The Crude Reality of Oil

Mitchell Beggs – Graduate Mechanical Engineer

APEX 2016

What is Oil?

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- Crude oil is the most commonly traded commodity in the world.
- Crude oil accounts for 1/3rd of the worlds energy use.
- Crude oil is used for many different purposes across a wide range of industries.
- Critical component in hydro generation equipment

Oil in Hydro Systems

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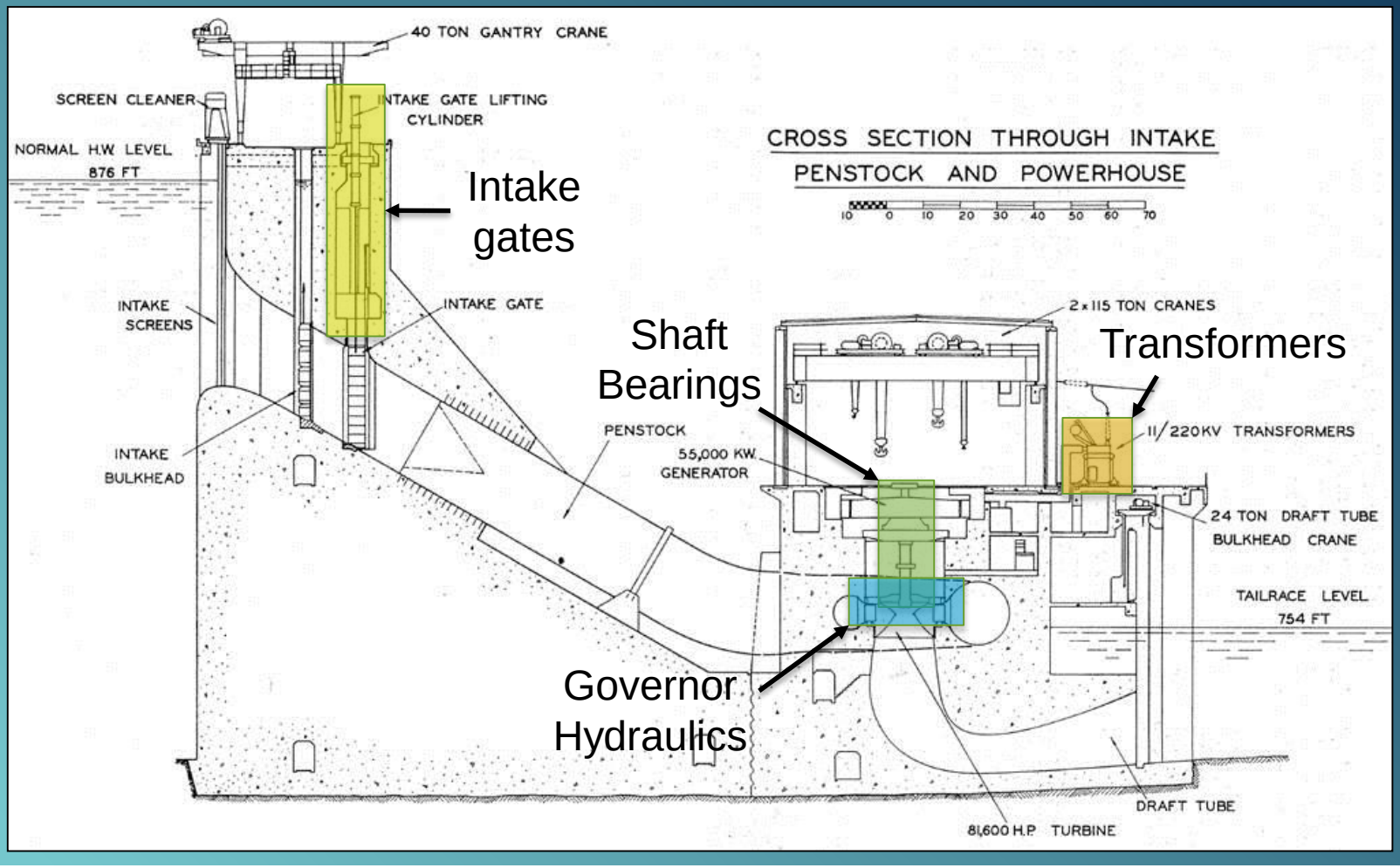

Oil in Hydro Systems - Governors

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- Used as a lubricant in hydraulic systems
- Used as a hydraulic fluid
- Viscosity of 68.1 cSt at 40 °C

Oil in Hydro Systems - Bearings

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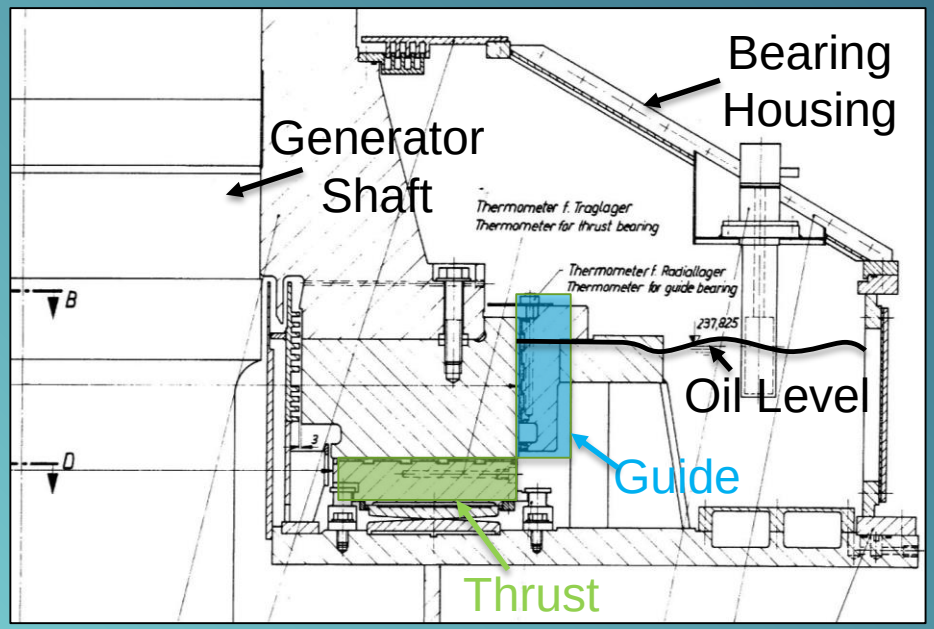
- Used as a lubricant in guide and thrust bearings
- Used as a coolant
- Viscosity of 68.1 cSt at 40 °C



Oil in Hydro Systems – Intake and Spill Gates

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- Used as a lubricant in hydraulic control system and gate hydraulic rams.
- Used as a hydraulic fluid.
- Environmentally friendly oil
- Viscosity of 48.8 cSt at 40 °C

Oil in Hydro Systems – Transformers

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- Used as an insulator
- Used as a coolant.
- Viscosity of 48.8 cSt at 40 °C

Promoting Good Oil Condition

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- Condition Monitoring
- Oil Filtration
- Purification
- Streamlining
- Oil Replacement
- Sump Design
- Breathers
- Oil Temperature

Promoting Good Oil Condition -Condition Monitoring

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ISO Particle Count

ISO 4406 Chart		
Range Code	Particles per milliliter	
	More than	Up to/including
24	80000	160000
23	40000	80000
22	20000	40000
21	10000	20000
20	5000	10000
19	2500	5000
18	1300	2500
17	640	1300
16	320	640
15	160	320
14	80	160
13	40	80
12	20	40
11	10	20
10	5	10
9	2.5	5
8	1.3	2.5
7	0.64	1.3
6	0.32	0.64

Element Testing

ELEMENT TESTS																								
Lab No	Eval	Cu	Fe	Cr	Pb	Al	Si	Na	Sn	Mo	Ni	Mg	Zn	Ca	P	B	Ba	Cd	Mn	Ag	Ti	V	K	iAN
G1312K0801	B	0	0	0	0	0	0	0	1	0	0	0	79	0	66	0	0	0	0	0	0	0	0	-
G1310K1002	A	4	3	0	0	0	0	0	0	0	0	0	11	0	113	0	0	0	0	0	0	0	0	-
G1309K0719	B	4	4	0	0	0	0	0	1	0	0	0	13	0	114	0	0	0	0	0	0	0	0	-
G1308K0702	B	4	4	0	0	0	0	0	0	0	0	0	14	0	122	0	0	0	0	0	0	0	0	-

DGA and Dielectric Testing

Certificate of Oil Sample Analysis — Page 1 of 1

Test Report No: 10322-17526/1
Client Name: Broadspectrum
Postal Address: PO Box 21, Clyde 9341
Client Contact: Bill Hayes
Client Ref/PO No: see below
*Comments are based on IEC 60599, IEEE C57, Roger's Ratios, Cigre Guideline and previous history

Transformer Name: Spare
Transformer Serial No. : 5BA219404
Current Location Code : OHB
Last Test Date: 28/Jul/2016
Next Test Date: 27/Jul/2017

For samples tested after May 2001 this Laboratory complies with the general requirements of ISO 17025 and ISO 9001. IANZ Accreditation Number 678

Oil Analysis:	Hydrogen ppm H_2	Oxygen ppm O_2	Nitrogen ppm N_2	Methane ppm CH_4	Carbon Mon. ppm CO	Carbon Dio. ppm CO_2	Ethylene ppm C_2H_4	Ethane ppm C_2H_6	Acetylene ppm C_2H_2	Total Comb. Gases (ppm)	Moisture ppm	Oil Temp °C	Di-Electric kV	Acidity mg KOH/g oil
COV	7.5	10	10	5	5	7.5	5	5	5	n/a	5	n/a	10	7.5
Acceptable Limits	50			50	1000	10000	100	100	15		<=30@60°C		>= 30	<= 0.15
Sample date/Laboratory No														
11/Oct/2010 50945	nt	nt	nt	nt	nt	nt	nt	nt	nt		9	28	89	0.12
	*Oil tests are within guidelines.*Recommend retest in 12 months to monitor.													
31/May/2011 54367	90	17,000	57,000	3	340	4,300	nd	nd	nd	433	6	14	91	0.13
	*DGA indicates steady operation compared to previous sample(s). But on-going hydrogen noted. Oil tests are within guidelines.													
13/Jul/2013 64336	100	14,000	52,000	4	320	4,200	nd	nd	nd	424	5	8	97	0.13
	DGA shows ongoing Hydrogen ie indicating partial discharges.*Oil tests are within guidelines.													

Promoting Good Oil Condition -Condition Monitoring

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Condition monitoring advantages

- Allows for predictive maintenance

Example: Much of Meridians governor oil is being replaced due to low Zinc (ZDDP) levels. During the oil changes the governor systems were inspected.

Promoting Good Oil Condition -Manapouri Transformer Failure

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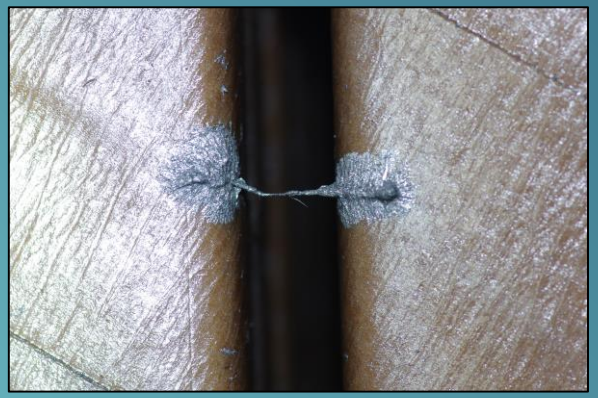
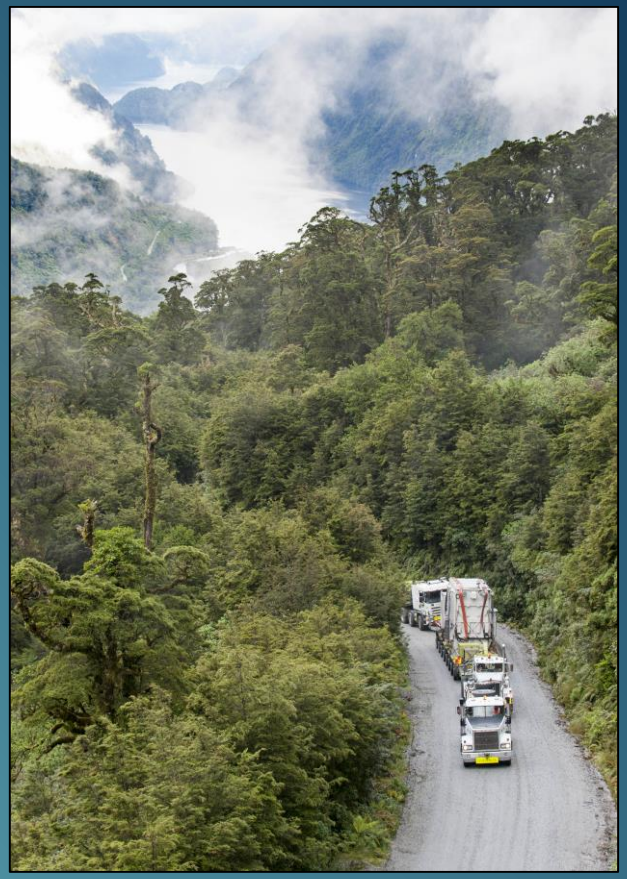
Transformer oil cooler fins were coming loose and entering the oil. No particle monitoring was in place so the Aluminium and Iron in the oil was not identified.





Promoting Good Oil Condition -Oil Treatment

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The Kidney Loop

- Filtration of oil while unit is in operation

Oil Purification

- Removes water from the oil

Oil Streamlining

- Removes contaminants from transformer oil

Promoting Good Oil Condition -Sump design

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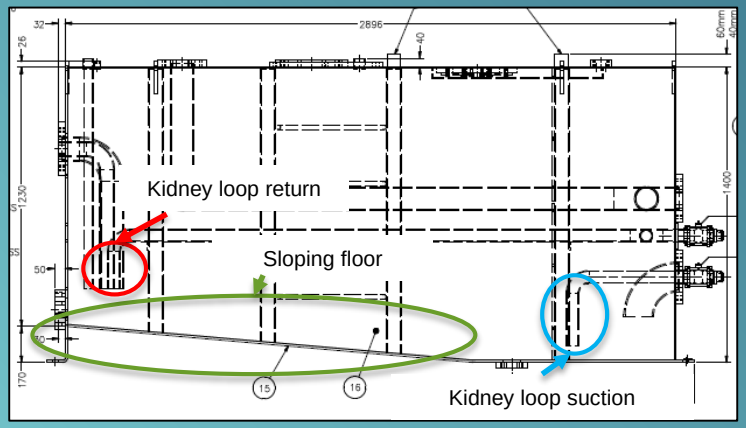
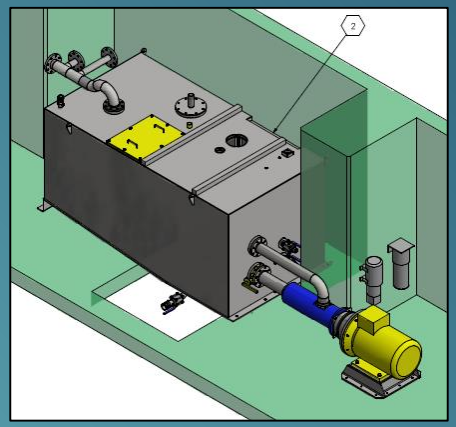
Tank Design Items to Consider:

- Oil flow
- Kidney loop suction and return
- Ease of access
- Tank breathers
- Oil temperature





Summary

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- Oil is critical to hydro plant operation.
- Oil has many different uses.
- Monitoring of oil condition allows early detection of failing equipment.
- Promoting good oil condition increases the life of both the oil and of generating equipment.

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Questions?