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Correlation of ISM to M11HST for use in API CH-4

ASTM HDEO Classification Panel

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Test Comparison

| | M11 HST | ISM |
|------------------------------|--|---|
| % Soot | 5.0% | 6.5% |
| EGR | No | Yes |
| Oil Filter Media | Microglass media Remay polyester and nylon overlay | Stratapore polyester media Remay polyester overlay |
| OFDP Hours | 200 | 150 |
| Bypass in Oil Filter Head | Open | Blocked |



TMC 1004 Test Comparison

| | M11 HST | | ISM | |
|--------------|----------|------------|----------|----------------|
| | TMC 1004 | CH-4 Limit | TMC 1004 | Proposed Limit |
| Xhd Wt. Loss | 20.5 mgs | 6.5 mgs | 8.6 mgs | 7.5 mgs |
| OFDP | 83 kPa | 79 kPa | 56 kPa | 79 kPa |
| Sludge | 8.75 | 8.7 | 8.97 | 8.1 |
| n size | 4 | | 3 | |

-  OFDP performance changes from borderline fail to solid pass
 -  2 of 3 ISM results less than half of pass limit (24, 35, 110)
-  Sludge performance changes from borderline pass to solid pass



Oil A Test Comparison

| | M11 HST | | ISM | |
|--------------|---------|------------|---------|----------------|
| | Oil A | CH-4 Limit | Oil A | Proposed Limit |
| Xhd Wt. Loss | 6.5 mgs | 6.5 mgs | 5.8 mgs | 7.5 mgs |
| OFDP | 42 kPa | 79 kPa | 265 kPa | 79 kPa |
| Sludge | 8.8 | 8.7 | 8.2 | 8.1 |

- OFDP performance changes from solid pass to very high fail
- Other parameters compare favorably to limits



TMC 1005 Test Comparison

TMC 1005 is M11 HST Reference Oil

| | M11 HST | | ISM | |
|--------------|-----------------|------------|------------------------------------|----------------|
| | TMC 1005 | CH-4 Limit | TMC 1005 | Proposed Limit |
| Xhd Wt. Loss | 4.53 mgs | 6.5 mgs | 6.7* mgs | 7.5 mgs |
| OFDP | 122 kPa | 79 kPa | 123 kPa | 79 kPa |
| Sludge | 8.4 | 8.7 | 8.9 | 8.1 |
| | Ref Oil Targets | | * After Industry Correction Factor | |

-  OFDP performance is similar in ISM and M11 HST
-  Sludge performance changes from a solid fail to a solid pass



Qualitative Summary

| | 1004 | | | Oil A | | | 1005 | |
|-----------------|-----------------|------------|--|-----------------|-----------------|--|-------------|------------|
| | HST | ISM | | HST | ISM | | HST | ISM |
| Xhd Wear | Solid Fail | Fail | | Borderline Pass | Pass | | Solid Pass | Solid Pass |
| OFDP | Borderline Fail | Solid Pass | | Solid Pass | Solid Fail | | Solid Fail | Solid Fail |
| Sludge | Borderline Pass | Solid Pass | | Borderline Pass | Borderline Pass | | Solid Fail | Solid Pass |



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Summary

- ▲ As agreed, Afton has run an ISM test on TMC 1005 (M11 HST reference oil) to generate data from a 3rd oil
 - ▲ All data to be used by the Surveillance Panel to either generate appropriate targets (if they exist) or deem the tests (or specific parameters) non-comparable
 - ▲ If the proposed limits are correct, TMC 1005 should have clearly failing OFDP, clearly passing Xhd wear, and failing sludge.
 - Above criteria were met with one exception; passing sludge was generated.
- ▲ The data suggests that these three oils perform differently in the ISM versus the M11HST. Engine design and soot level may account for the oil performance differences between these tests.
- ▲ While Afton is hesitant to endorse the proposed ISM limits, we will abstain with comment on the proposed CH-4 limits ballot.