

# Diesel Fuel Lubricity

## The Need for Specification

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# Outline

- Background
- Lubricity 101
- Issues & Challenges
- ASTM Ballot
- Next Steps

# Background

- Fuel Lubricity is Not a New Issue – Aviation Fuel Groups Addressed it First in the 1960s
- We started in 1989 to prepare for CARB low aromatics diesel fuel.
- Sweden had catastrophic failures in 1991.
- Chevron established an internal guideline of 2,600 g on SLBOCLE.
- California did not experience a problem in 1993 because the industry was prepared, but had the elastomer problem which led into forming the Governor's Task Force.
- This group came up with a 3,000 SLBOCLE recommendation.

# Background...

- CARB monitored refineries and everything worked fine.
- ISO came up with the HFRR and a limit of 450 micron. Same study also came up with SLBOCLE of 3100.
- ASTM recognized that the 15-ppm sulfur diesel is coming in 2006 and that the need for a lubricity specification is urgent now to continue to protect injection equipment.
- We took a systematic approach to have a consensus proposal and to adopt an ASTM specification.
- A 3,100 g SLBOCLE limit will be balloted shortly.

# The Issue

- Hydrotreating Process to Reduce Aromatics is Known to Reduce the Lubricating Properties of Fuel
- Lower Fuel Sulfur Content is Not an Indication of Poor Lubricity Fuel
- Equipment Can Be Designed to Tolerate Lower Fuel Lubricity, But Sufficient Lubricity is Required for Existing Equipment
- Contamination Can Be Responsible for Equipment Wear and Failure
- Elastomer Seal Leak is Not a Fuel Lubricity Issue

# Restoration

- Diesel Fuel Lubricity is Affected by Crude Source, Processing, Blending, and/or Additive Use
- Additive Use Generally is a Convenient Way to Restore Lubricity, But
  - Existing Lab Test Methods Tend to Require Excessive Amounts of Additives
- Excessive Additive Concentrations Can Be Harmful
  - Sediment Formation in Fuel
  - Gum Formation When Exposed to Crankcase Oil
  - Water Retention in Other Fuels Such as Jet

# Additive Use

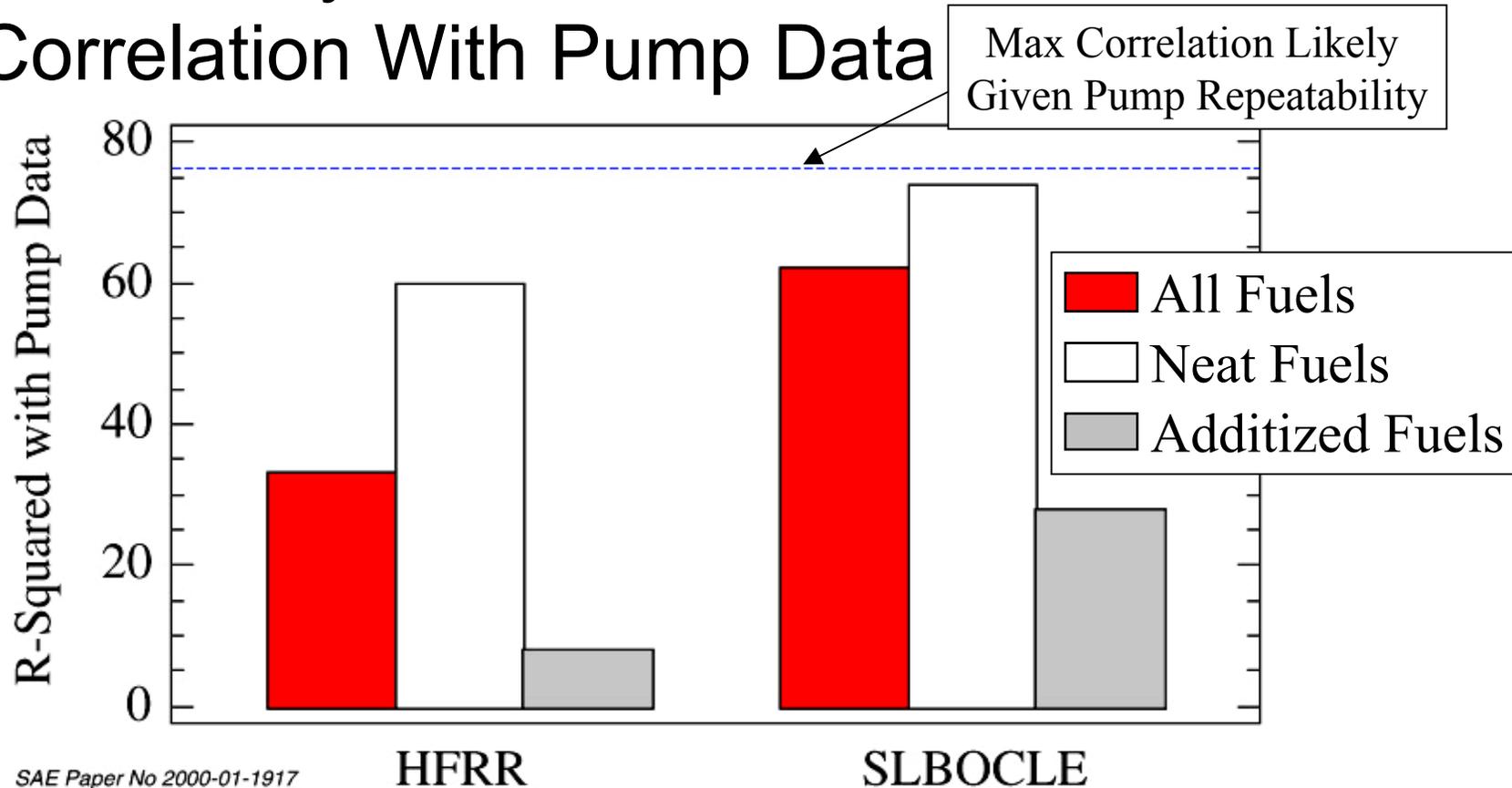
- Criteria
  - Performance
  - Cost
  - Harmful Side Effects
- Classes
  - Refinery Additives
  - After-Market Additives and Others

# Two Fuel Lubricity Tests Standardized

- High Frequency Reciprocating Rig (HFRR)
  - ASTM D 6079 (USA)
  - CEC F 06-A-96 (Europe)
  - ISO DIS 12156 (World)
- Scuffing Load Ball on Cylinder Lubricity Evaluator (SLBOCLE)
  - ASTM D 6078

# Additives Effect Pump Correlation

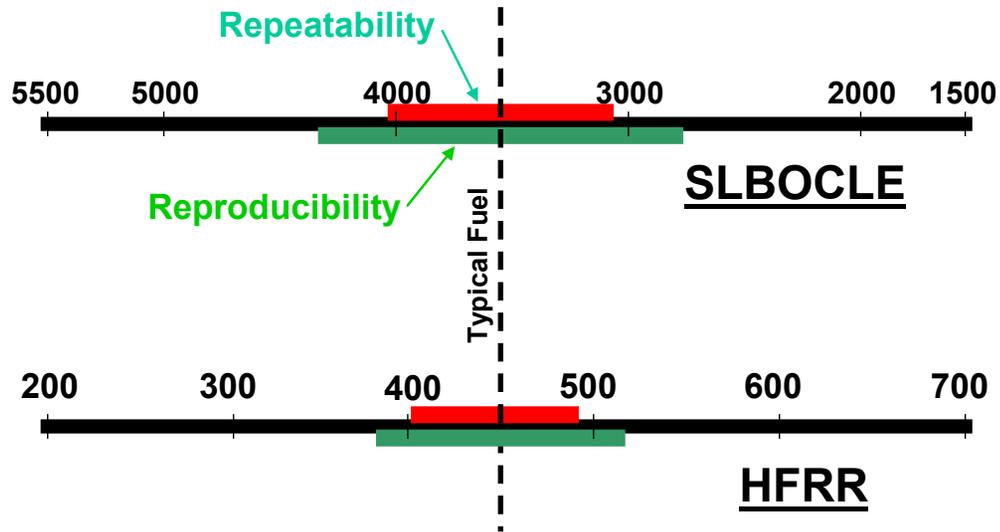
- Particularly Detrimental to HFRR Correlation With Pump Data



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# Repeatability Better in HFRR

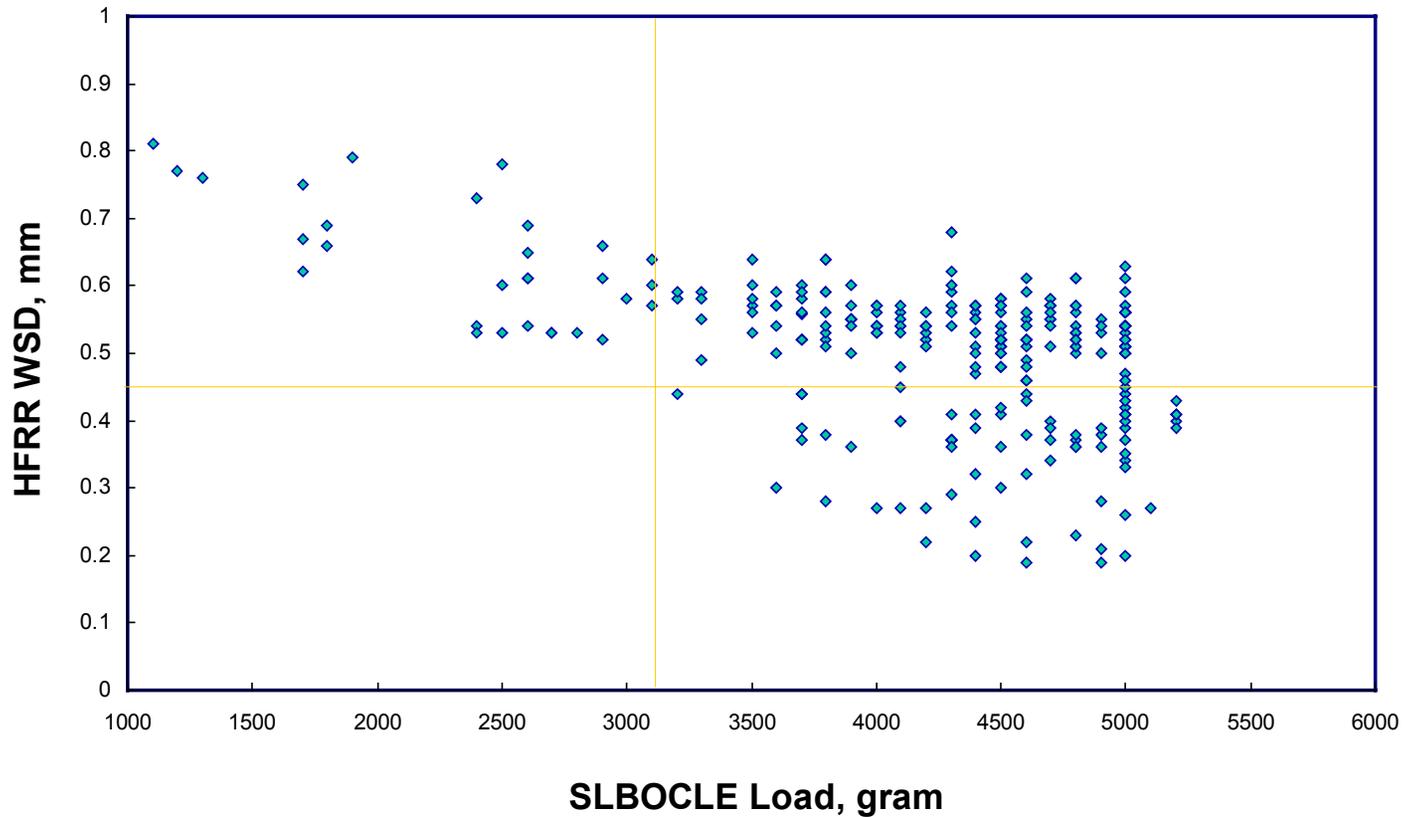


	HFRR	SLBOCLE
Repeatability*	0.8	900
Reproducibility*	0.136	1500

“Repeatability is Fuel Sensitive”

\*Defined in Respective ASTM Test Methods

# Comparison of Some HFRR and SLBOCLE Test Results



# ISO Phase 2 Round Robin Program

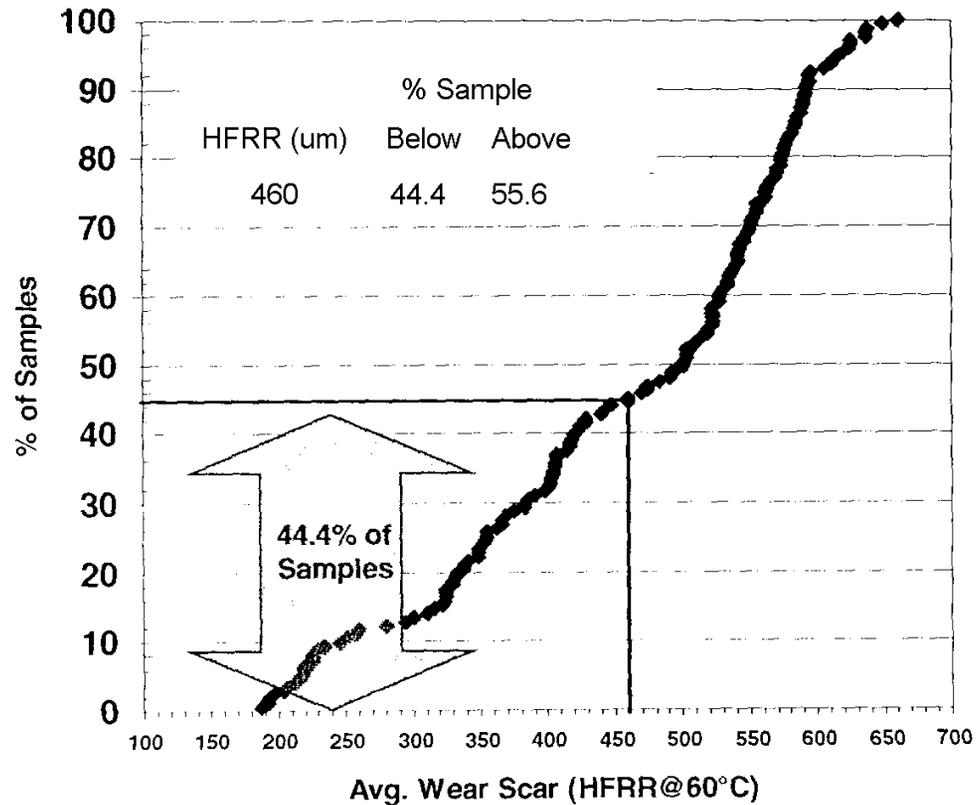
Fuel →	A	C	E	F	B	G	D
<b>Additive:</b>							
Type	None	Acidic	Acidic	Acidic	Non-acidic	Non-acidic	Non-acidic
Level	0	Low	Medium	High	Low	Medium	High
<b>Equipment Rating:*</b>							
Cummins Steel Injectors	3.3	3.7	4.3	3.3	3.0	4.0	4.0
Cummins Ceramic Injectors	2.0	2.3	2.0	2.0	2.0	2.7	2.0
Lucas Pump	3.5	3.0	2.0	3.0	**	**	**
Bosch Pump	4.75 5.0	3.5 6.0	2.5 3.0	**	**	**	**
Stanadyne Pump	1.2 1.6	2.9 2.3	1.5 1.4	1.0 1.3	1.0 1.0	1.4 2.5	1.1 1.1
<b>HFRR WSD at:</b>							
Stanadyne ***	549	537	540	543	519	411	360
Lucas	540	540	512	510	**	**	**
Cummins	570	580	570	580	560	400	320
Average of 10 European Labs	563	564	564	546	566	386	345

\* Rating of 1 is best and 10 is worst. Rating above 5 is unacceptable for all except Bosch which has a limit of 3.5.

\*\* This condition was not tested.

\*\*\* HFRR tests were conducted before and after the pump test. No significant change in the HFRR results was noted.

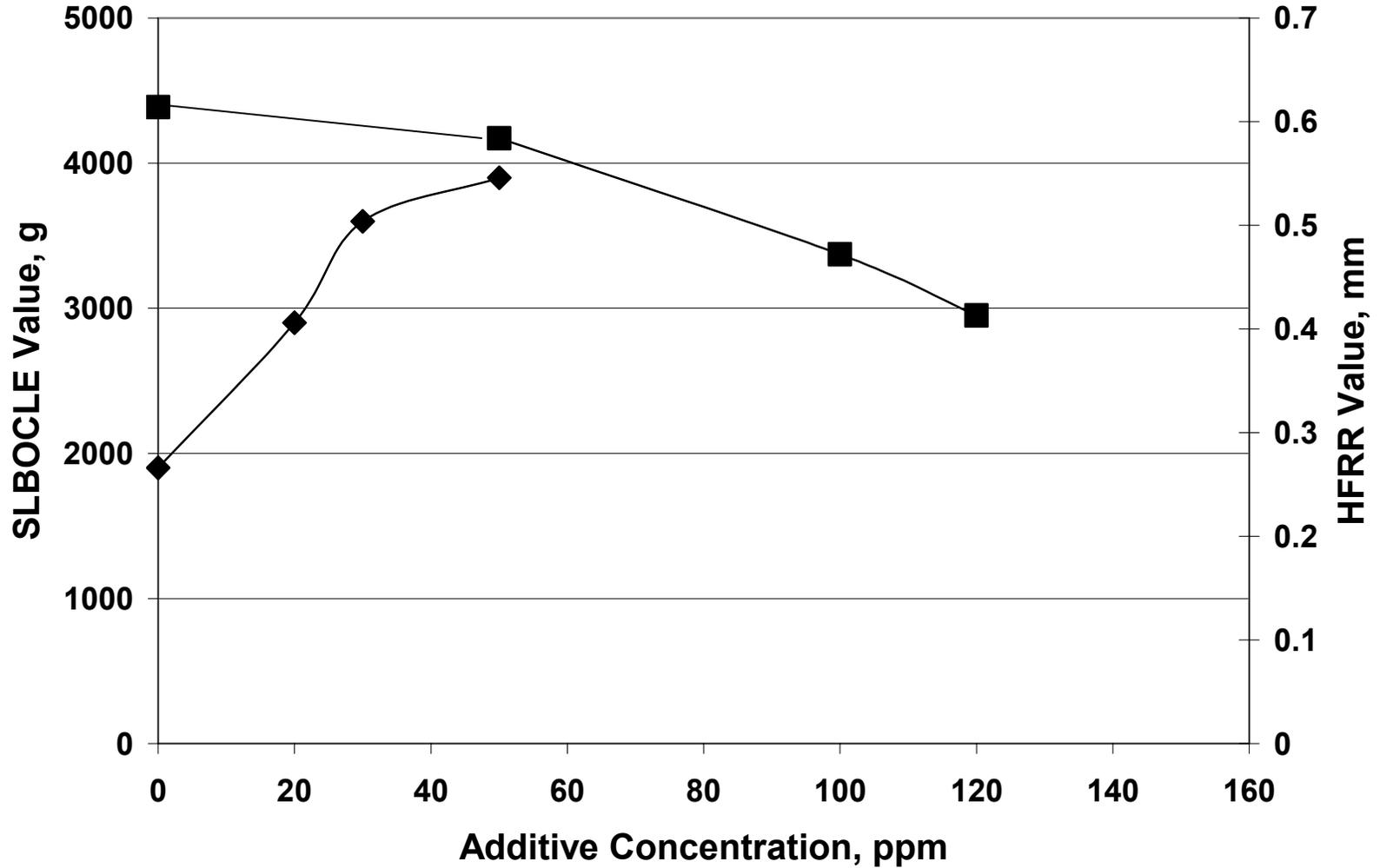
# Lubricity of 1996-2000 US Commercial Winter Diesels



Source: Infineum Winter Diesel Fuel Survey



# Additive Requirement by HFRR and SLBOCLE



# ASTM Task Force

- The Objectives of This Task Force Are to
  - Recommend Diesel Fuel Lubricity Test Methods
  - Recommend Diesel Fuel Lubricity Specifications
- Test Method Must Have
  - Adequate Precision
  - Correlation to Injection Equipment and
  - Good Response to Additized Fuels

# California Recommendation

- Specify a Reasonable Lubricity Level Based on an Existing Test and Suggest Use of Additive if Necessary
- In California it is SLBOCLE 3,000 Grams, if Below, Use Additive

# The Existing ASTM Guideline

- HFRR                    450                    600
- SLBOCLE            3100                    2000
- Pump Testing                    Pass

# Approach 1

- Start with a minimum requirement that has everybody's endorsement as being necessary, but perhaps not everybody's agreement as being sufficient. Such level would be a big step forward from where we are currently which is having no requirement at all. Continue work as a group to generate additional supporting data to increase the requirement if necessary.

# Approach 2

- Start with a severe limit and ease it as more research is conducted. One issue with this approach is that fuel suppliers would invest in refinery processes and other means to comply and later would lose their investment. Also equipment suppliers would design new equipment based on the higher limit and would have problems switching to a lower specification.

# Proposed ASTM Specification

- Test Method: SLBOCLE, D 6078
- Minimum Level: 3,100 gram
- Diesel Grades: 1D & 2 D
- Sulfur: 0.5 % and 0.05 %

# Comments

- Everybody agrees that this level is necessary for a minimum requirement.
- Some believe that it is not sufficient.
- This is a major step forward from our current status of not having anything in place to protect injection equipment.
- The proposed level is one that:
  - Came out of a large ISO study,
  - Is practically the same level that has been recommended and used in California since 1994, &
  - Has the endorsement of the EMA.

# Comments...

- With the introduction of the lower sulfur diesel fuel in 2006, the ASTM working group believes that we must do our best to establish a fuel specification using our existing tools even if they are not perfect. We must accomplish this task well in advance of the introduction of the fuel.

# Comments...

- The following proposed specification will provide a starting point that would protect the injection equipment without creating harmful side effects and unnecessary cost to the fuel suppliers. Also if this is accomplished through ASTM, it can be improved as new research data and/or better test methods become available. If it is regulated through government agencies, the probability of revisions based on new data will be very low.

# Future Work

- Adopt an ASTM specification.
- Improve the precision of the test method.
- Consider new and modified test methods.
- Evaluate the requirement of future equipment through additional work at ASTM and possible CRC.
- Adjust the level as needed.