

Compatibility Study

Report:	2947324	Report Date:	8/10/2020
Sample number:		ATTN:	Jack Boilerman
Lubricants:	New Oil In-Service Oil	Company:	Great Lakes Generation
Analyst:	Muge Bilgin		20338 Progress Dr. Strongsville, OH 44149

Summary of Findings:

No visual sign of incompatibility was observed in Tier I test for 90:10 mixture of New Oil with In-Service Oil as defined by ASTM D7155-20.

The 50:50 and 10:90 mixtures of New Oil with In-Service Oil were observed to have developed a cloudy appearance as well as significant sediment both after heating and after incubation. These are considered failing results as per ASTM D7155-20.

Summary of Test Results for Tier I			
New Oil: In-Service Oil Mixtures	50:50	90:10	10:90
Visual Assessment after Heating	Fail	Pass	Fail
Visual Assessment after Incubation	Fail	Pass	Fail

Table 1 Summary of Tier I Results

Tier II test results for the 50:50, 90:10 and 10:90 mixtures were found to be acceptable as defined by ASTM D7155-20.
Tier III test results for the 50:50, 90:10 and 10:90 mixtures were found to be acceptable as defined by ASTM D7155-20.
Tier IV test results for the 50:50, 90:10 and 10:90 mixtures were found to be acceptable as defined by ASTM D7155-20.

Please note that laboratory tests are not a guarantee of field performance.

Summary of Test Results for Tier II, III and IV			
New Oil: In-Service Oil Mixtures	50:50	90:10	10:90
MPC	Pass	Pass	Pass
Demulsibility	Pass	Pass	Pass
Foam Sequence I	Pass	Pass	Pass
Viscosity at 40°C	Pass	Pass	Pass
Viscosity at 100°C	Pass	Pass	Pass
Viscosity Index	Pass	Pass	Pass
Acid Number	Pass	Pass	Pass
Phosphorus by ICP	Pass	Pass	Pass
Water Content	Pass	Pass	Pass
RPVOT	Pass	Pass	Pass
Rust	Pass	Pass	Pass
Copper Corrosion	Pass	Pass	Pass

Table 2 Results for Tier II, III, and IV

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Scope of Testing:

ASTM D7155-20 Tier I compatibility testing for 50:50, 90:10 and 10:90 mixtures of New Oil with In-Service Oil

ASTM D7155-20 Tier II compatibility testing to include: ASTM D7843 Membrane Patch Colorimetry (MPC), ASTM D1401 Demulsibility (Water Separability) and ASTM D892 Sequence I (Foaming Characteristics) for neat fluid samples and all mixtures.

ASTM D7155-20 Tier III compatibility testing to include: ASTM D445 Viscosity at 40°C and 100°C, ASTM D2270 Viscosity Index, ASTM D974 Acid Number, ASTM D5185 Additive Metals (ICP) and ASTM D6304 Water Content for neat fluid samples and all mixtures.

ASTM D7155-20 Tier IV compatibility testing to include: ASTM D2272 (RPVOT), ASTM D665 (Rust) and ASTM D130 (Copper Corrosion) for neat fluid samples and all mixtures.

Analysis:

Tier I:

50:50, 90:10 and 10:90 mixtures of New Oil with In-Service Oil were prepared in the laboratory. The prepared mixtures were placed in an oven along with samples of the original fluids and heated to 65°C for 72 hours. At the end of this time period the samples were visually evaluated for fluid clarity and sediment. The samples were then incubated at room temperature for an additional 72 hours. At the end of the incubation period, the samples were again visually evaluated for fluid clarity and sediment.

The 90:10 of New Oil with In-Service Oil mixture was observed to be free of sediment and to have an acceptable clarity rating after both heating and room temperature incubation.

The 50:50 and 10:90 of New Oil with In-Service Oil mixtures were observed to have developed a cloudy appearance as well as significant sediment both after heating and after incubation. These are considered failing results as per ASTM D7155-20.

After Heating:



Figure 1 samples after heating from left to right: New Oil, In-service Oil, 50:50 mixture

Observations After Heating				
50:50 mixture of New Oil with In-Service Oil				
Sediment rating after heating:				
0 No Sediment	1 Very Slight Sediment	2 Slight Sediment	3 Heavy Sediment	4 Appreciably More Sediment than 3
Clarity rating after heating:				
0 Absolutely Bright	1 Bright	2 Very Slight Cloud	2.5 Medium Moderate Cloud	
3 Moderate Cloud	4 Heavy Cloud	5 Detectable Floc	6 Heavy Floc	

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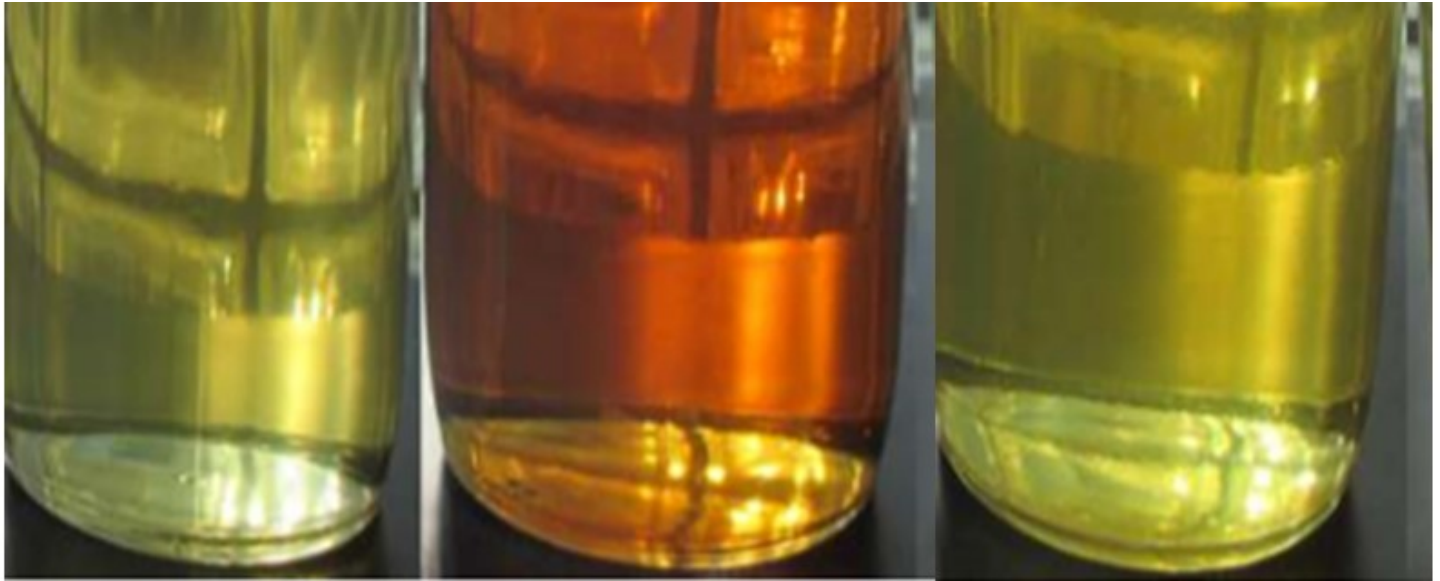


Figure 2 samples after heating from left to right: New Oil, In-service Oil, 90:10 mixture

90:10 mixture of New Oil with In-Service Oil				
Sediment rating after heating:				
0 No Sediment	1 Very Slight Sediment	2 Slight Sediment	3 Heavy Sediment	4 Appreciably More Sediment than 3
Clarity rating after heating:				
0 Absolutely Bright	1 Bright	2 Very Slight Cloud	2.5 Medium Moderate Cloud	
3 Moderate Cloud	4 Heavy Cloud	5 Detectable Floc	6 Heavy Floc	



Figure 3 samples after heating from left to right: New Oil, In-service Oil, 10:90 mixture

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10:90 mixture of New Oil with In-Service Oil				
Sediment rating after heating:				
0 No Sediment	1 Very Slight Sediment	2 Slight Sediment	3 Heavy Sediment	4 Appreciably More Sediment than 3
Clarity rating after heating:				
0 Absolutely Bright	1 Bright	2 Very Slight Cloud	2.5 Medium Moderate Cloud	
3 Moderate Cloud	4 Heavy Cloud	5 Detectable Floc	6 Heavy Floc	

After Incubation:



Figure 4 samples after incubation from left to right: New Oil, In-service Oil, 50:50 mixture

Observations After Incubation				
50:50 mixture of New Oil with In-Service Oil				
Sediment rating after incubation:				
0 No Sediment	1 Very Slight Sediment	2 Slight Sediment	3 Heavy Sediment	4 Appreciably More Sediment than 3
Clarity rating after incubation:				
0 Absolutely Bright	1 Bright	2 Very Slight Cloud	2.5 Medium Moderate Cloud	
3 Moderate Cloud	4 Heavy Cloud	5 Detectable Floc	6 Heavy Floc	

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Figure 5 samples after incubation from left to right: New Oil, In-service Oil, 90:10 mixture

90:10 mixture of New Oil with In-Service Oil				
Sediment rating after incubation:				
0 No Sediment	1 Very Slight Sediment	2 Slight Sediment	3 Heavy Sediment	4 Appreciably More Sediment than 3
Clarity rating after incubation:				
0 Absolutely Bright	1 Bright	2 Very Slight Cloud	2.5 Medium Moderate Cloud	
3 Moderate Cloud	4 Heavy Cloud	5 Detectable Floc	6 Heavy Floc	



Figure 6 samples after incubation from left to right: New Oil, In-service Oil, 10:90 mixture

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10:90 mixture of New Oil with In-Service Oil				
Sediment rating after incubation:				
0 No Sediment	1 Very Slight Sediment	2 Slight Sediment	3 Heavy Sediment	4 Appreciably More Sediment than 3
Clarity rating after incubation:				
0 Absolutely Bright	1 Bright	2 Very Slight Cloud	2.5 Medium Moderate Cloud	
3 Moderate Cloud	4 Heavy Cloud	5 Detectable Floc	6 Heavy Floc	

Tier II:

Requested Tier II tests conducted included membrane patch colorimetry, demulsibility, and foaming tendency. In order to be considered a passing result, test results for mixtures must either be equal to or better than the results of the two constituent oils or fall within the range of the two constituent oils \pm of the expected repeatability defined in the ASTM test methods.

Membrane Patch Colorimetry ASTM D 7843		
Sample	Result	Pass/Fail
New Oil	2	N/A
In-Service Oil	5	N/A
50:50	4	Pass
90:10	2	Pass
10:90	6	Pass

Demulsibility ASTM D1401		
Sample	Result (ml oil/ml water/ml emulsion(minutes))	Pass/Fail
New Oil	40/40/0 (10)	N/A
In-Service Oil	29/27/24 (60)*	N/A
50:50	39/39/2 (15)	Pass
90:10	40/39/1 (15)	Pass
10:90	30/30/20 (40)*	Pass

*Note: Although the 10:90 mixture did not achieve acceptable demulsibility results per ASTM D1401, the constituent In-service oil sample also did not achieve an acceptable result per ASTM D1401. Therefore, the mixture results are equal/better to the constituent oil results and is considered a passing compatibility result as per ASTM D7155-20.

Foam Sequence I ASTM D892		
Sample	Result (ml foam after blowing/ml foam after settling)	Pass/Fail
New Oil	10/0	N/A
In-Service Oil	260/0	N/A
50:50	50/0	Pass
90:10	20/0	Pass
10:90	130/0	Pass

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Tier III:

Requested Tier III tests conducted included viscosity at 40°C and 100°C, viscosity index, acid number, additive metals and water content. In order to be considered a passing result, test results for mixtures must fall within the range of the two constituent oils \pm of the expected repeatability as defined in the ASTM test methods.

Viscosity at 40°C ASTM D 445		
Sample	Result (cSt)	Pass/Fail
New Oil	31.5	N/A
In-Service Oil	31.3	N/A
50:50	31.4	Pass
90:10	31.5	Pass
10:90	31.4	Pass

Viscosity at 100°C ASTM D 445		
Sample	Result (cSt)	Pass/Fail
New Oil	5.4	N/A
In-Service Oil	5.3	N/A
50:50	5.3	Pass
90:10	5.4	Pass
10:90	5.3	Pass

Viscosity Index ASTM D2270		
Sample	Result	Pass/Fail
New Oil	105	N/A
In-Service Oil	101	N/A
50:50	100	Pass
90:10	105	Pass
10:90	100	Pass

Acid Number ASTM D974		
Sample	Result (mg KOH/g)	Pass/Fail
New Oil	0.04	N/A
In-Service Oil	0.10	N/A
50:50	0.07	Pass
90:10	0.04	Pass
10:90	0.08	Pass

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Phosphorus by ICP ASTM D5185		
Sample	Result (ppm)	Pass/Fail
New Oil	-	N/A
In-Service Oil	20	N/A
50:50	16	Pass
90:10	-	Pass
10:90	18	Pass

Water Content ASTM D6304		
Sample	Result (%)	Pass/Fail
New Oil	0.0036	N/A
In-Service Oil	0.0028	N/A
50:50	0.0020	Pass
90:10	0.0013	Pass
10:90	0.0011	Pass

Tier IV:

Requested Tier IV tests conducted included RPVOT, Rust and Copper Corrosion (CC). In order to be considered a passing result for RPVOT, test results for mixtures must either be equal or better than the results of the two constituent oils. The mixture is considered compatible if the Rust and CC tests are a pass.

Rotating Pressure Vessel Oxidation ASTM D2272		
Sample	Result (min)	Pass/Fail
New Oil	1235	N/A
In-Service Oil	1151	N/A
50:50	1250	Pass
90:10	1336	Pass
10:90	1236	Pass

Rust ASTM D665		
Sample	Result (Pass/Fail)	Pass/Fail
New Oil	Pass	N/A
In-Service Oil	Pass	N/A
50:50	Pass	Pass
80:20	Pass	Pass
90:10	Pass	Pass
10:90	Pass	Pass

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Copper Corrosion ASTM D130		
Sample	Result (Pass/Fail)	Pass/Fail
New Oil	1A	N/A
In-Service Oil	1A	N/A
50:50	1A	Pass
80:20	1A	Pass
90:10	1A	Pass
10:90	1A	Pass

Questions:

Analysis completed by Muge Bilgin. For questions please e-mail mbilgin@testoil.com.

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