

Shear Stability and the Relationship to Heavy Duty Engine Lubricants

ASTM HDEOCP
June 19, 2001

For ASTM D02.B0.02 Heavy Duty
Engine Oil Classification Panel Use Only

Issues Considered

- **Temporary shear loss (reversible):HTHS viscosity**
 - Relationship of HTHS viscosity to wear
 - Fresh versus used HTHS viscosity
- **Permanent shear stability**
 - Mechanisms of shearing
 - Measurement techniques
 - » Real world
 - » Engine tests
 - » Bench tests
 - **Issue: Bosch Injector (Kurt Orbahn) does not correlate with heavy duty field use when comparing different polymer chemistries**

Temporary Shear Stability: HTHS Viscosity



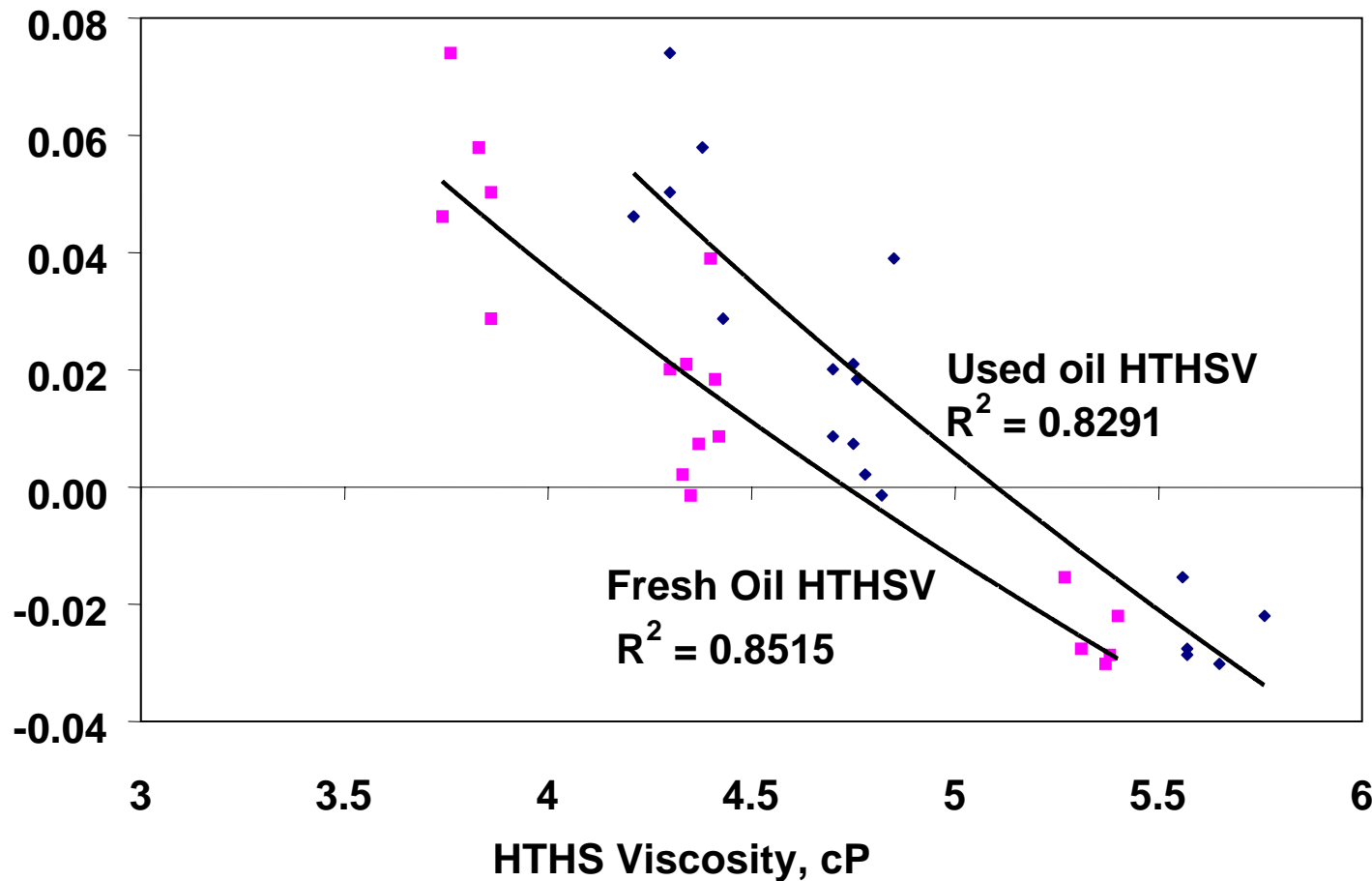
- **HTHS viscosity relates to oil film thickness in high shear conditions**
 - Bearing film thickness and wear
 - Liner wear
 - Engine tests do not represent full range of potential conditions which could be encountered in the field
- **Fresh oil HTHS viscosity and used oil HTHS viscosity give similar relationship to wear**
- **With permanent shearing, both Kv and HTHS viscosity decrease**



Relationship of HTHS viscosity to Cylinder Liner Wear



Relative Liner Wear Rate, $\mu\text{m/h}$



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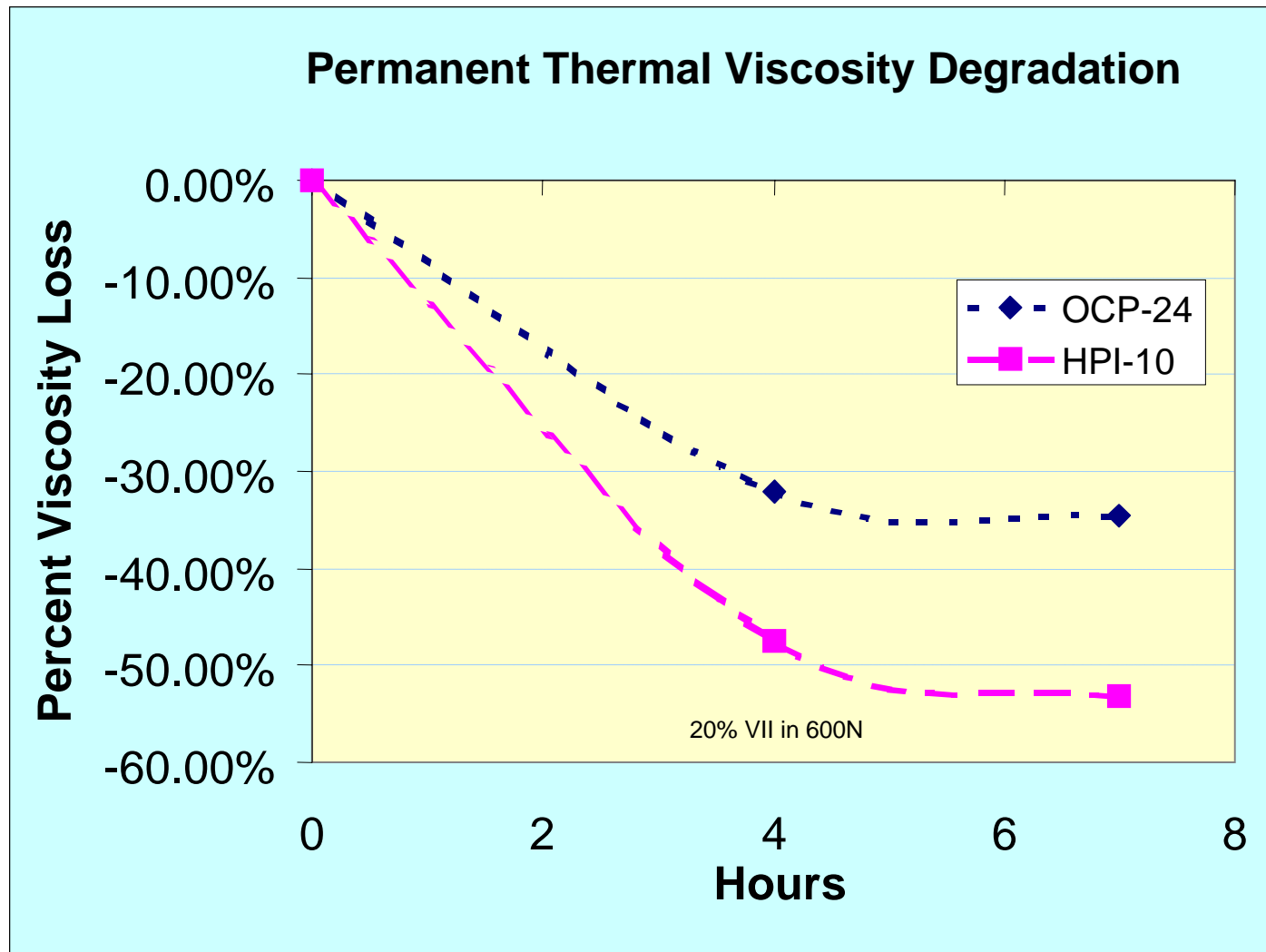
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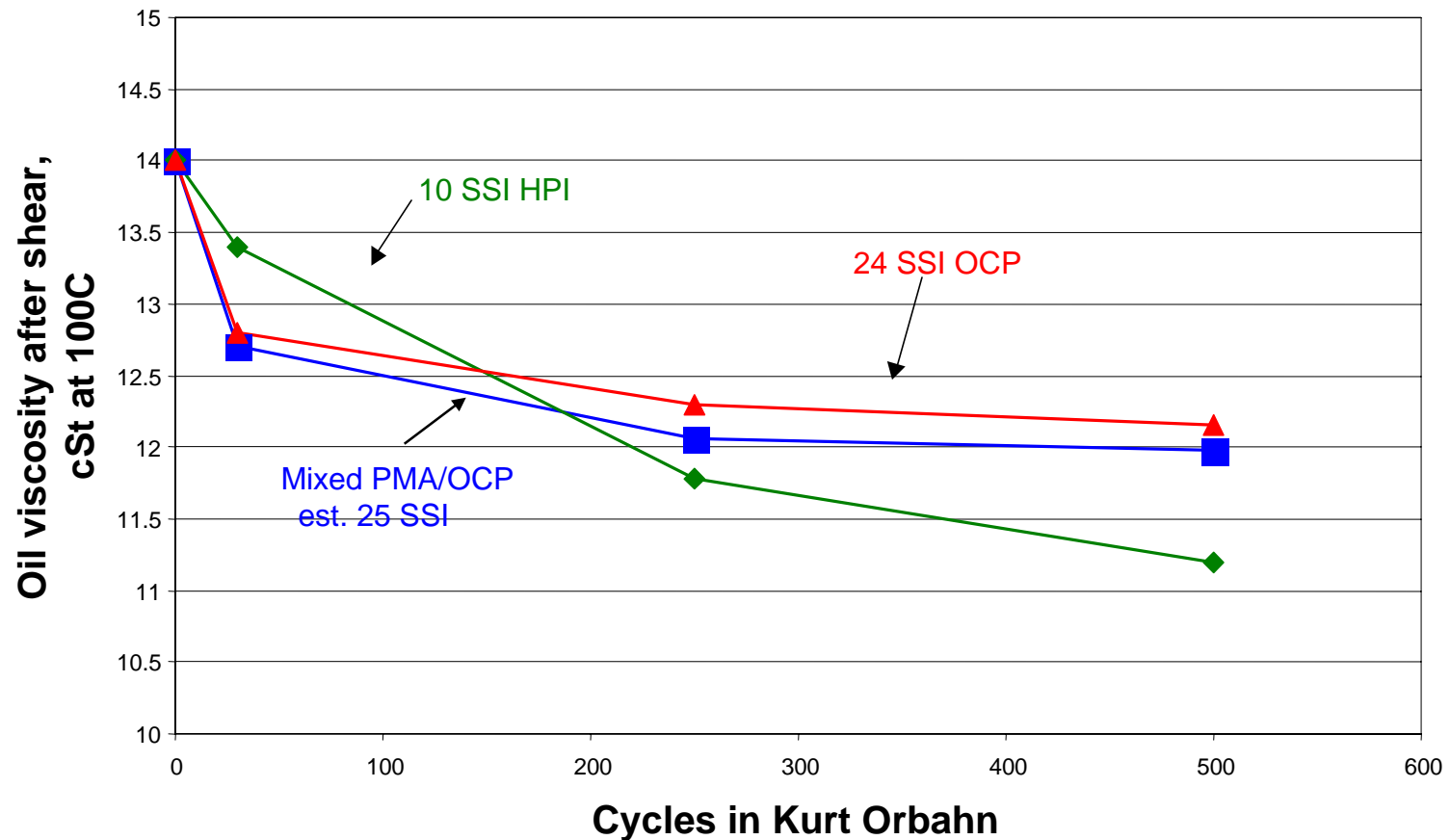
Permanent Shear Stability

- **Kurt Orbahn (Bosch Injector):**
 - **Basis of 'Permanent Shear Stability Index' (SSI)**
 - **Designed to correlate to European passenger car application**
 - » short drain
 - » no or very little oxidative, nitration, acidic contamination impact
 - **Mechanical shearing only**
 - **Data show it does not correlate to HD diesel field service**
 - **Even within KO test, different test lengths can change conclusions**
- **Field data from multiple tests indicates:**
 - **Kurt Orbahn will rank oils differently than the field**
 - » OK within a VII chemistry but not across chemistries
 - **Degree of protection assumed from KO test may be less than in the real world**

VII Thermal Shearing



Viscosity loss after extended Kurt Orbahn

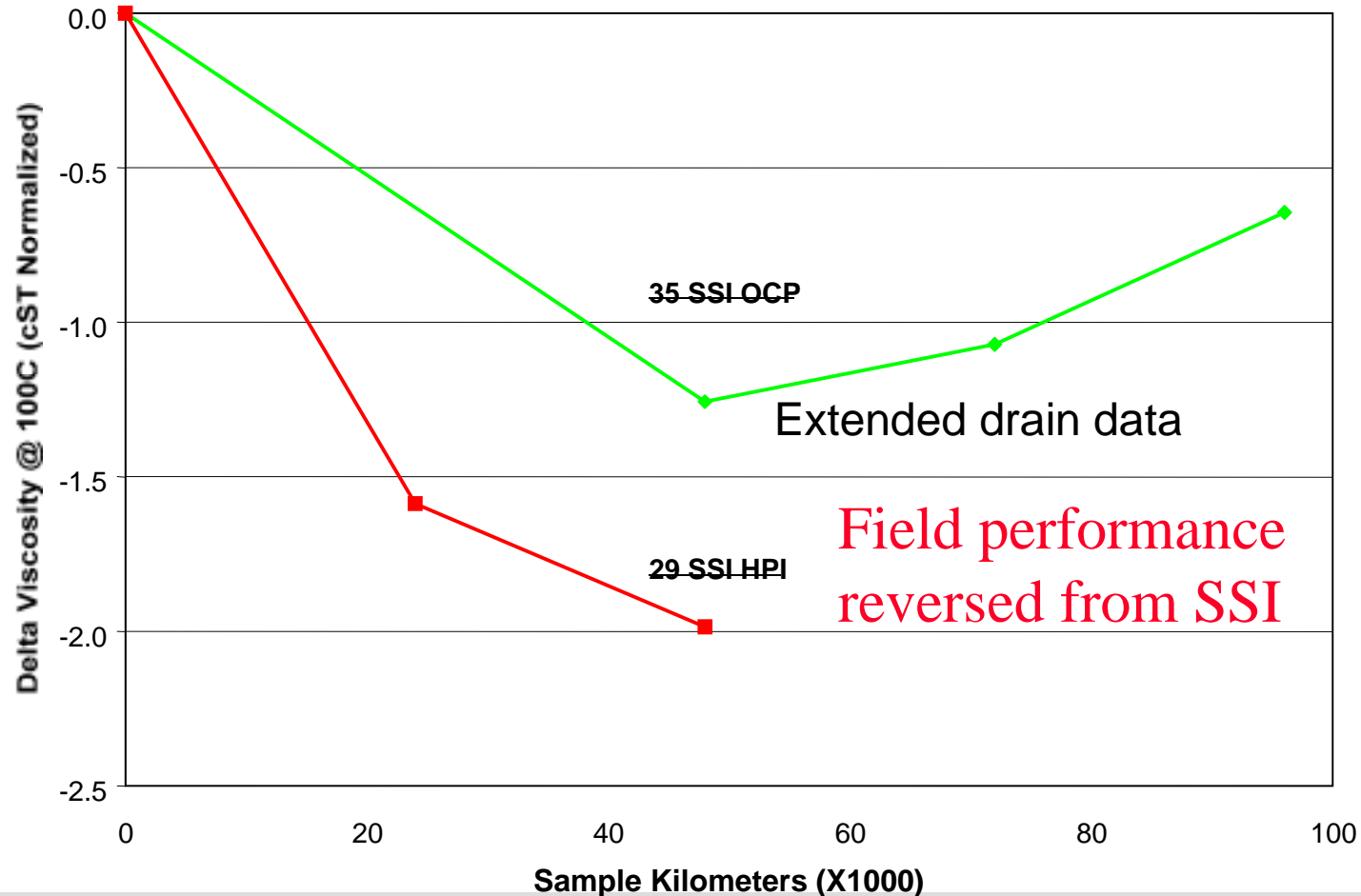


- Extended shearing can dramatically impact relative performance

Diesel Engine Field Service Permanent Shear Stability



Field Test Comparison of VM's
Cummins M11 - Line Haul Trucking



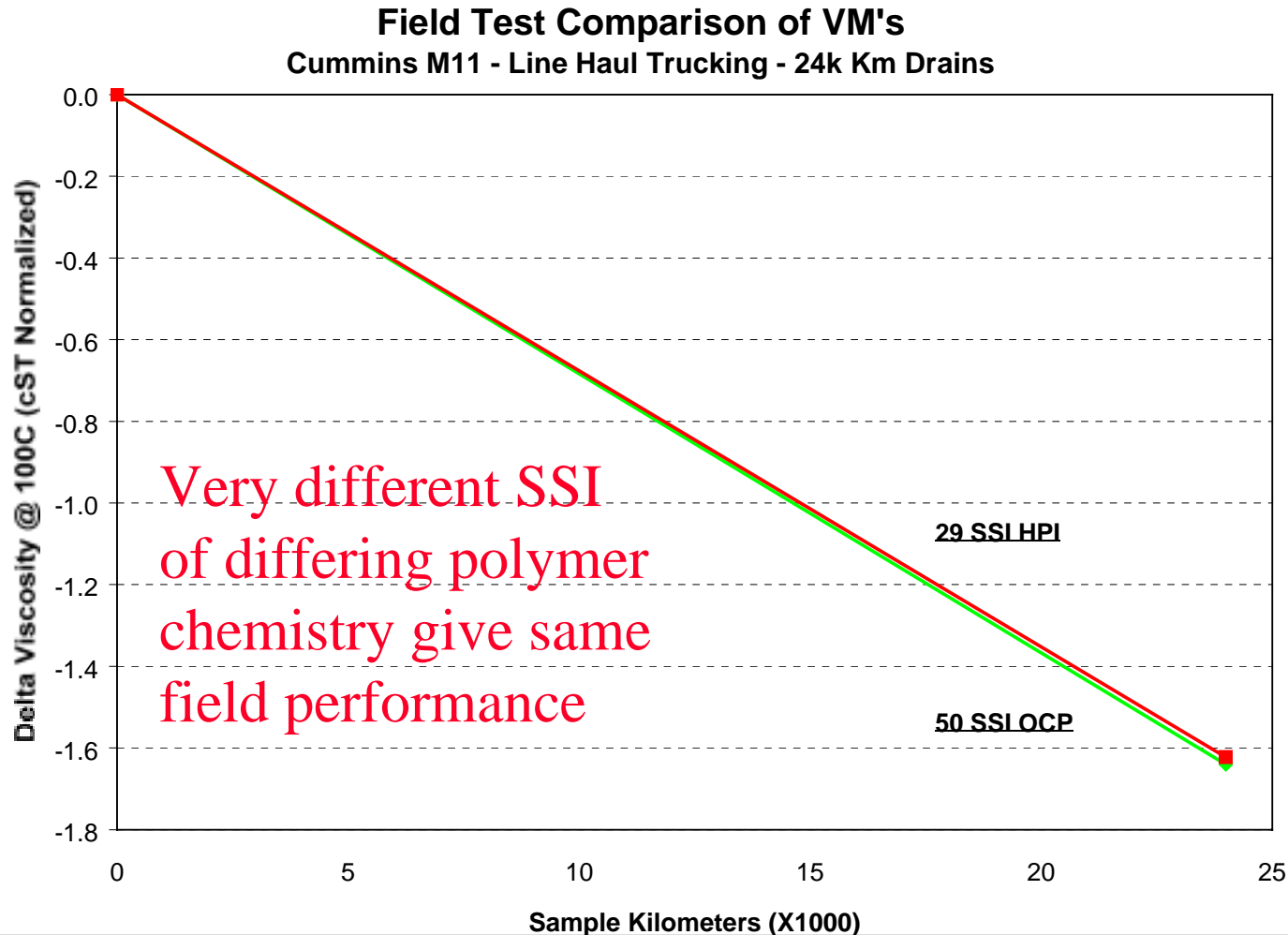
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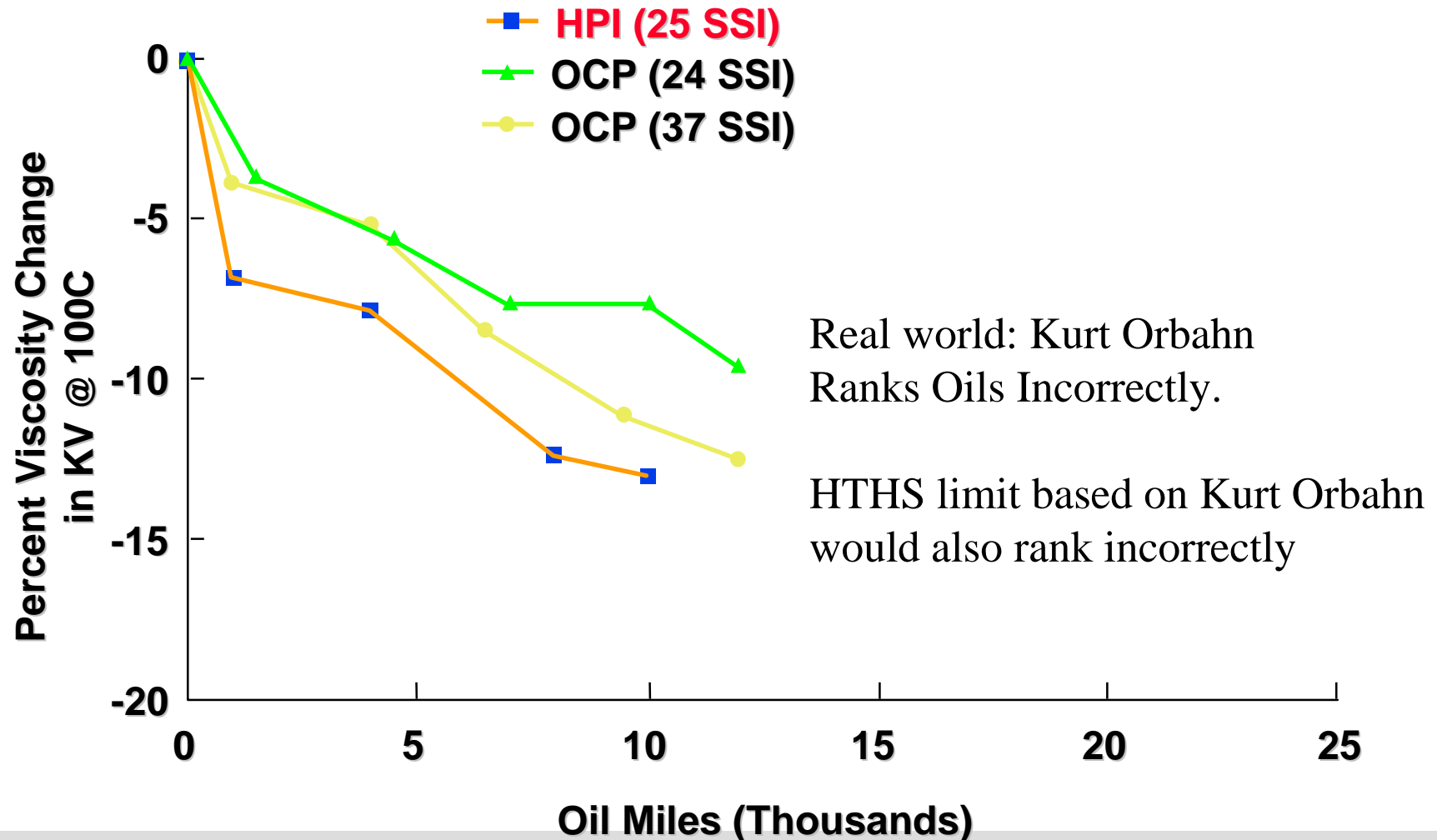
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Diesel Engine Field Service Permanent Shear Stability



CUMMINS N14 - VII SHEAR STABILITY STUDY

VISCOSITY LOSS COMPARISON



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Permanent Shear Stability and HTHS Viscosity



- **Data already shown relating loss of Kv to losses of HTHS viscosity (May 2th HDEOCP)**
- **Kurt Orbahn shearing does not predict HD field**
 - **“Correlations” based on very short drain data**
 - **Lacks thermal component**
 - **Extended shearing can impact polymers in different ways**
 - **Significantly more shearing than SSI predicts has been shown in multiple HD field trials when real world drains used**
 - **Oils blended to take advantage of SSI ‘advantage’**
 - » May be blended low in Kv range
 - » Have lower HTHS viscosity and thus less initial protection
 - » Greater than predicted (by Kurt Orbahn) viscosity loss in field may result in lower than anticipated real world HTHS viscosity.
 - » May provide less engine protection in the field



Rheological Property Requirements



- **HTHS Viscosity based on sheared oil?**
 - Good in theory *but would need way to permanently shear oils in a way which correlates with HD diesel experience - Do we want to develop this?*
 - Kurt Orbahn shows major misalignments with real world
 - » Not appropriate for performance determination of HD oils
- **HTHS viscosity minimum**
 - Fresh oil HTHS viscosity is an established rheological specification (it is not a chemical specification).
 - » HTHS viscosity has been shown to relate to wear
 - » Current engine tests don't capture full range of field conditions - doesn't guarantee viscometrics are suitable in the field
 - **Appropriate limit? Issues:**
 - » Other global specifications
 - » OEMs in best position to recommend what they need

