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OPAL Cold Neutron Source Maintenance, Reliability and Operational Status

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Outline

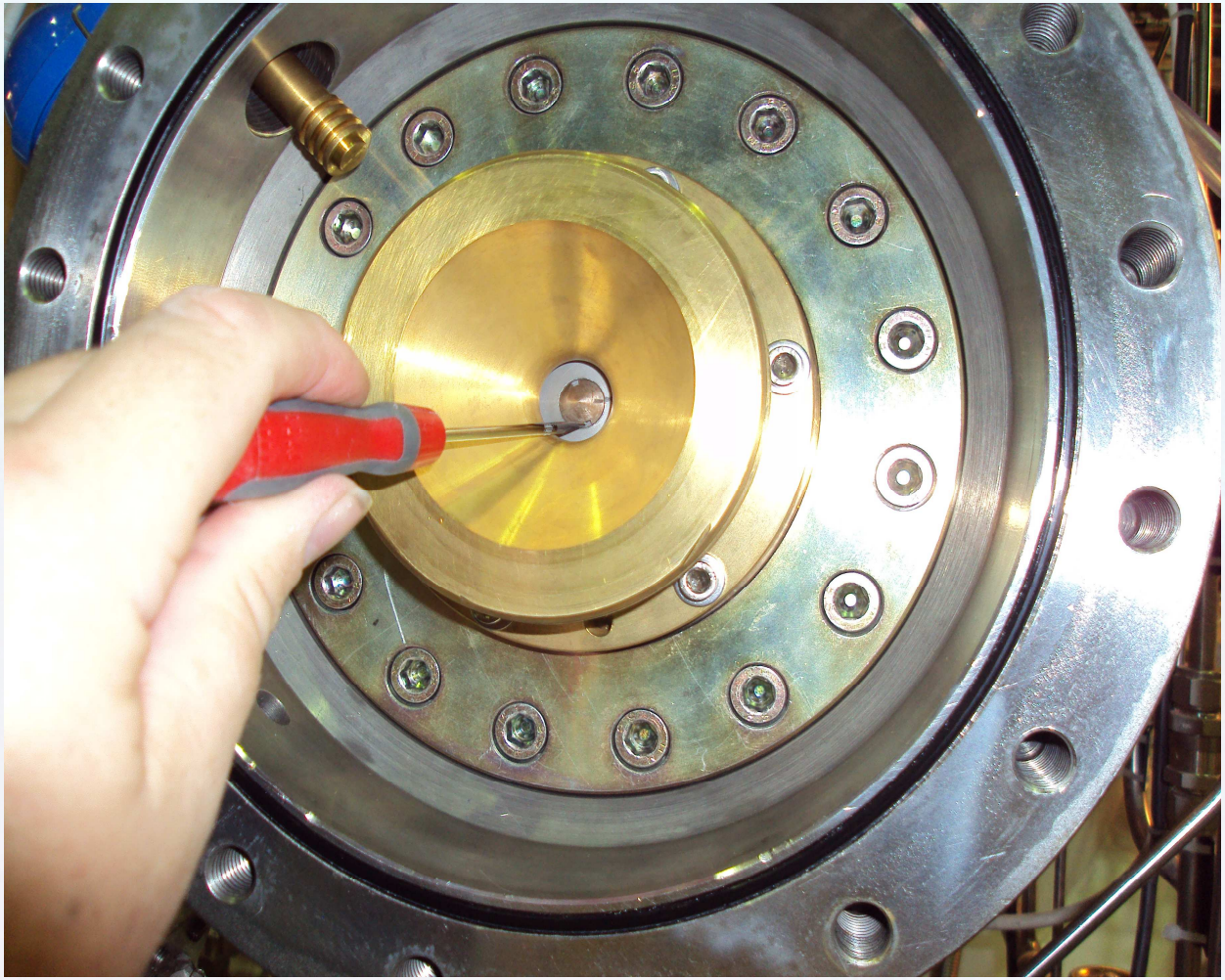
- Background
- Summary description of CNS
- Operational issues encountered
- **Event investigation**
- **Conclusions**

The message I want to relay to you is:

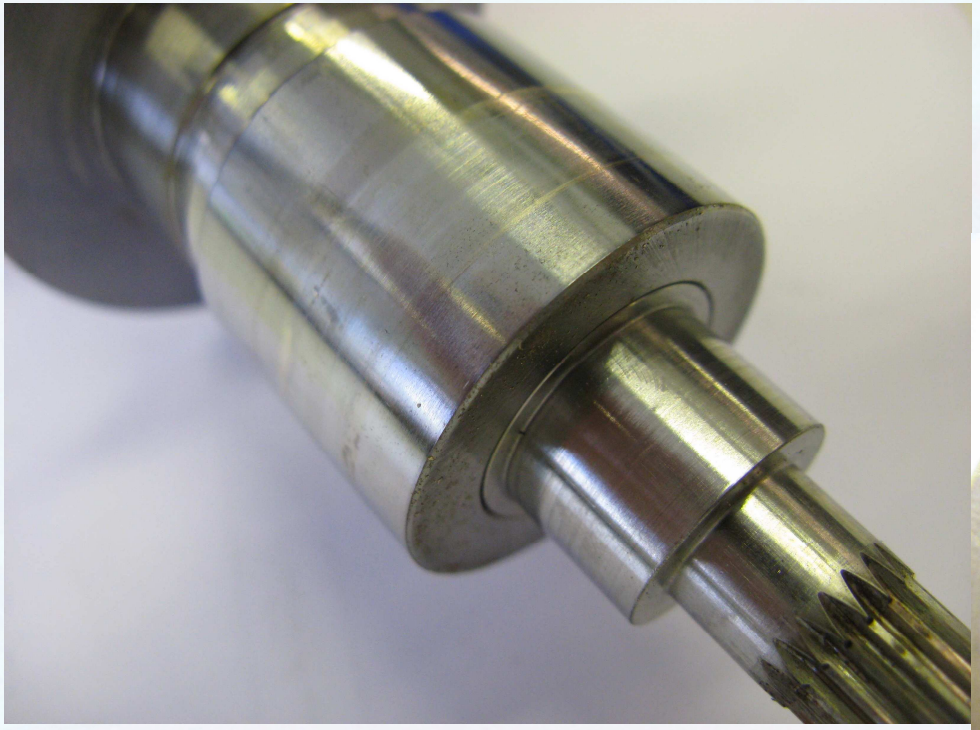
Reliable Turbine Operation is sensitive to Subtle Changes in Compressor Oil Chemistry

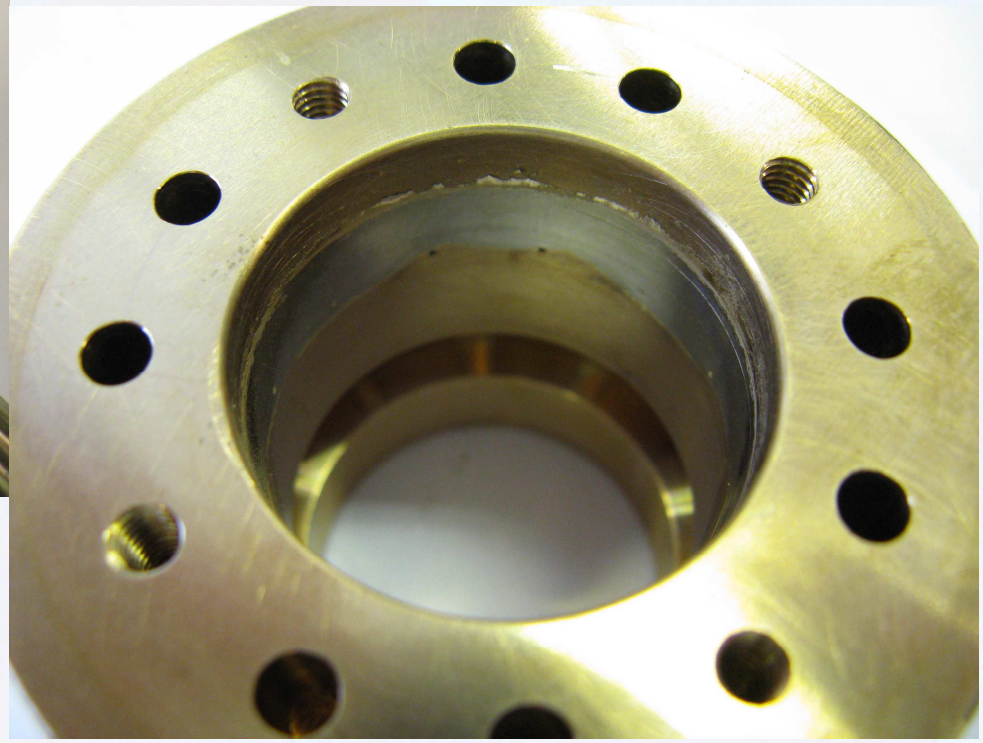
Cryogenic Turbine used at OPAL

Turbine Failure Event



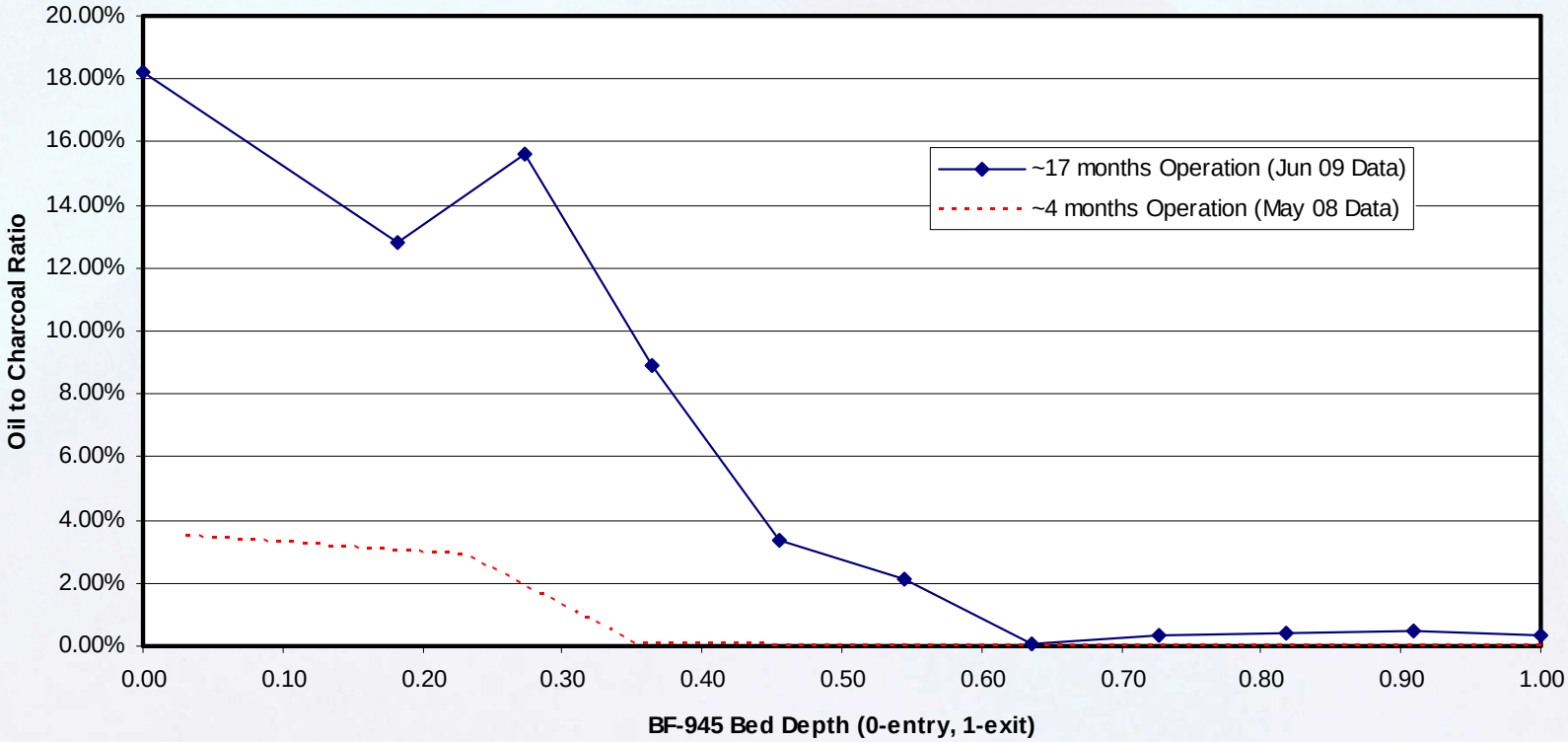
Observations (1)





Observations (2)

Bearing damage, No air or oil contamination.



Observations (3)

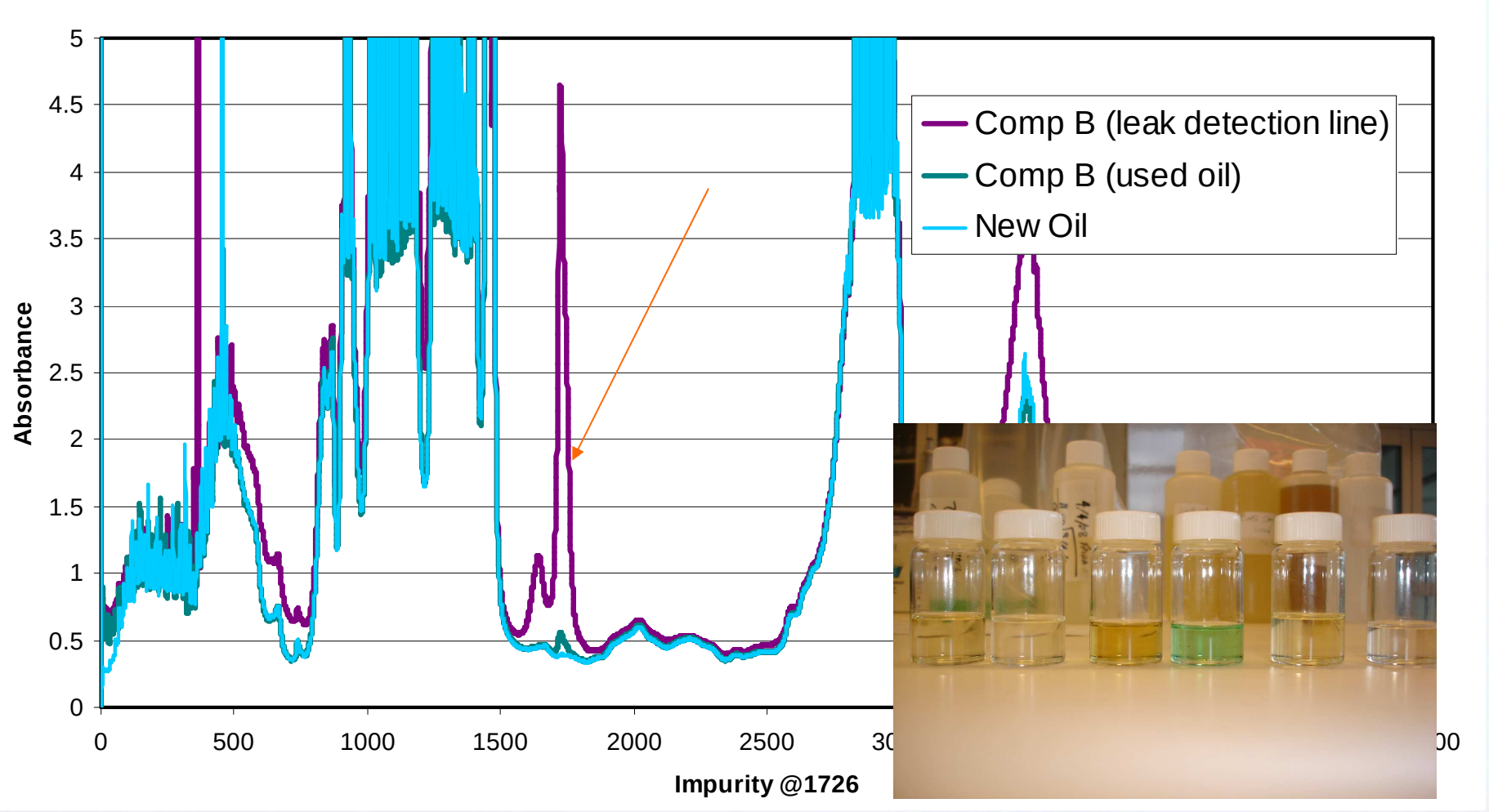
Summary of Event

1	09 June Compressor B overhauled	Oil quality good
2	10 June Helium purity checked	Air and water free
3	12 June Cold operation commenced	Normal cool down
4	19 June Turbine seized	Helium purity confirmed free of oil, water, air.

The Remaining Questions

- **What was this contamination?**
- **Why was this contamination not removed by cold operation?**

What Was This Contamination?



Analysis of our process gas (helium) has shown high levels of gas impurities at the same time the compressor failed.

Component	Concentration of Component
	(µmol/mol)
Hydrogen / Deuterium	133
Carbon Monoxide	67
Oxygen *	4
Nitrogen	10
Methane	32
Ethane *	0.44

These H_2, D_2 levels had not been seen before, even in previous events where the Breox B35 was reacted with oxygen

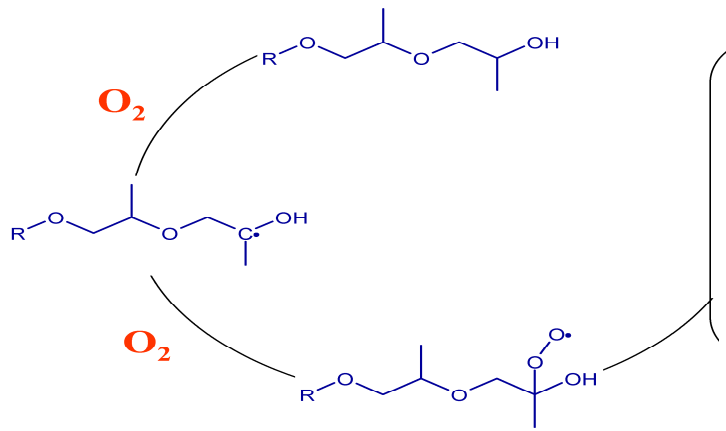
CO had not been seen before

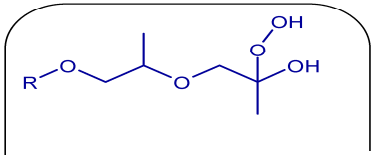
C1 and C2 not expected (assume it is an oil degradation product).

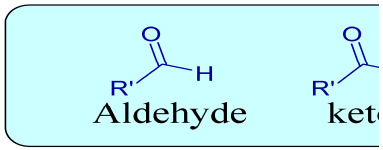
Later analysis, C3 and C4 also found at similar levels ~1ppm.

What Was This Contamination?

Oxidation mechanism

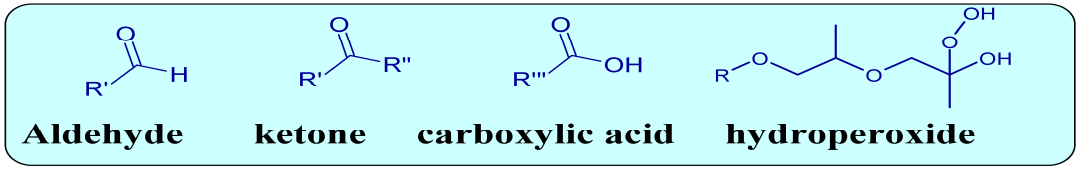






oxidation

Oxidation mechanism (2)



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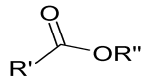
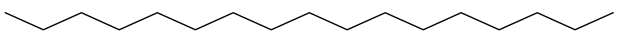
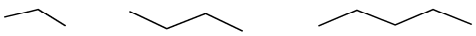


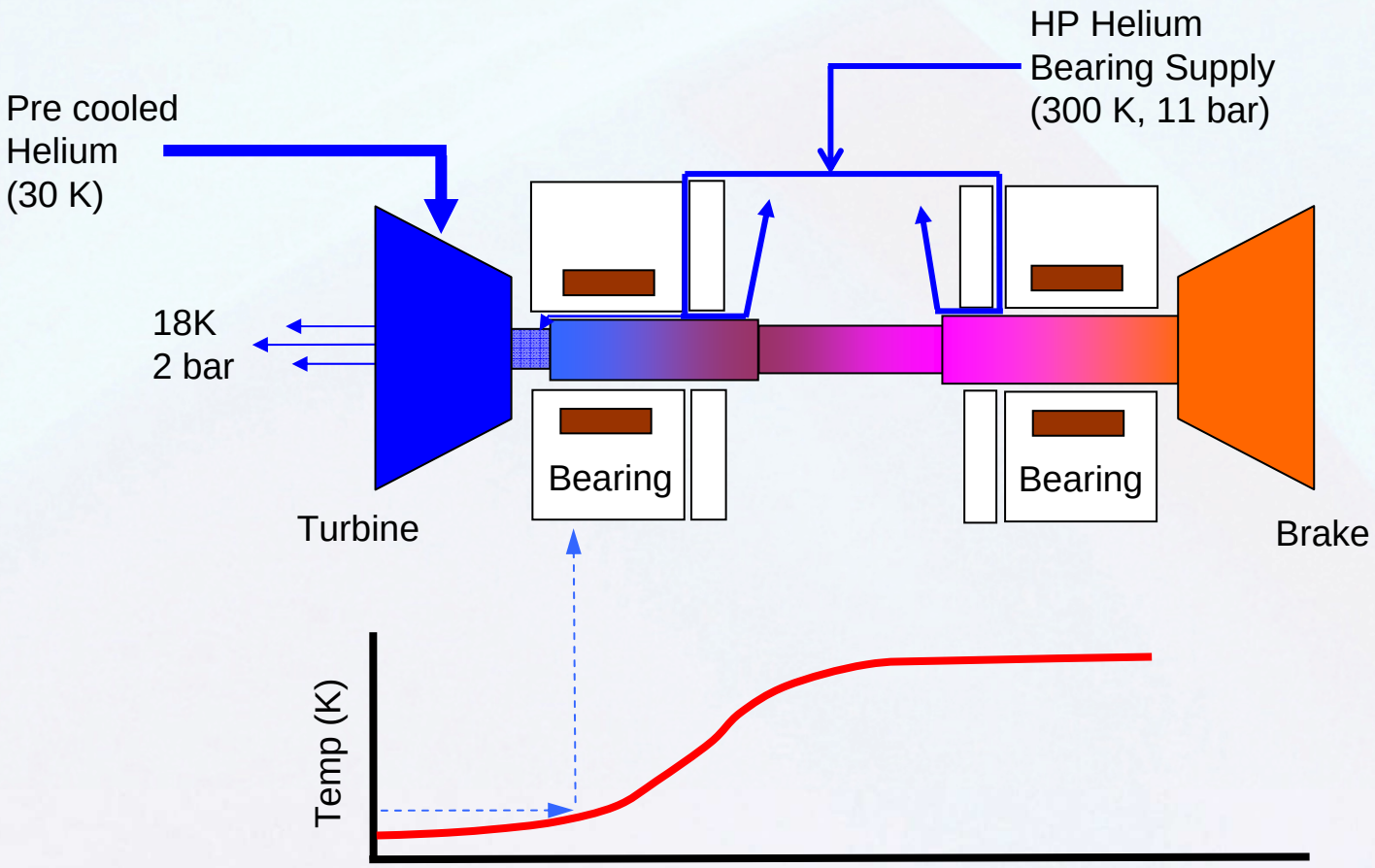
Longer chain polymer



Molecule breakdown



Turbine Failure During Cold Operation?



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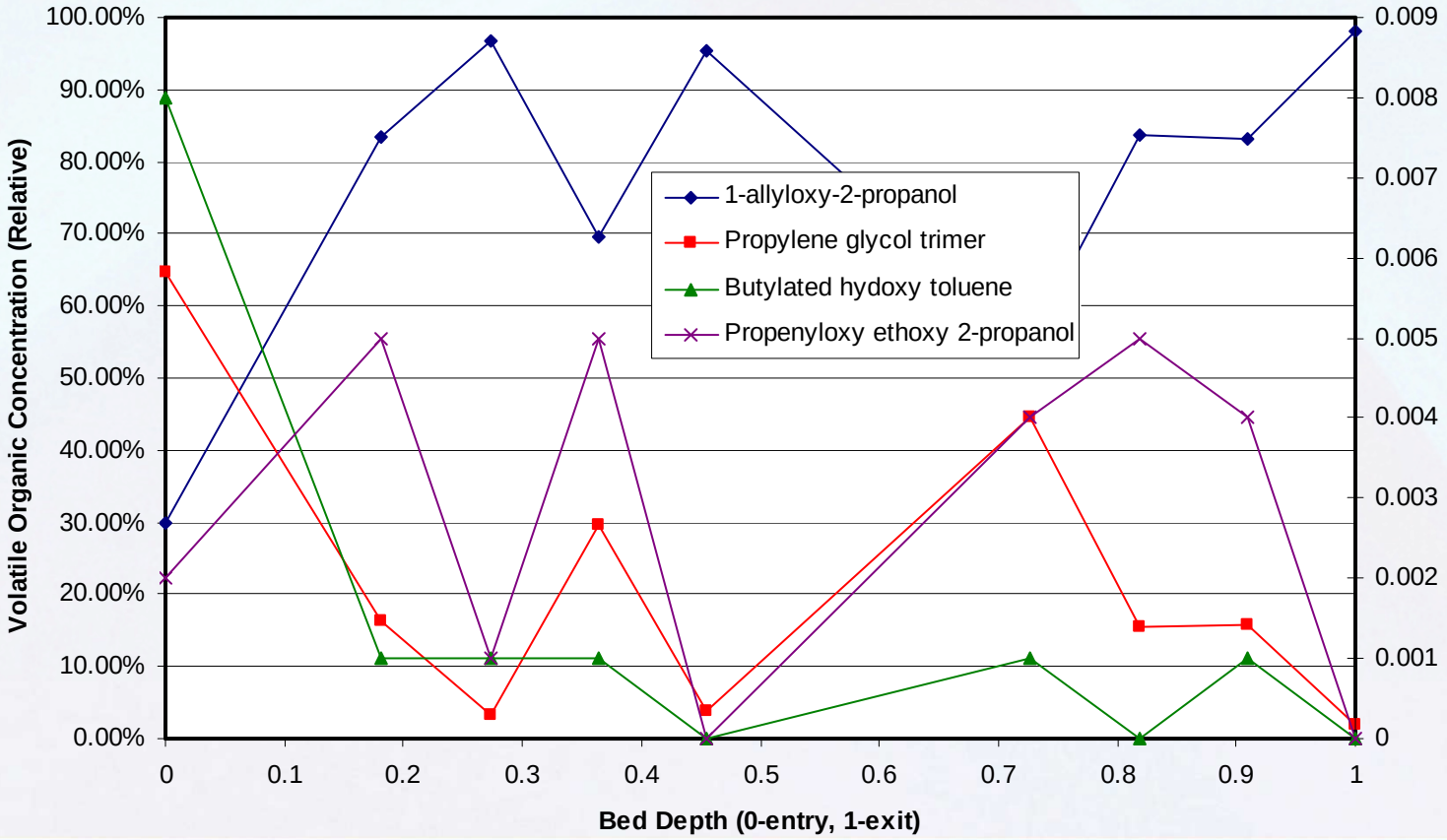

Lessons Learnt

- Turbine failure is possible during steady state cold operations
- The warm turbine bearing is vulnerable to condensate
- Monitoring of compressor oil chemistry is routine
- Charcoal adsorption bed life is determined by historical oil condition

I repeat again the message to you:

Reliable Turbine Operation is sensitive to Subtle Changes in Compressor Oil Chemistry


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