



Optimization of Metal-on-Metal Lubricants for CT Applications

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ICoTA Canada Roundtable

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Project Rational

- Cost efficiencies
 - Reduce reliance on water hammer tools
 - Optimize the amount of MFR pumped
- Formation Damage
 - Reduce the amount of chemical pumped
- Technical Competence
 - Lots of options
 - Every supplier claims their MFR is the best

Conventional FR Testing

- Field Trials
 - Every well is different.
 - Debris
 - Bottom Hole Temperature...
 - Water / Fluid varies
 - Cationic / Anionic
 - Biocide interactions
 - pH, TDS...

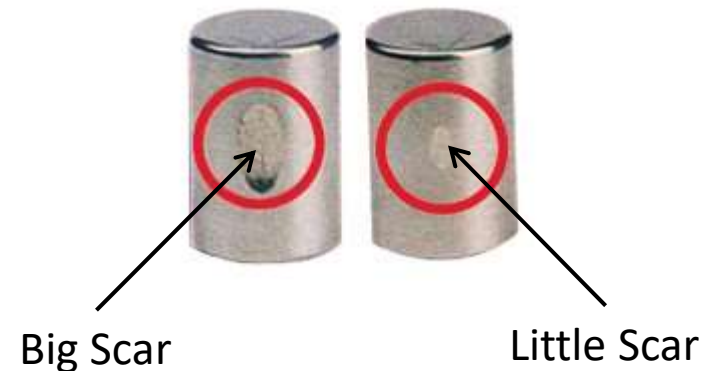


Most customers don't support science experiments at the field level...

Conventional FR Testing

Reichert Test

- Hardened steel disk is immersed in lubricant,
- Disk is rotated a predetermined number of revolutions while pressed against cylindrical specimen under constant 1 kg load.
- The temperature of the oil bath is monitored.
- The size of the wear patch is indicative of the quality of the lubricant.

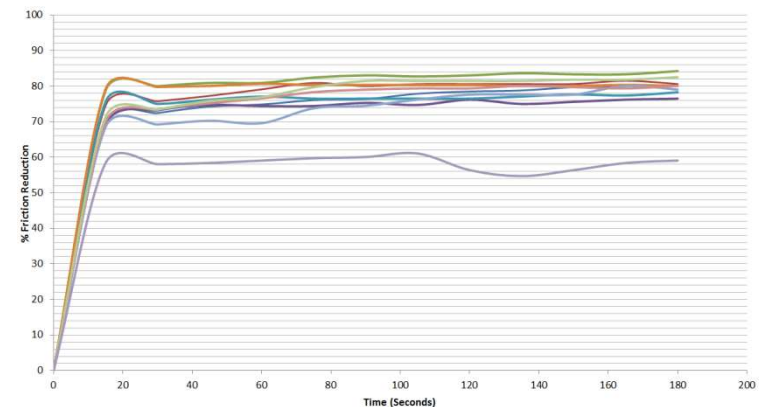


Not really relevant to CT applications...

Conventional FR Testing

OFITE EP Lubricity Test

- Hardened steel ring is immersed in lubricant,
- Ring is rotated at 1000 RPM while pressed against cylindrical block.
- The radial load on the test specimen is increased until the test stalls (5000 – 100000 psi).
- The load associated with the stall is indicative of the quality of the lubricant.



Not really relevant to CT applications...

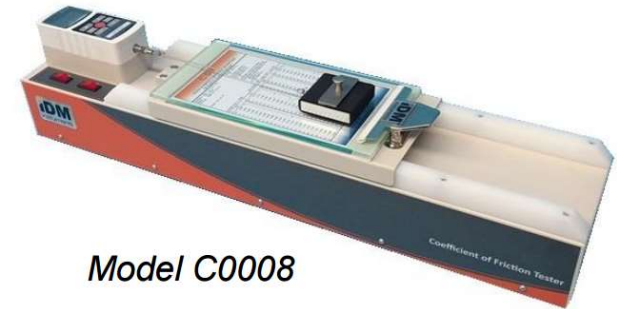


Design a Lab Scale MFR Test Representative of CT Operations

Brainstorming:

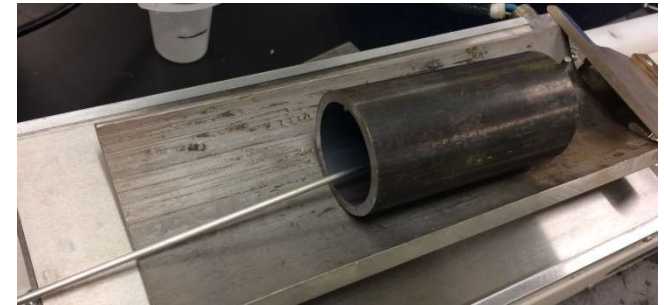


- Commercially available COF Testers



Model C0008

- Coiled Tubing in Casing

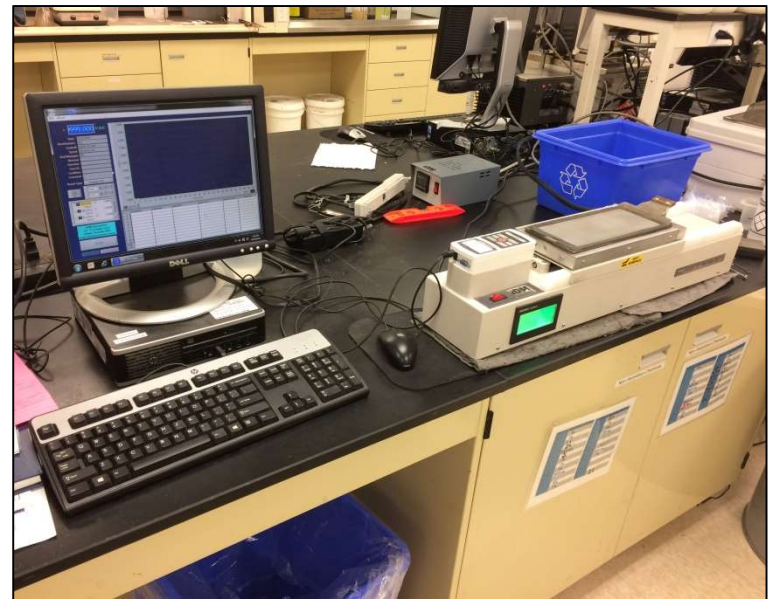


- Coiled Tubing Strip on Coiled Tubing Strip



Modified Dry COF Test Fixture

- Acquired and Modified COF Test Equipment
- Made Test Fixture
 - FLAT CT Strip used for stationary plate and sled
 - Built Dam to hold in fluid
 - Developed connection between sled and load cell



Test Plan

- Grit-blast the platen every test
- Baseline pass first then repeat with with MFR
 - Measure difference.
- Water First, API Brine, API Brine at Elevated Temperature

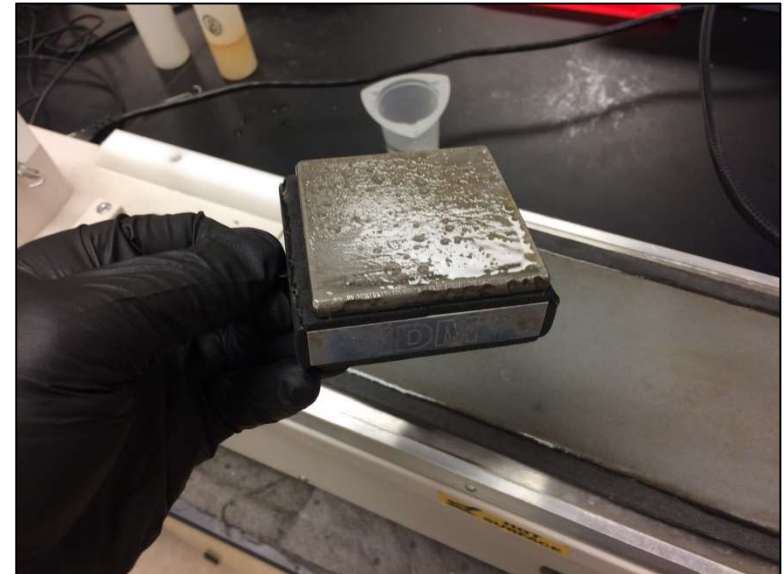
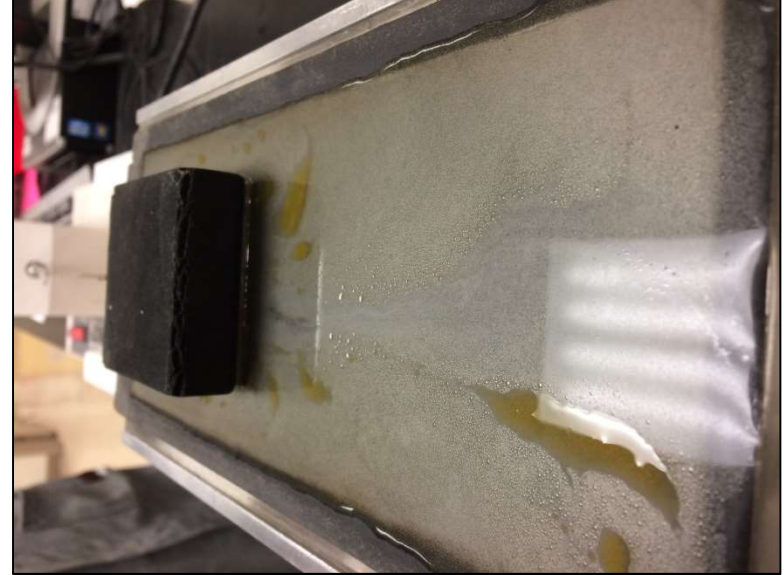
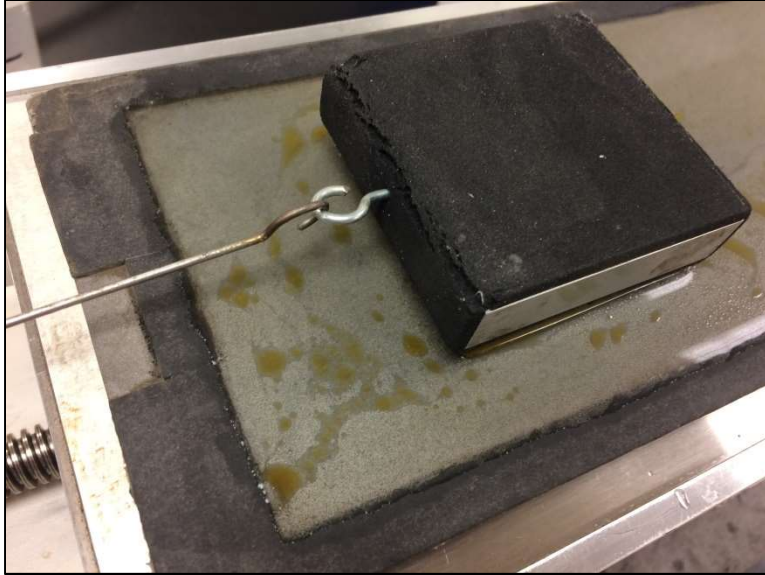


Video

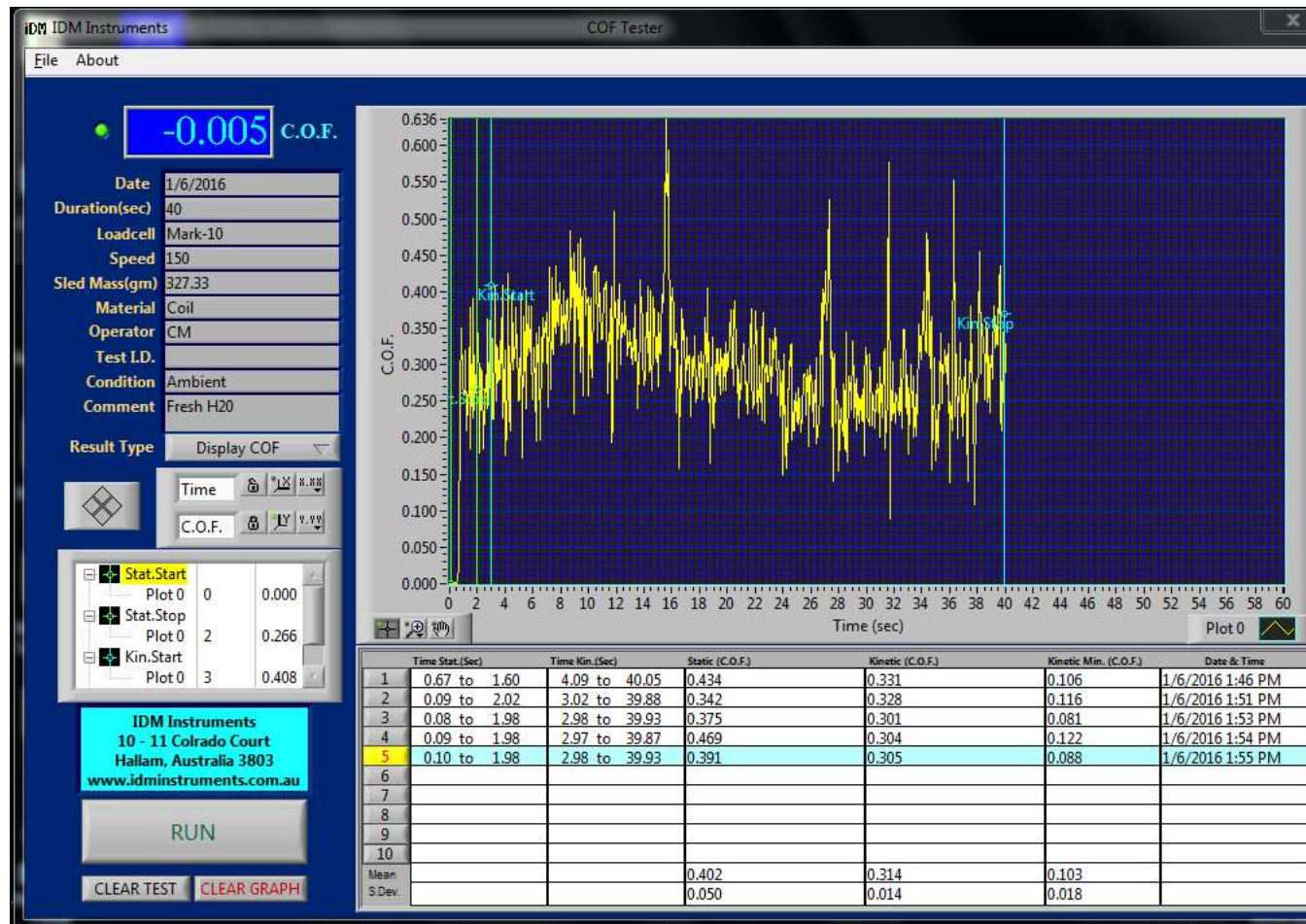


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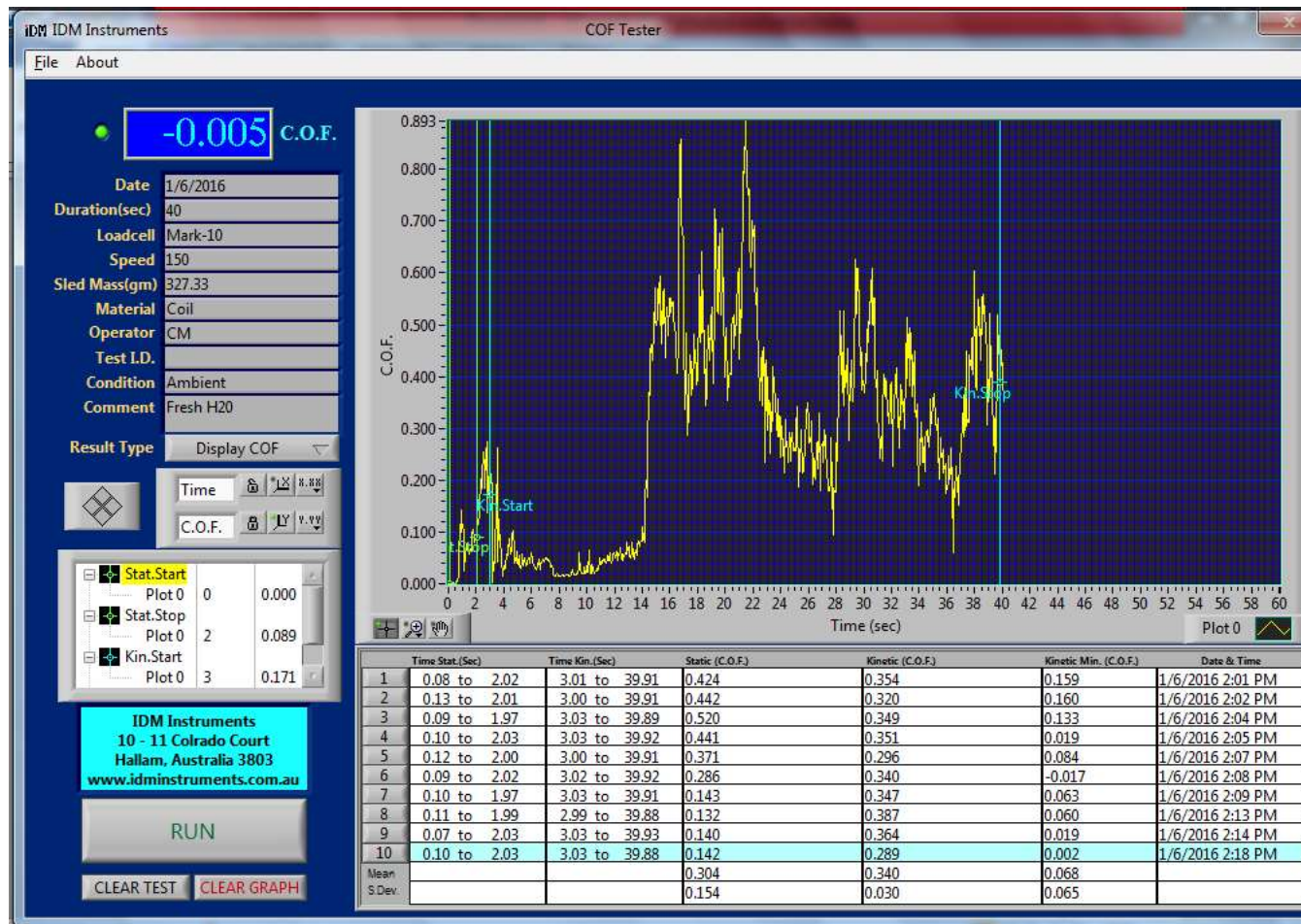
Photos of Dispersed MFR



Test Data - Baseline



Test Data – MFR-X



Subset of MFR Test Data

Average Water COF		0.256182									
MFR	MFR Loading (L/m ³)	Average Baseline COF Water	Measured COF MFR	Friction reduction %	Normalized COF by water baseline MFR	Dispersant	FR Loading (L/m ³)	Fluid Base	Temp (°C)	Notes:	
MFR - I	40	0.249	0.192	0.2289157	0.18661746	D-1	2	Fresh Water	20		
MFR - II	40	0.286	0.19	0.3356643	0.21211498	D-1	1	Fresh Water	20		
MFR - III	40	0.248	0.173	0.3024194	0.1674748	D-1	2	Fresh Water	20		
MFR - IV	40	0.237	0.181	0.2362869	0.16744748	D-1	2	Fresh Water	20	Stick - Slip observed. Last 4 samples were very good.	
MFR - V	40	0.265	0.173	0.3471698	0.17895493	D-1	2	Fresh Water	20	Smells Horrid.	
MFR - VI	40	0.238	0.166	0.302521	0.15421859	D-1	2	Fresh Water	20	Smells Horrid.	
MFR - VII	40	0.265	0.198	0.2528302	0.20481547	D-1	2	Fresh Water	20		
MFR - VIII	0	0.271	0.252	0.0701107	0.2665763	D-1	2	Fresh Water	20		
MFR - IX	40	0.273	0.207	0.2417582	0.22058943	D-1	2	Fresh Water	20		
MFR - X	5	0.243	0.258	-0.061728	0.24472463	none	0	Fresh Water	20		
MFR - XI	40	0.243	0.204	0.1604938	0.19350319	D-1	2	Fresh Water	20	Brown Residue plates out., Smells horrible	

Lessons Learned

- Need to look at average COF over length of test
- Dispersant – good but not too good
 - Must keep Lube in suspension inside coil
 - Must allow FR to plate out on casing and coil
- Need to normalize every test
- High Temp is a Challenge
- API Brine is Different than Water
- Test Plate warped due to sandblasting one side

Next Steps

- Field Trials
 - Will evaluate 4 best products based on lab testing.
 - Pad site with 4 ‘identical’ wells.
 - Confirmation runs so few variables are anticipated.
 - Customer buy in!





Acknowledgements

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ICoTA Canada