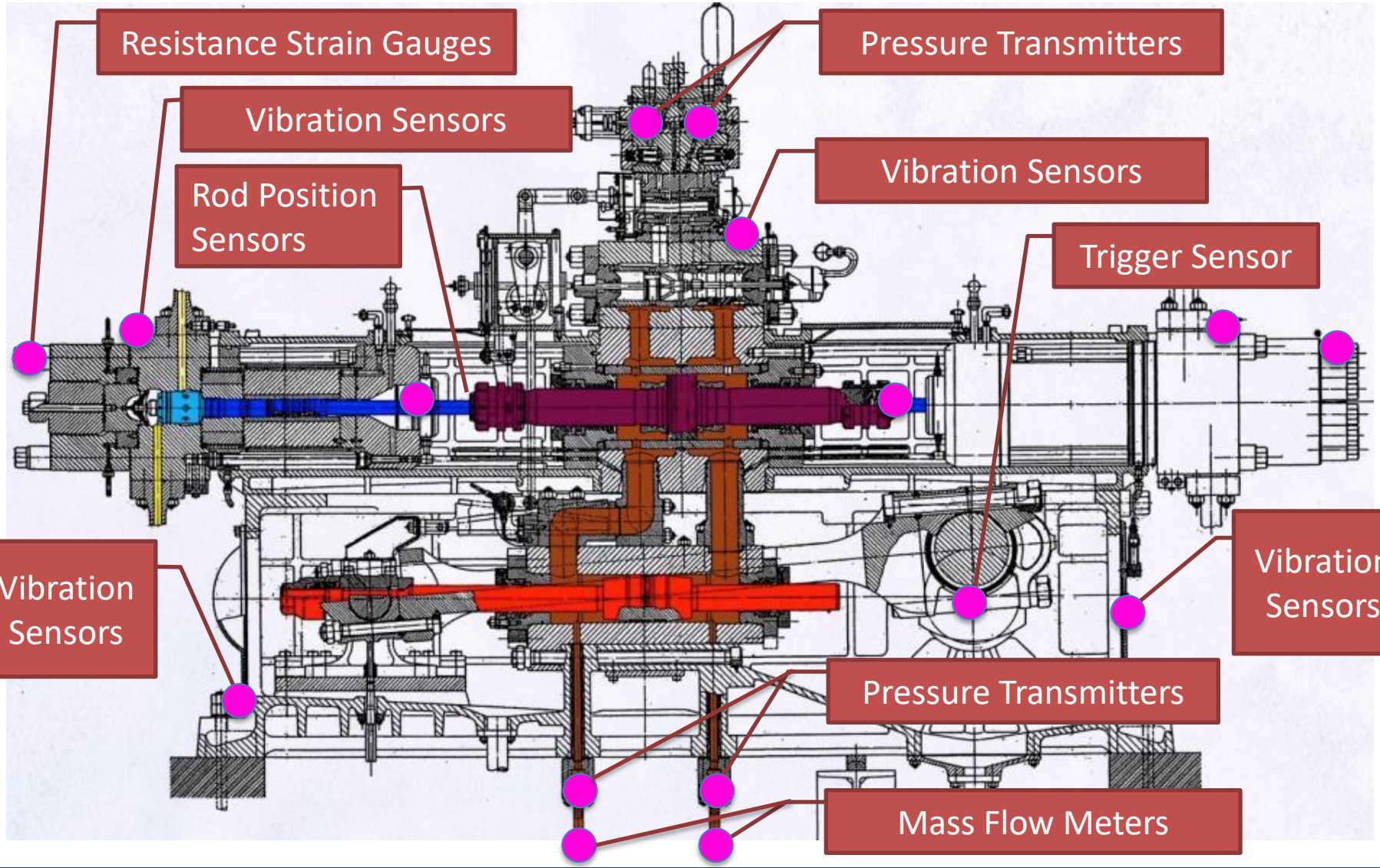
- Additives for:
  - PVC processing
  - Masterbatches
  - Printing inks
  - Lacquers
  - Hot melt adhesives
  - Road marking
  - Candles/Paraffine compounds
  - Bitumen/asphalt

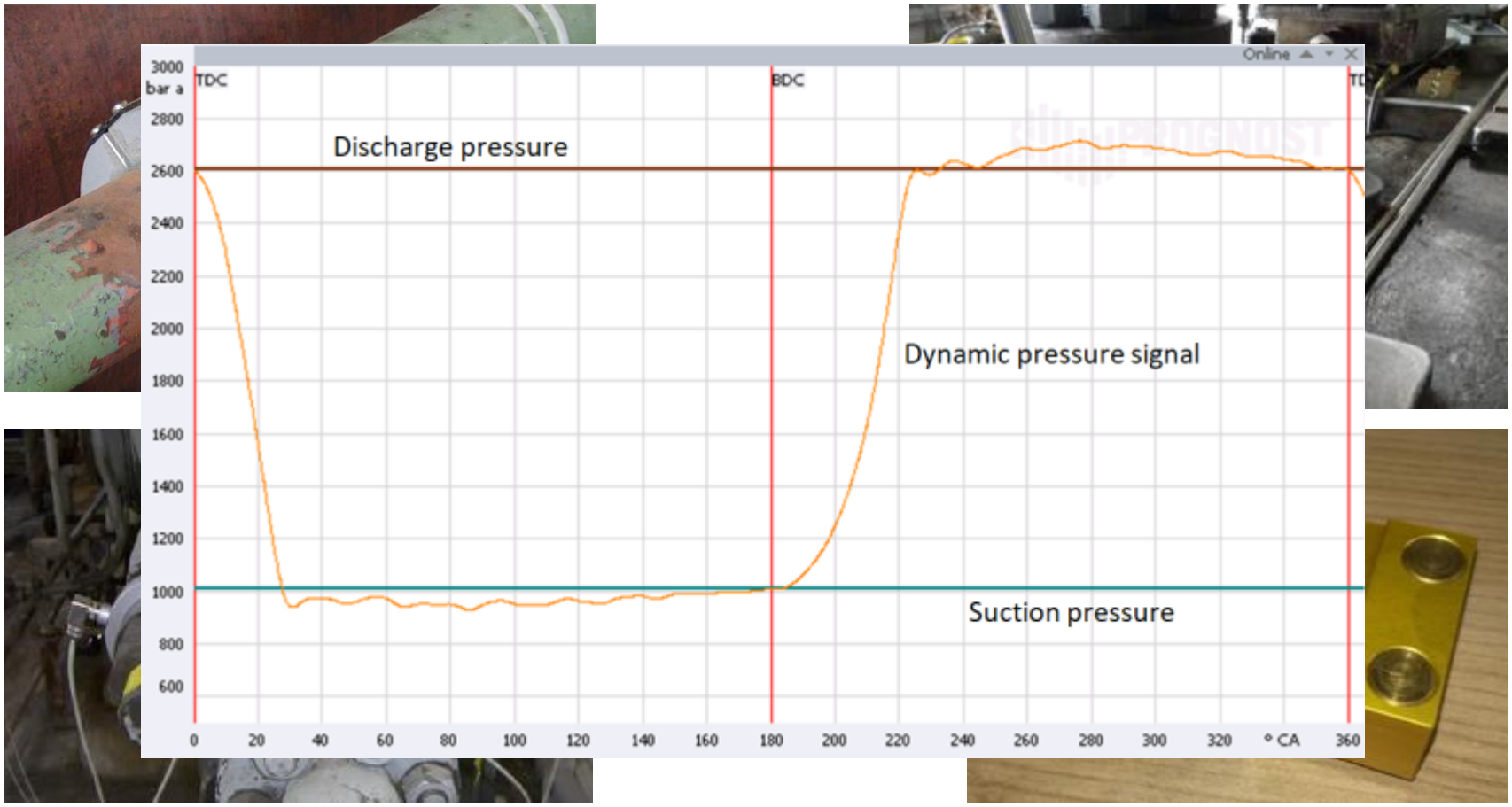
EVA Cold Flow Improver

- Diesel Fuel
- Heating Oil

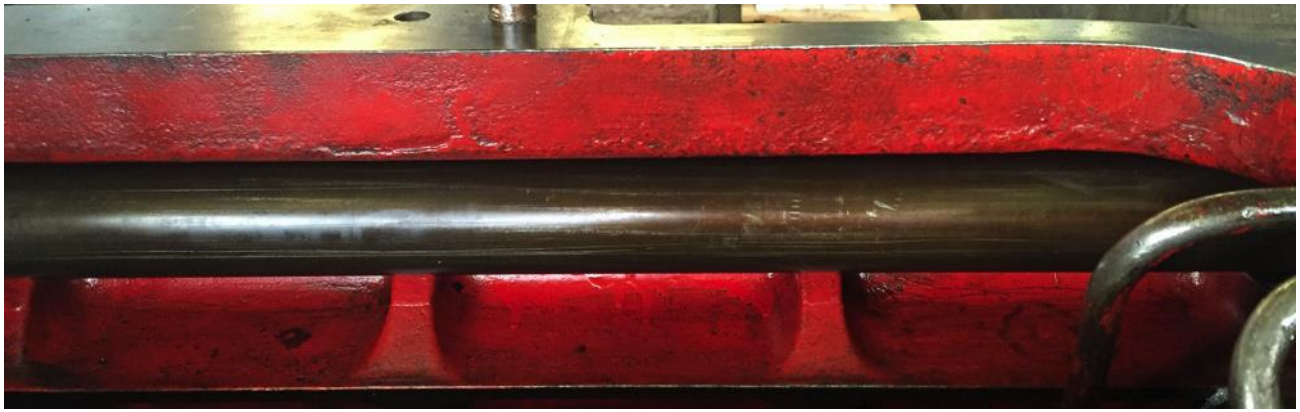


- Manufacturer: Burckhardt Compression
- Commissioning in 1968
- 2 Stages / 6 Cylinders
- Hydraulic Load Transmission
- SP = 250 bar, DP = 2,350 bar
- Gas pistons with piston rings


Resistance Strain Gauges
Pressure Transmitters
Vibration Sensors
Vibration Sensors
Rod Position Sensors
Trigger Sensor
Vibration Sensors
Vibration Sensors
Pressure Transmitters
Mass Flow Meters

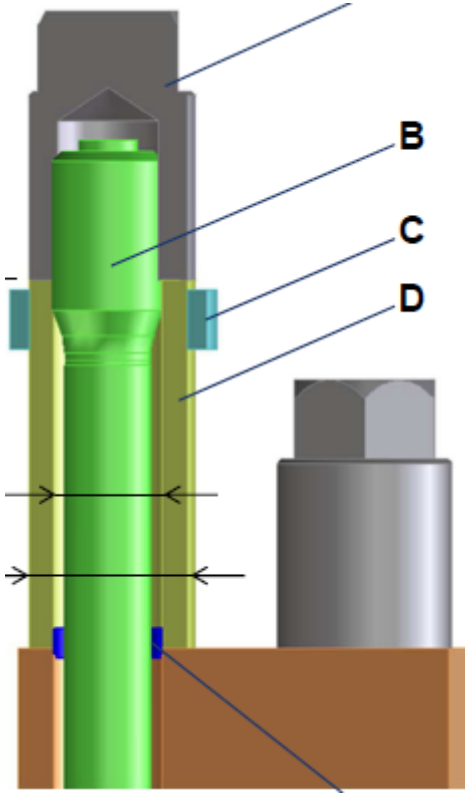

Online
3000
bar a
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
TDC
BDC
Discharge pressure
Dynamic pressure signal
Suction pressure
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
° CA
360

- To depict the Valve Acitivity: two Rod Position Sensors, one Vibration Sensor and normally two Resistance Strain Gauges are required on each cylinder. Furthermore one Trigger sensor for the entire machine is required.
- Normally the **Resistance Strain Gauges** are easy to implement on the exposed cylinder bolts.



- The hydraulically-driven Hyper has cylinder bolts only on the interior side.
- A customised solution was required.

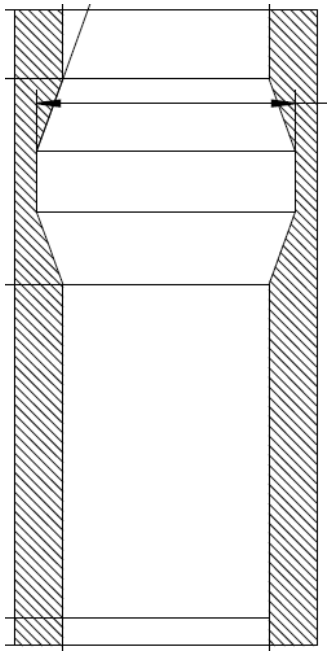
1st Approach:



Prolonged cylinder bolts for the inclusion of a distance bush to implement the Resistance Strain Gauges.

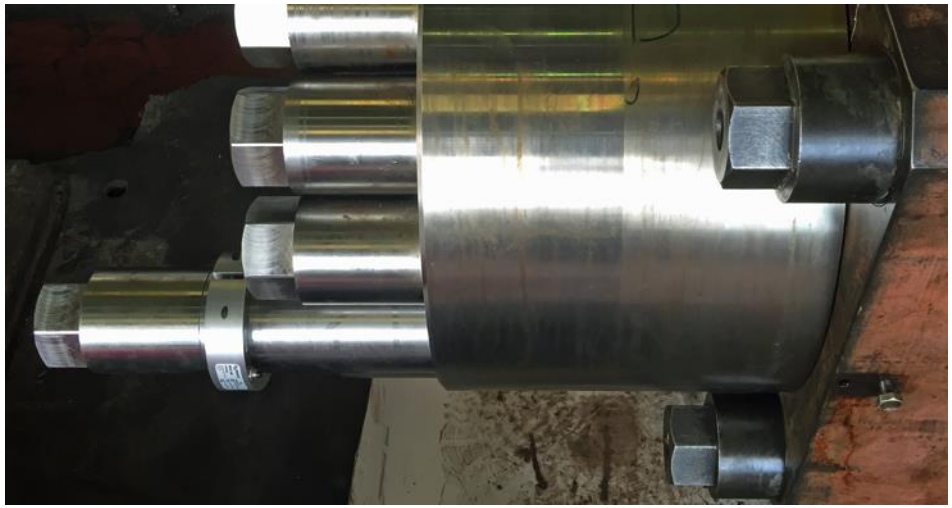
RESULT: Signals were too weak and therefore not evaluable.

2nd Approach:

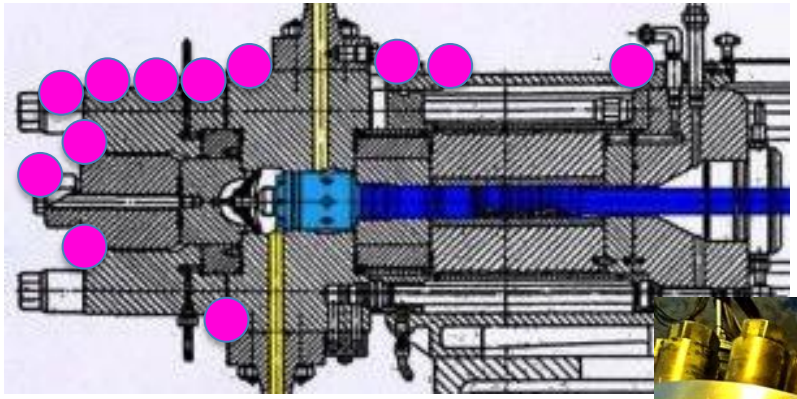


Modified distance bushes containing a machined out strain area.

RESULT: No improvements to signals.



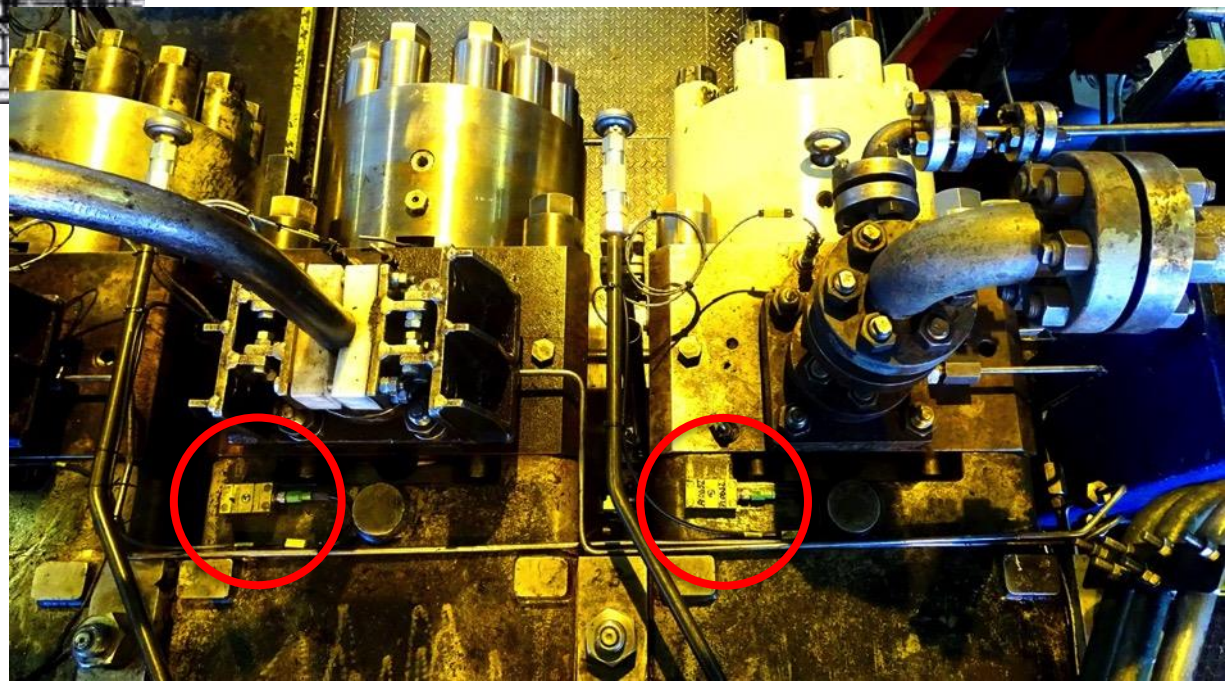
3rd Approach: Full examination of the entire cylinder where else to implement Resistance Strain Gauges.



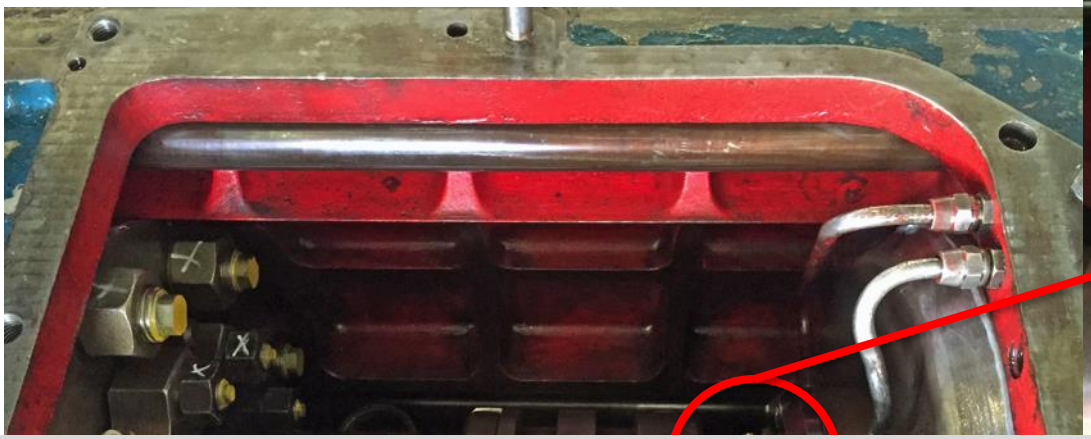
RESULT: One unexpected location was found on cylinder housing.

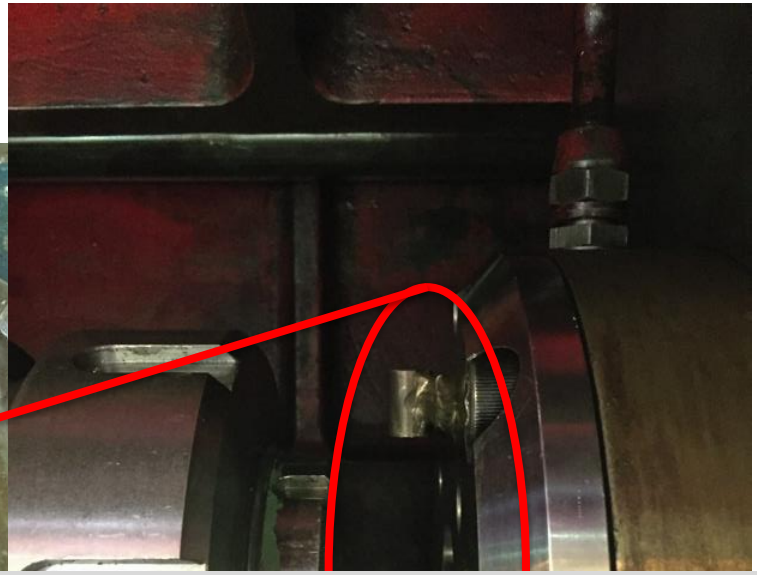
RESULT:

Reliable signal output!

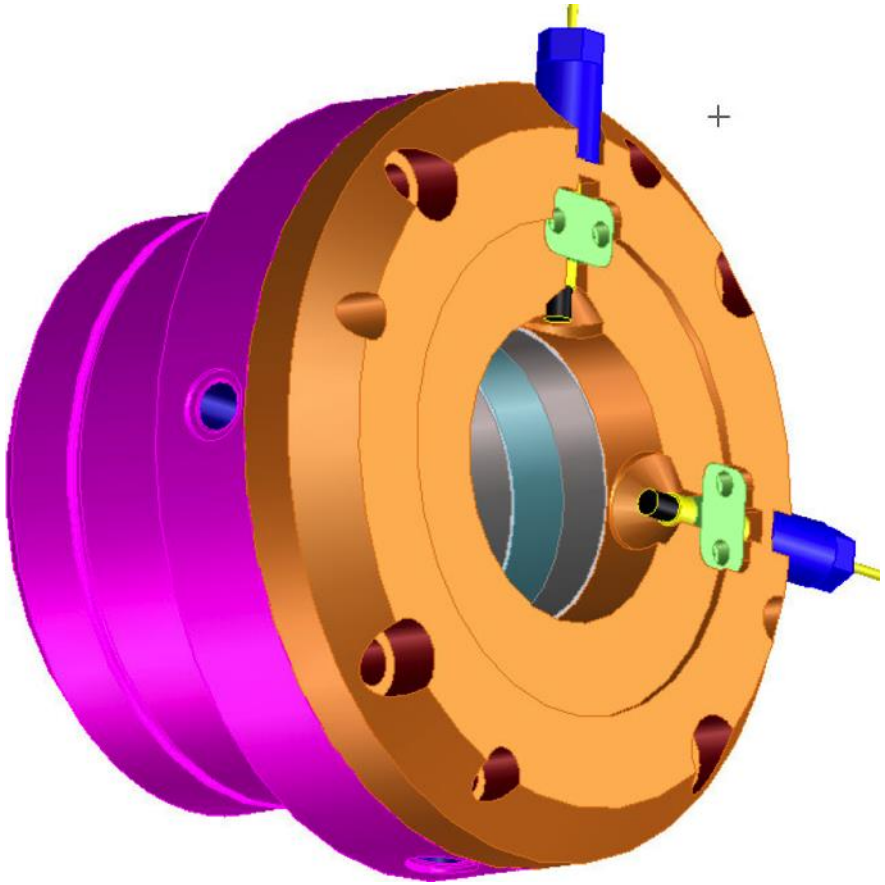


- **Rod Drop Sensors** are useful to identify i. e. piston ring damages.
- Normally the **Rod Drop Sensors** are easy to implement in the outer area of the safety packing gland.

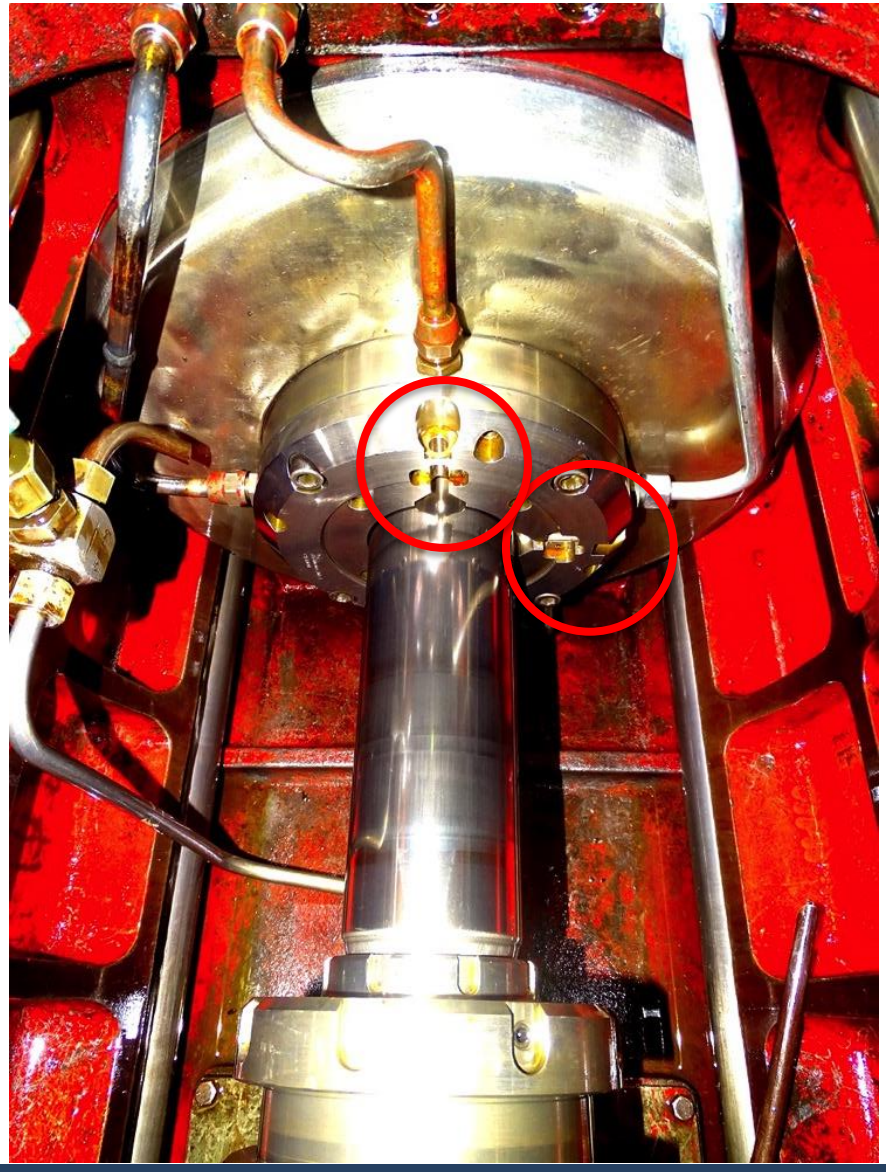




- At a hydraulically-driven Hyper Compressor the piston nut is able to override its final position by specific failures of the hydraulic oil pumps, which deliver the oil pressure of about 300 barg.
- An electric failure led to a crush of totally 6 sensors after 3 months of operation.
- Improvements to the sensor implementation were required.



Sensor adaptors are implemented into the lid of the safety packing gland.



Vibration Sensors on Main Bearings

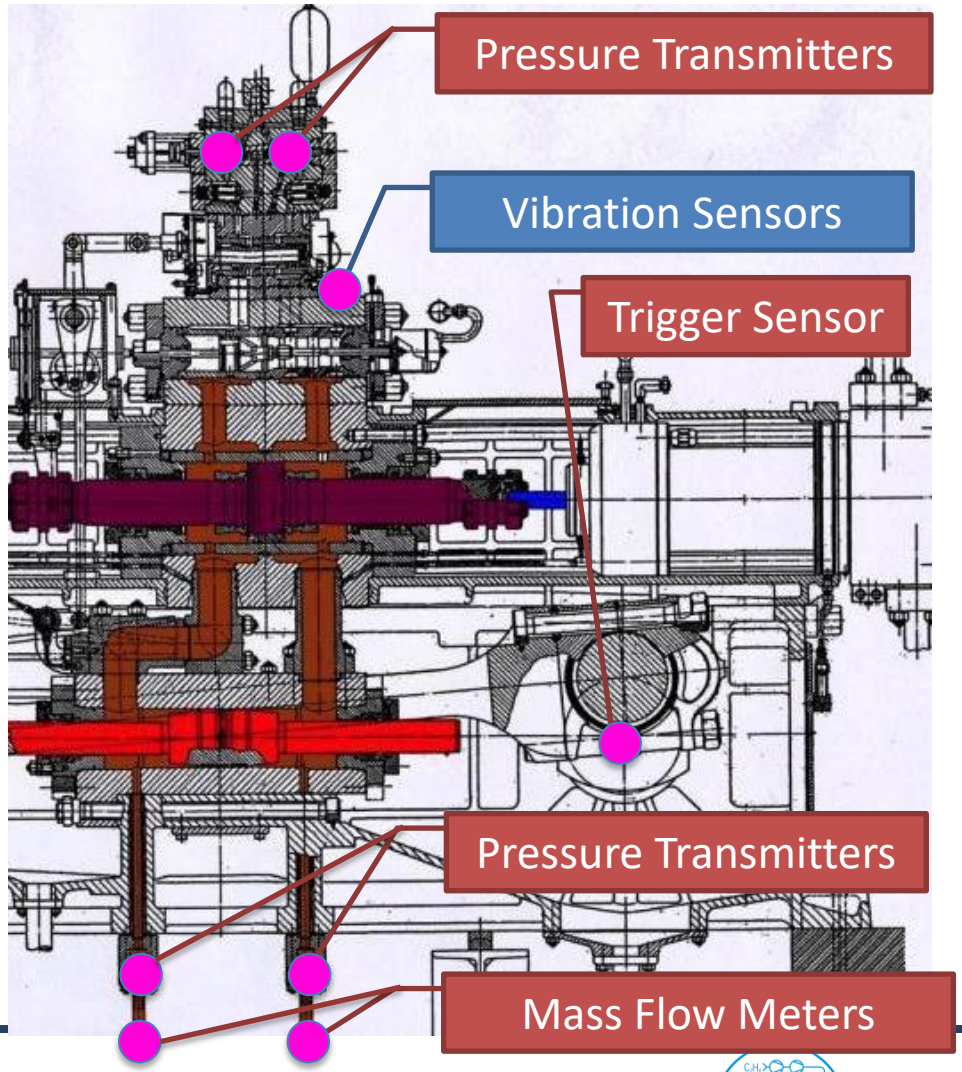
Upper bearing shell.

Lower bearing shell.

- An early detection of a starting failure at one of the main bearings was possible by the **Vibrations Sensors**.
- Overheating traces at the **upper** bearing shell.
- Starting material fractures at the **lower** bearing shell.
- **Cause of damage:** temporarily inadequate lubrication of bearing.

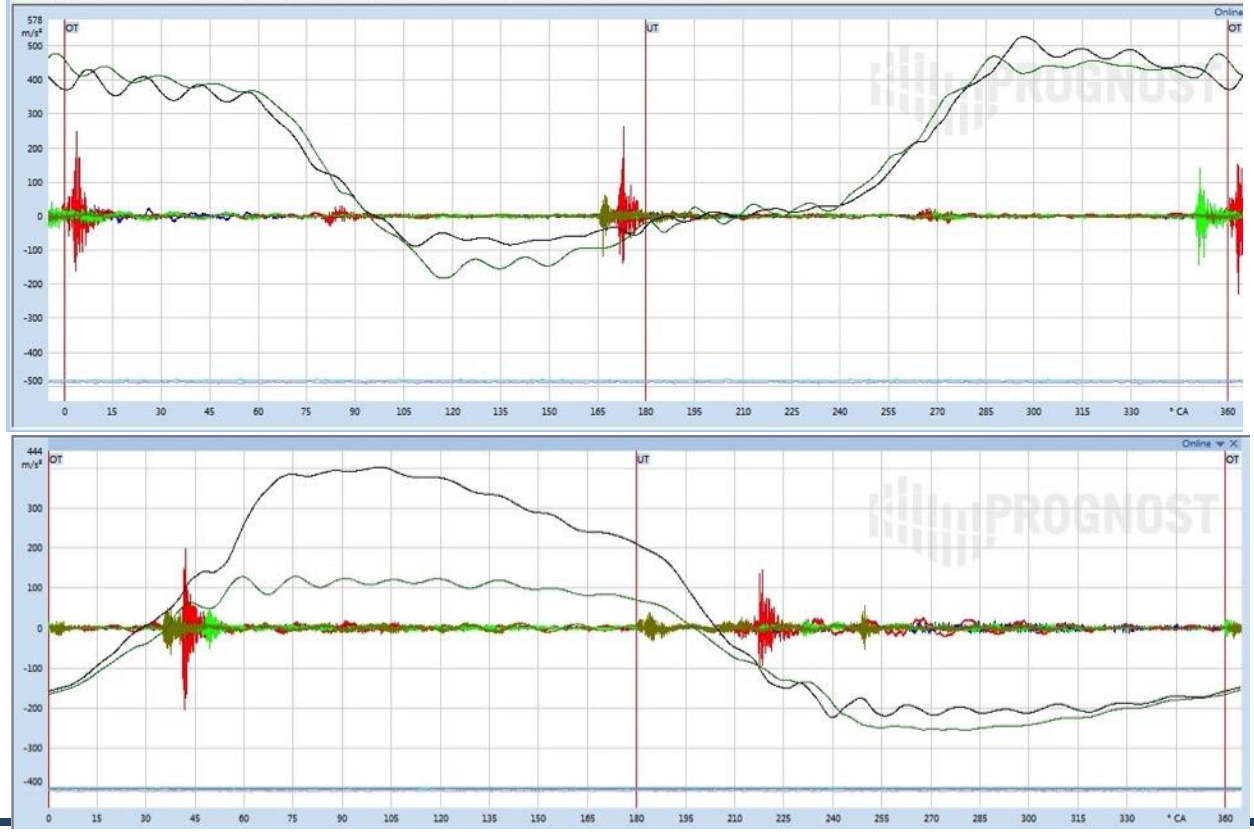
Vibration Sensors on Hydraulic Control Unit I

- **Pressure Transmitters** and **Mass Flow Meters** are convenient for hydraulic systems in the industry.
- **Vibrations Sensors** on hydraulically-driven Hyper Compressors are suitable to identify troubles at the hydraulic control unit.
  - Inner leakages by broken O-rings.
  - Broken control pistons.
  - Blockages by metal pieces.



Vibration Sensors on Hydraulic Control Unit II

Maschine	Messpunkt	Bezeichnung	TAG-Name	Messwert	Einheit
RDK-B	V KKB Linie 3	Schw. Kreuzkopfbahn	GI0612	-250,0 - 250,0	m/s²
RDK-B	V Hubr. Linie3	Schw. Gehäuse, hor.	GI0622	-1000 - 1000,0	m/s²
RDK-B	V Zyl. 3A	Schw. Zylinder	GI0605	-1000 - 1000,0	m/s²
RDK-B	V Zyl. 3B	Schw. Zylinder	GI0606	-1000 - 1000,0	m/s²
RDK-B	PP X 3A	Kolbenst.Lage, horizontal	GI0637	0 - 2000	µm
RDK-B	PP Y 3A	Kolbenst.Lage (Standard)	GI0638	0 - 2000	µm
RDK-B	PP X 3B	Kolbenst.Lage, horizontal	GI0639	0 - 2000	µm
RDK-B	PP Y 3B	Kolbenst.Lage (Standard)	GI0640	0 - 2000	µm
RDK-B	P Hyd. 3A	Druck Rohrleitung	PI0644	0 - 250,0	bar a
RDK-B	P Hyd. 3B	Druck Rohrleitung	PI0645	0 - 400,0	bar a

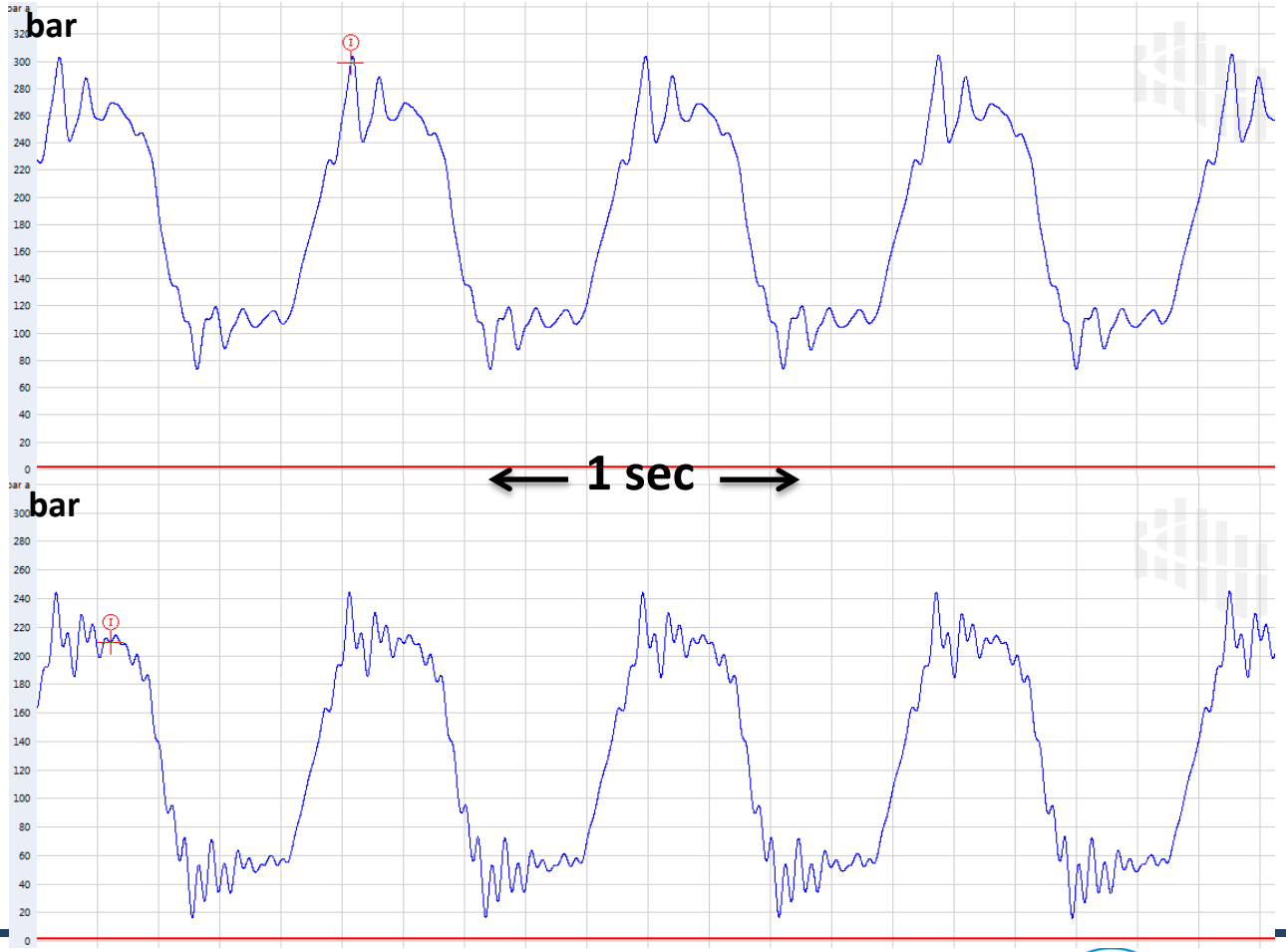


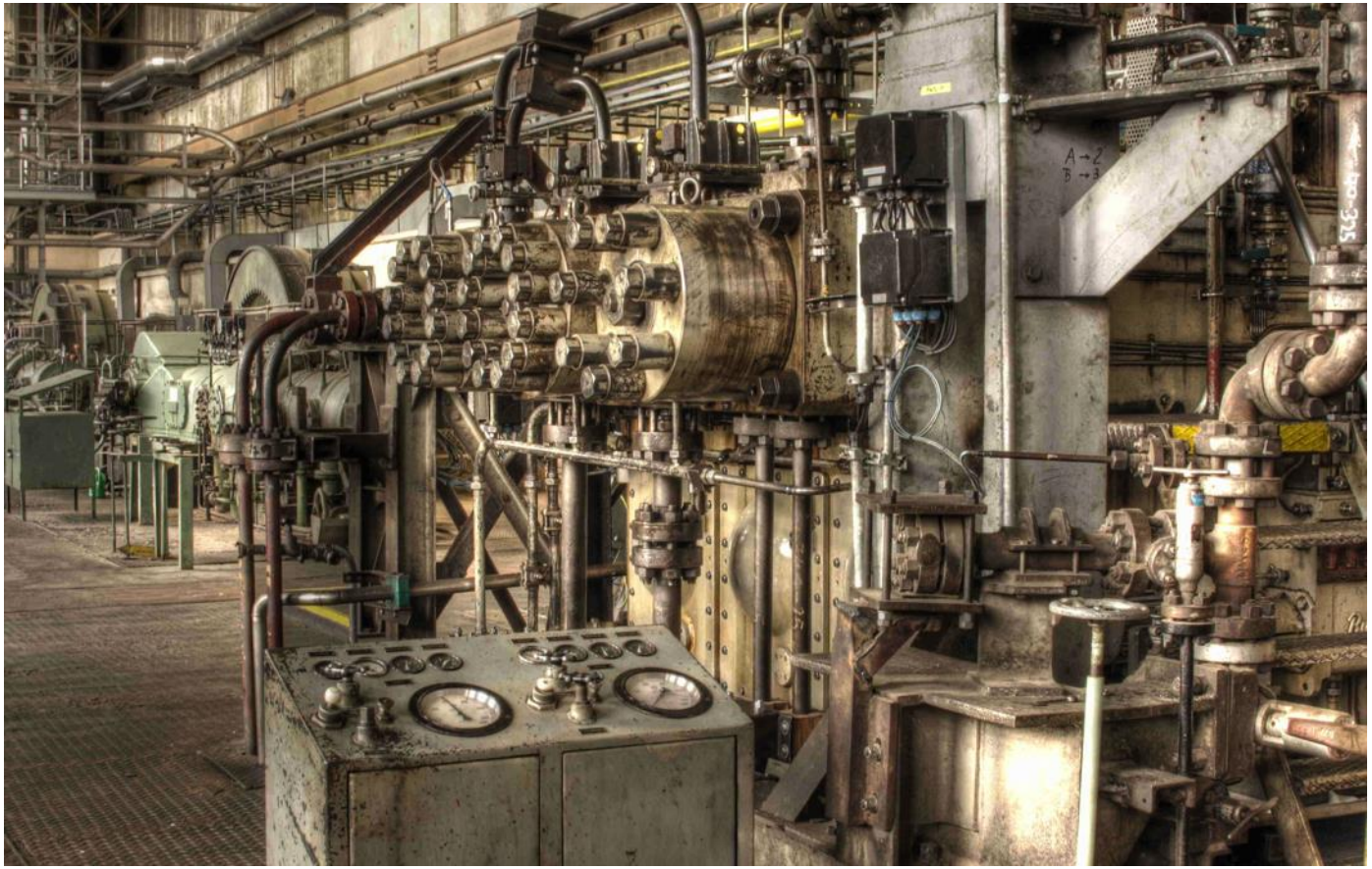
- Strong increase of vibration signals (red) of hydraulic control unit
- Broken control piston with damaged sealing surface was found.
- Easy identification and scheduled shutdown were possible prior to a major damage and unexpected shutdown.

Pressure Transmitter at Hydraulic Oil Pumps

Pressure Transmitter identify troubles with oil pumps.

Comparison of signals of 2 different pumps:





Many thanks for your attention!

mirko.graf@innospecinc.com