

Pipe inspection technology and removal of oil contamination for cryogenic plants

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Problem of oil contamination

Performance losses:

- Heat exchanger surface gets coated by oil → loses heat transfer capacity, heat transfer of HP and LP gets unbalanced

Damaged Turbines:

- Frozen oil vapor blocks turbine wheel → mechanical damages (broken blades)
- Bearings (axial & radial) get contaminated by oil through bearing or process gas → turbine operation properties change (start up delay)

Defect 80/20K adsorber:

- Activated charcoal adsorbs oil → Nitrogen/Hydrogen/Neon adsorption capacity reduces

Damaged sensors and clogged pipes and tubes:

- Pressure sensor tubing can be clogged or restricted by oil vapor → incorrect value reading from damaged sensors
- Cold and warm tubing (small sizes DN2-10) can be clogged or restricted by oil vapor → less gas flows through the tubing, especially for warm-up and turbine bearing gas tubing, + warm-up lines for cavities or other user interfaces

- Condensate drain/BEKOMAT (service kit, missing gaskets)
- Oil adsorber (incorrect filling quantity, loose fill)

High pressure compressor discharge temperature too high (viscosity)

Defect material (engineering and material changes of supplier), mostly not communicated to end user

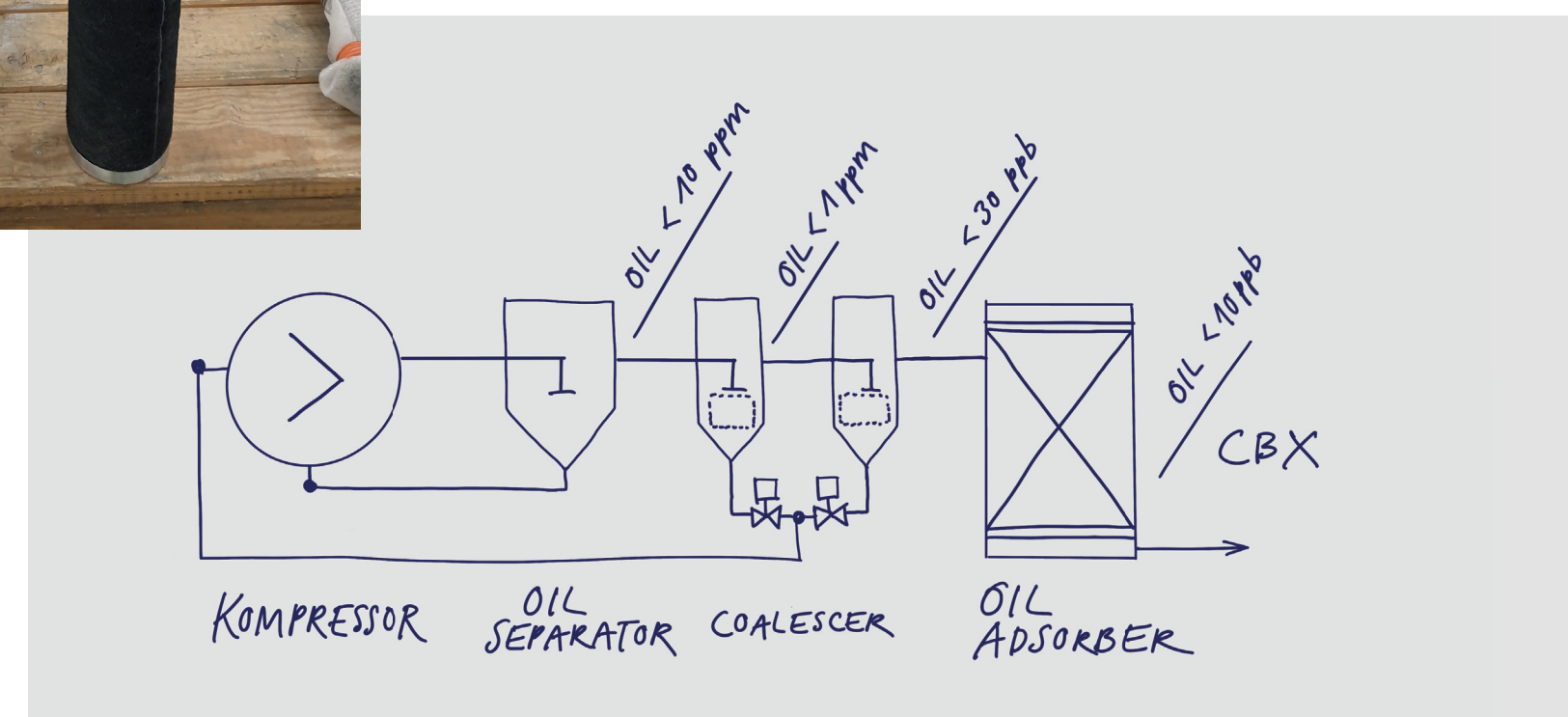
Too Low compressor discharge, $P < 9\text{ bara}$:

- Adsorber retention time too short
- Radial speed of gas thru coalescer filter element too fast



transported to final position, additional pump and purge thru LN2 cold trap is recommended

- Warm piping: compressor discharge, GMP, coldbox interfaces (bearing gas, warm up line) and buffer vessels should be checked and cleaned also, it can be helpful to use special pipe cleaning projectiles



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Common Oil sources

- Oil carry over from oil lubricated compressor and pumping systems, recycle, recovery, backup compressors
- Turbine oil bearings
- Backflow of vacuum pumps

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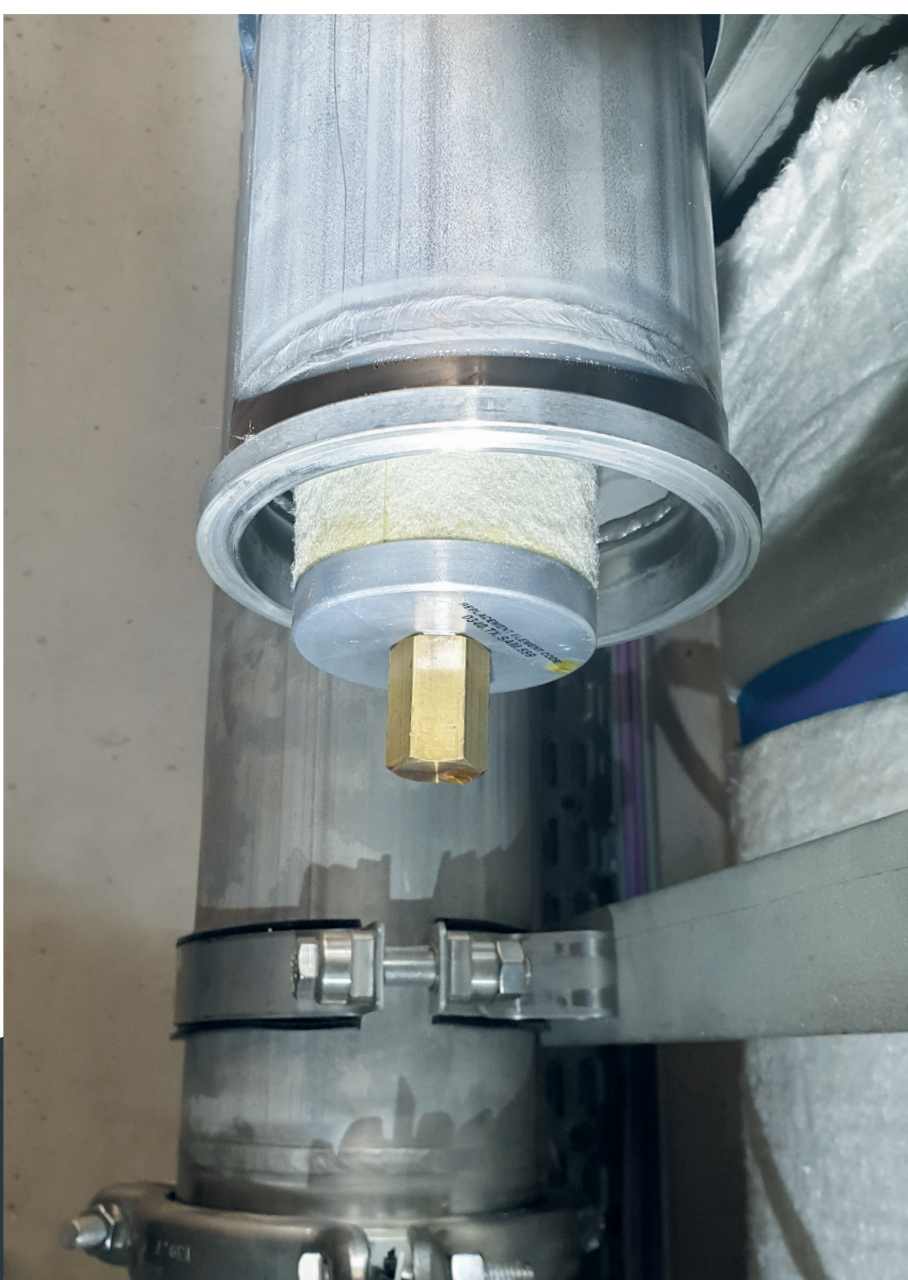
Oil contamination causes

Bypassed, missed or neglected maintenance intervals:

- Replacement of coalescer filter elements
- Oil separator filter element
- Screw compressor oil
- Activated charcoal

Incorrect (mistakes) mechanical service work for:

- Compressor (oil separator, other service components)
- Coalescer cartridges (bypass flow, missing gaskets)



Oil filter element wrongly installed, inclined, socket gas flow bypass

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Oil contamination detection

- Unexplainable performance losses
- Changed plant behavior, especially sequence of turbine start up, operating temperatures of first heat exchanger
- Gas analyzer: Pyrolyzer/MKD measurement
- Visual detection by checking of:
 - Oil adsorber outlet
 - Coalescer
 - Inner process components: valve seats, turbines, filters, buffer vessels, instrument tubes and other

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Oil contamination cleaning and repair

Heat exchanger and piping is cleaned mechanically with cleaning solvent

- Written procedure how to detect and clean the oil contaminated areas
- Cleaning procedure is carried out with an electrical grounded, air driven membrane pump (ATEX)
- Typically, two cleaning cycles (each 4-8 hours) with acetone or other cleaning solvents are sufficient for smaller plants, it is recommendable to take samples after the first run
- Heat exchangers and piping have to be dried with hot nitrogen for several days afterwards
- Re-welding of purging ports, reinstallation of temperature sensors, installation of super insulation
- Pressure and leak test
- After coldbox is reassembled and

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RAK Industrial consulting pipe inspection technology and removal of oil contamination for cryogenic plants service

- Performance of pipe inspections using endoscopy in cases of unexpected pressure loss or unusual plant behaviour
- Summary of the actual condition for the process room for documentation purposes
- Utilisation of state-of-the-art inspection technology
- Endoscopy of pipelines up to 50m including high-resolution photo or video recordings
- Inspection of component interiors, valves, filters, vessels, etc.
- Determination of the extent of oil contamination; preparation of a repair concept
- Performance of the pipe and component cleaning work utilising state-of-the-art technology

RAK Industrial Consulting

CRYOGENIC SERVICE & FIELD ENGINEERING

RAK troubleshooting / error diagnostics in cryogenic plants

Construction and Commissioning management

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