AEROMOTIVE RESEARCH

Comparative Performance Testing

Synmax 75W90 Synthetic Gear Lube

Mobil 1 75W90 Synthetic Gear Lube

Red Line 75W90 Gear Lube

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Test Engineering

Water

- **Superior Comparative Results in Demulsibility Tests:**
  (ASTM 2711, 1401)

Heat

- **Superior Comparative Results in Oxidation Test:**
  (ASTM 2893)

Wear

- **Superior Comparative Results in Wear Tests:**
  (ASTM 2783, 3233)

DEMULSIBILITY CHARACTERISTIC

- **Gear Lubricants are Frequently Exposed to Water Contamination**
- **Water Can Cause Rust and Corrosion of Machinery Parts, Rapidly Accelerate Oxidation of the Gear Lubricant and Cause Drop-out of the Gear Lubricant's Additive System.**
- **Gear Lubricant's Must Possess the Ability to Rapidly Separate from and Resist Emulsification with Water for Quick and Effective Water Removal from the System During Static Conditions.**
- **The Ability of a Gear Lubricant to Separate from Water is Called Demulsibility.**

STANDARD TEST METHOD for DEMULSIBILITY CHARACTERISTICS OF LUBRICATING OILS ASTM D-2711

- **This test method measures the ability of medium and heavy viscosity (ISO 220 through 1500 grades) extreme pressure gear lubricants to separate from water.**

- **An extreme pressure gear lubricant is considered to possess very good demulsibility characteristics if it exhibits 2% maximum water in oil; 80ml of total free water minimum and 1ml maximum of emulsion according to the US Steel 224 and AGMA 9005 performance specifications and 1% maximum water in oil; 60ml of total free water minimum and 2ml maximum of emulsion per the AGMA 250.04 specification.**

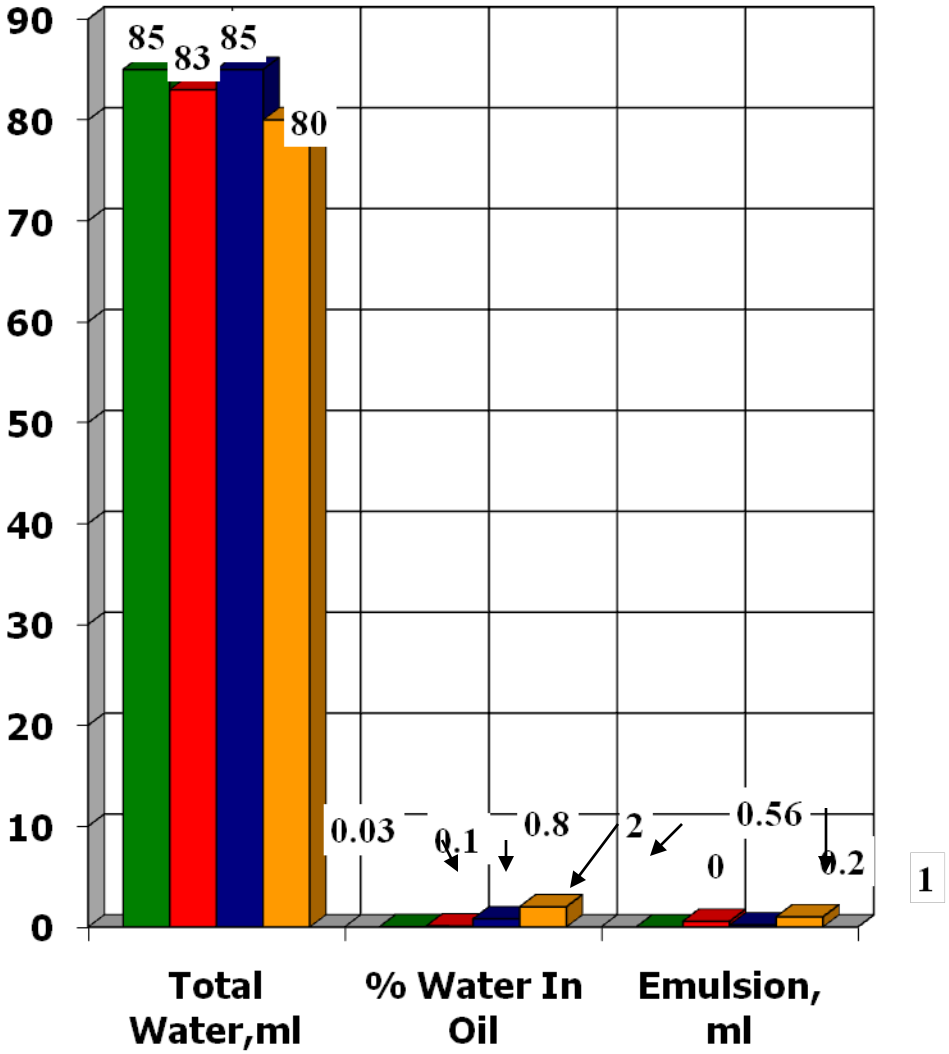
TEST DETAILS

- In this test a 360 ml sample of oil and 90 ml of distilled water are vigorously stirred together at a speed of 2500 500 rpm in a special graduated separatory funnel for 5 minutes at a temperature of 180 F/82 C.

- At the end of the 5 hour settling period a 50 ml sample of oil drawn from near the top of the oil layer is centrifuged for 10 minutes to determine the “Percent Water in the Oil” and “Milliliters of Free Water”

- The mixture is siphoned off until only 100ml remain in the bottom of the funnel. The remaining 100ml is centrifuged and the milliliters of water and emulsion are reported. The amount of water is added to the amount of free water determined in the first separation step, and the sum is reported as “Total Water”

DEMULSIBILITY CHARACTERISTICS
ASTM D-2711

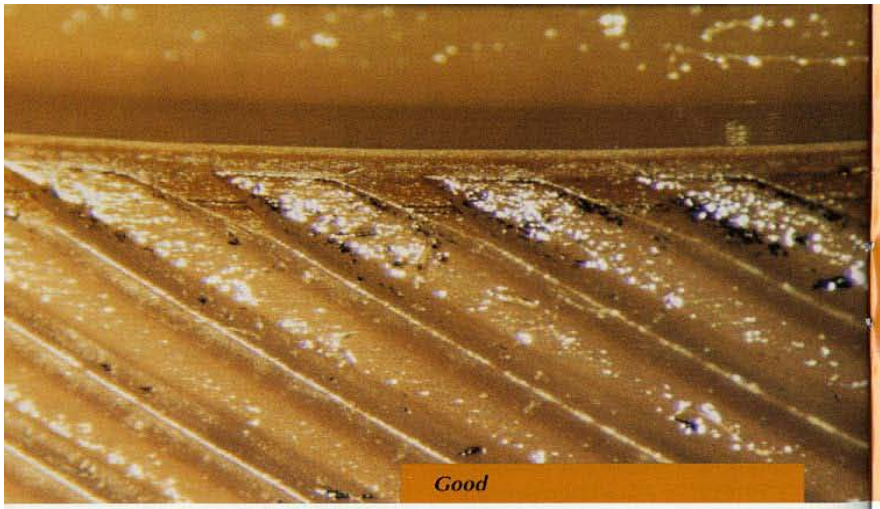


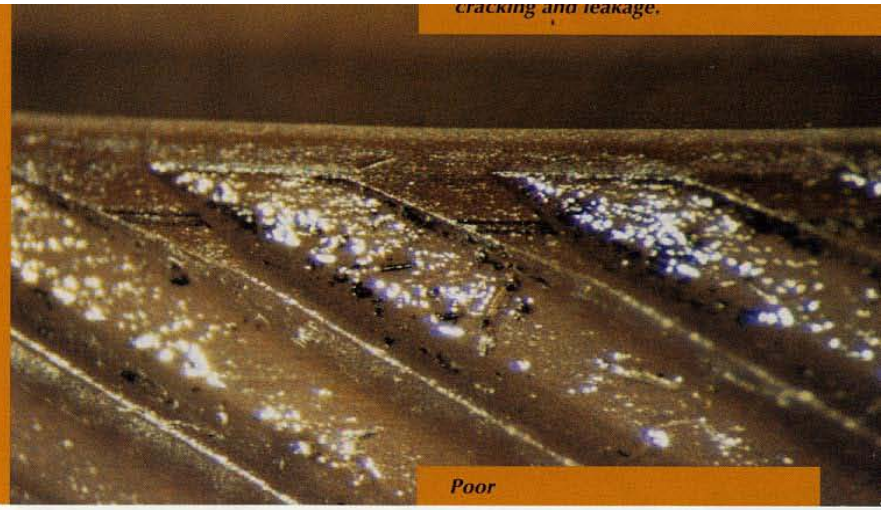
THERMAL STABILITY

Definition:

- **A Thermally Stable Gear Oil Keeps Critical Parts Clean, With Respect to Deposits and Sludge, When Subjected to Sustained High Temperature Service, Thereby Significantly Extending Equipment Life.**
- **Non-Thermally Stable Gear Oils Oxidize and Decompose When Subjected to High Temperatures.**
- **Oxidized Oils Can Deposit Sludge, Varnish and Carbonaceous Deposits on Gears, Bearings, and Seals.**
- **These Deposits Can Cause Premature Wear, Abraded Seals, Premature Seal Hardening and Brittleness, Increased Operating Temperatures and Decreased Gearbox Efficiency.**

Thermally stable gear lubricants resist oxidation and decomposition, preventing deposits on seals which can lead to seal failure and lubricant loss.





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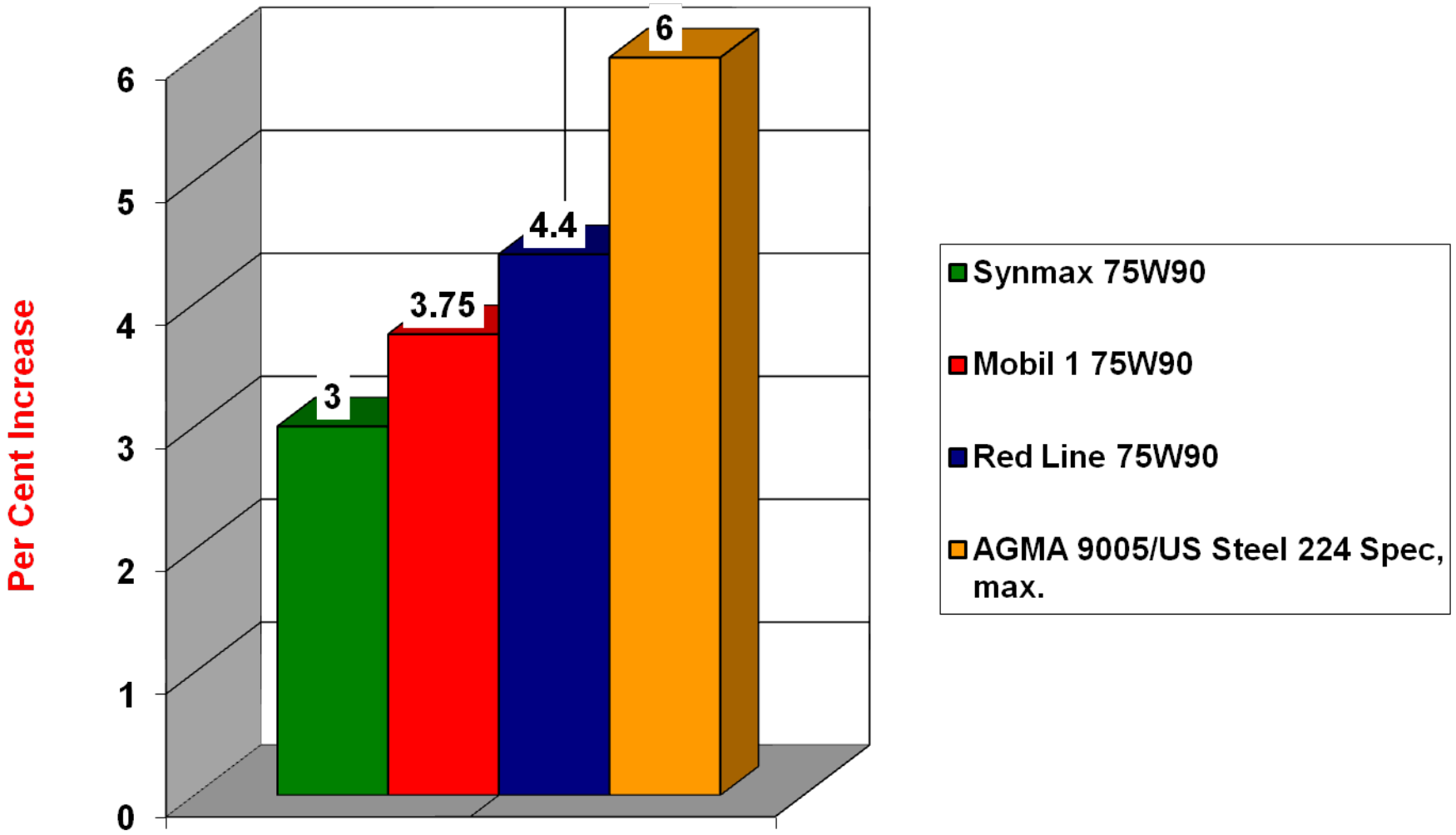
OXIDATION CHARACTERISTICS of EXTREME PRESSURE LUBRICATING

US STEEL S-200 METHOD (MODIFIED ASTM D-2893)

- The test method is used to measure the ability of extreme pressure gear lubricants to resist oxidation and the formation of deposits when subjected to high operating temperatures.
- Before the tests is performed the extreme pressure gear lubricant's kinematic viscosity at 100 C is determined
- In the test a 300ml sample of the gear lubricant being tested is placed in a 600mm in length test tube, that contains a flow meter to regulate air flow.
- The entire assembly is placed into an oil bath that is held at a temperature of 121 C for 312 test hours, with dry air at a flow rate of 10 liters/hour is bubbled through the sample
- At the end of 312 test hours the gear lubricant's viscosity at 100 C is determined and the per cent increase in viscosity and the appearance of the tube and flow meter are reported.
- The AGMA 9005-D94 Specification allows only a 6% maximum increase in viscosity.

OXIDATION STABILITY TEST US STEEL METHOD S200



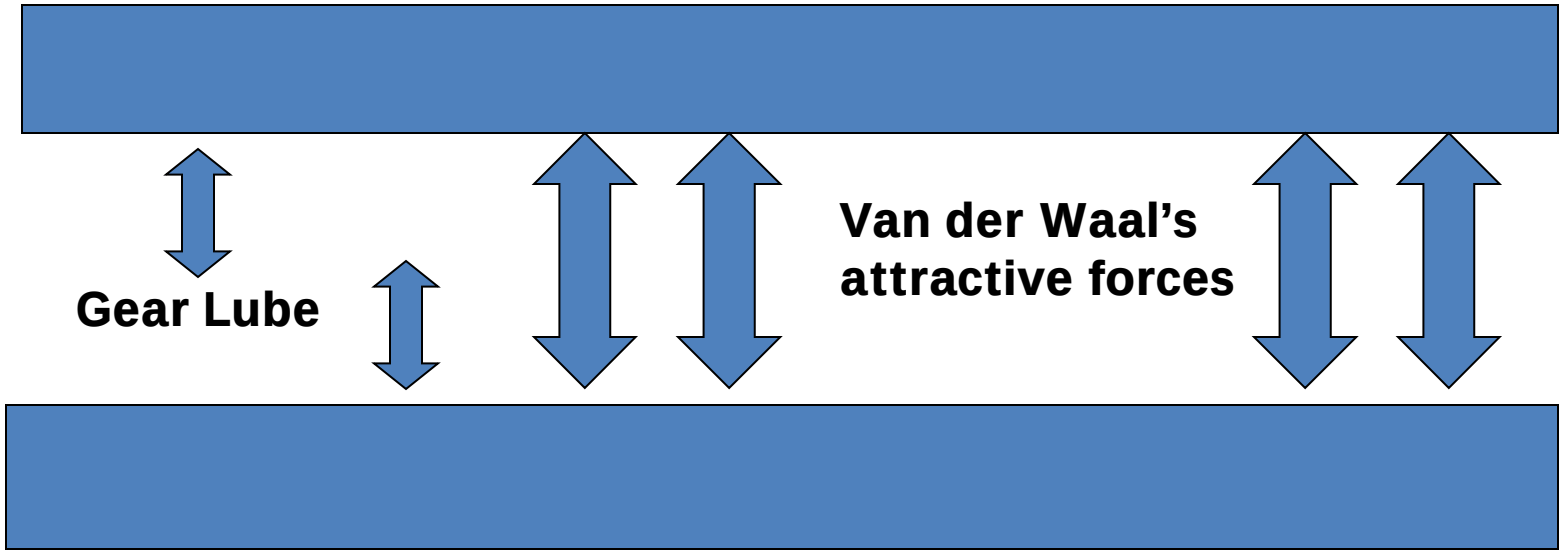
SEAL COMPATIBILITY

- **Seals Commonly Fail Due to Hardening or Deposit Formation, Especially when High Operating Temperatures are Encountered.**
- **Thermal Stress can Break Down Some Gear Lubricants and Cause Deposits in and Around the Seal Lip.**
- **These Deposits Abrade the Seal Material and Cause Cracking and Tearing of the Seal.**
- **Seal Leakage Can be Further Aggravated by a Loss of Elasticity in the Seal Material caused by Chemical Interactions of the Seal Material with the Lubricant.**
- **Therefore it is Important That the Gear Lubricant Must Incorporate a Careful Balance of Additive Chemistry and Base Oils in Order to Avoid Seal Failures.**

SEAL COMPATIBILITY

Some Types of Base Oils and Additive Systems Can Cause Elastomer Swell:

⇒"plasticization

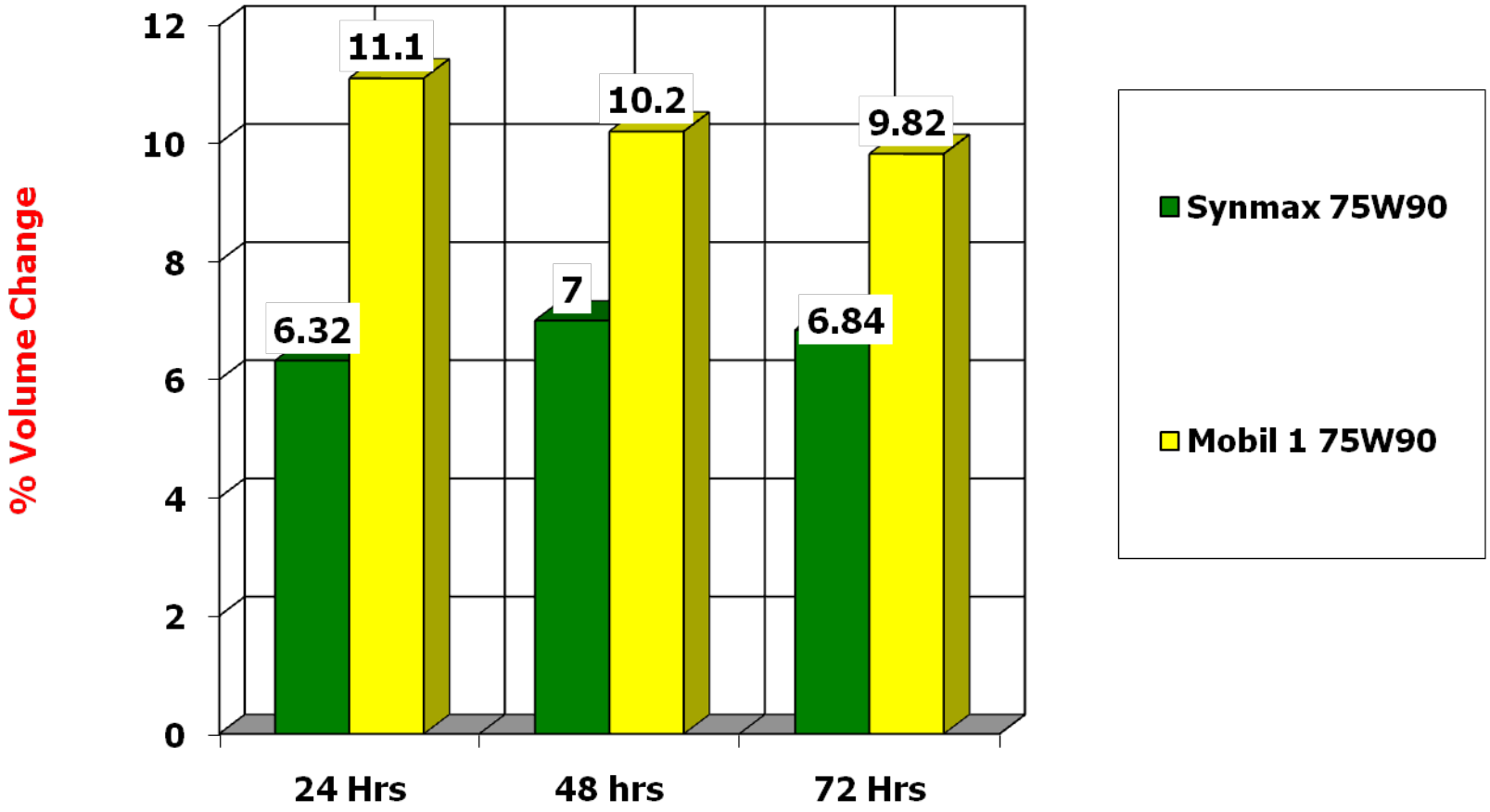


STATIC IMMERSION SEAL TESTING

- **Static Immersion Testing Involves Placing Elastomer Samples in Baths of the Candidate Fluid and Heating Them to a High Temperature for Extended Periods Of Time.**
- **The Test Times May Last from Several Days to Several Months.**
- **At the Conclusion of the Test, the Elastomer is Evaluated for Performance Changes.**
- **Presently The Only Gear Lubricant Specification That Specifies Seal Compatibility Test is the API MT-1 Service Classification for Gear Lubricants Specified for Use in Non-Synchronized Manual Transmissions**

ELASTOMER COMPATIBILITY

Elastomer Compatibility - Nitrile ASTM D-4289 150C



GEAR WEAR PROTECTION

- **Industrial gear drives are operating under increased power density loads.**
- **These higher power density loads are the direct result of increased horsepower and torque being applied to gear drive.**
- **These conditions result in increased stress on the gears and bearings that can lead to premature or catastrophic failure.**
- **The gear lubricant being used must protect against excessive gear and bearing wear, scoring, spalling and pitting, especially when high torque, high shock load and high temperature conditions are encountered**

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TESTS USED TO EVALUATE GEAR WEAR PROTECTION

- **Four Ball E.P. ASTM D-2783**
- **Falex Continuous Load ASTM D-3233**

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STANDARD TEST METHOD for MEASUREMENT OF EXTREME PROPERTIES OF LUBRICATING FLUIDS (FOUR BALL METHOD) ASTM D-2783

- **The Test Method is Used to Determine the Load Carrying Capabilities of Lubricating Fluids**
- **The Test Method is Used for Specification Purposes in Order to Differentiate Between Lubricating Fluids Having Low, Medium, and High Levels of Extreme Pressure in Sliding Steel-On-Steel Conditions.**
- **Two Determinations are Made in This Test. The Load Wear Index and the Weld Point.**
- **The Load Wear Index is an Index of the Ability of a Lubricant to Prevent Wear at Applied Loads.**
- **The Weld Point is the Lowest Applied Load at Which the Sliding Surfaces of Four Steel Balls Seize and Weld Together.**

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STANDARD TEST METHOD for MEASUREMENT OF EXTREME PRESSURE PROPERTIES OF LUBRICATING FLUIDS (FOUR BALL METHOD) ASTM D-2783

- **In This Test Steel Balls of the Same Size and Metallurgy are Used. Three Steel Balls which are Immersed in the Lubricant Being Tested are Locked into a Test Cup.**

- **A Fourth Steel Ball that is Held in Place in a Rotating Chuck is Placed on Top of the Three Steel Balls Locked in the Test Cup.**

- **The Fourth Steel Ball is Rotated at a Speed of 1770rpm and Subjected to a Series of 10 second durations at Increasing Loads Until Welding of the Steel Balls Occurs.**

- **At the End of each 10 Second Test, the Ball in the Chuck is Discarded and the Other Three Balls are taken from the Cup in Order to Examine the Diameter of the Wear Scar. These Wear Scar Diameters are Used to Calculate the Load Wear index.**

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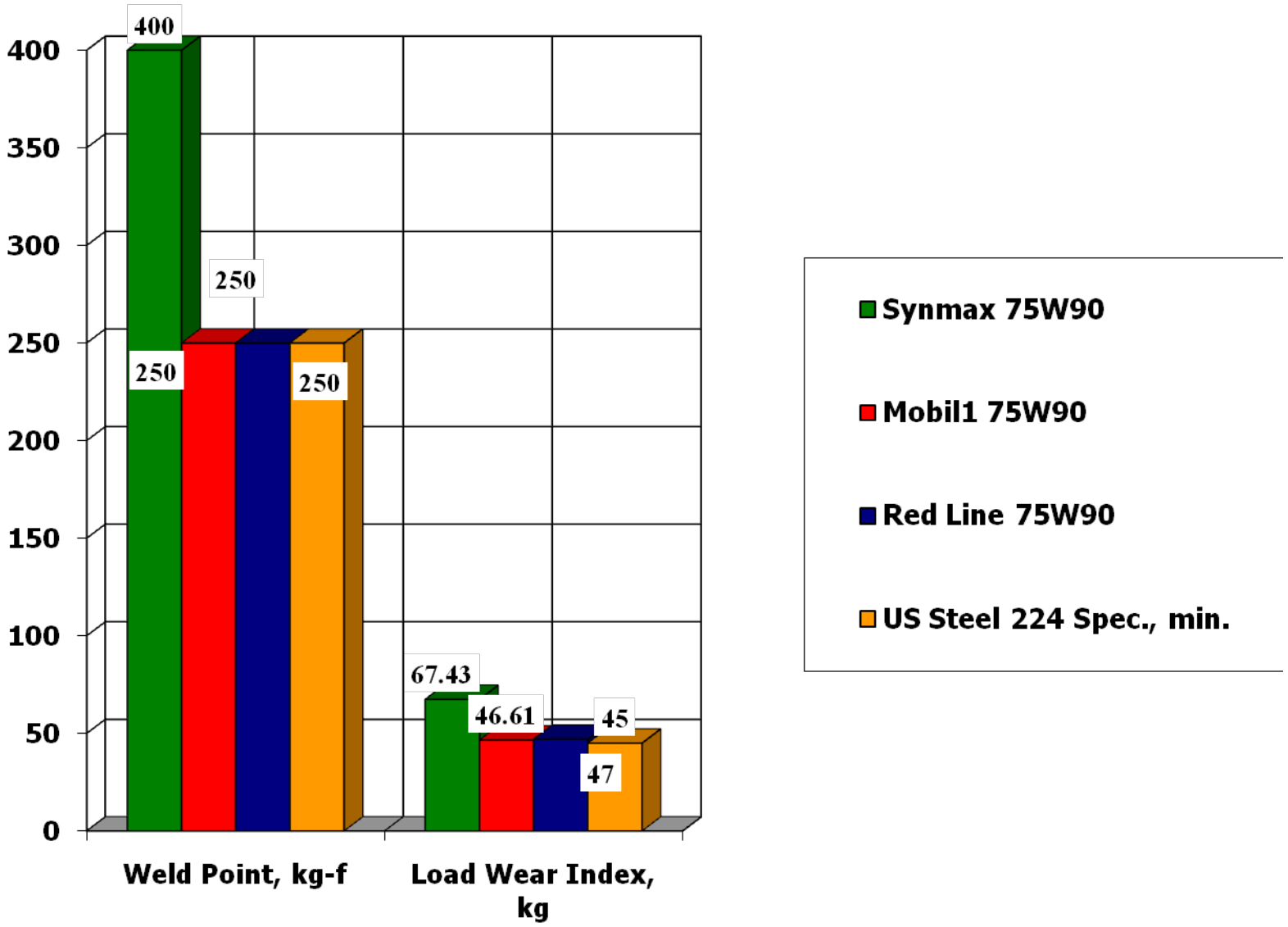
STANDARD TEST METHOD for MEASUREMENT OF EXTRME PRESSURE PROPERTIES OF LUBRICATING FLUIDS (FOUR BALL METHOD) ASTM D-2783

- **With Each Load Applied New Steel Balls are Used.**
- **The Loads are Applied in a Stepped Series With the First Load Being 6kgsf.**
- **The Loading Series Used is 6,8,10,13,16,20,24,32,40,50,63,80,100,126,160,200,250,315, 400,500,620 and 800 kgs-f.**
- **If Welding Does not Occur at 800 kgs-f the Lubricant is Reported as Having a Weld Point of +800kgsf.**

FOUR BALL E.P TEST RESULTS



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STANDARD TEST METHOD for MEASUREMENT of EXTREME PRESSURE PROPERTIES of FLUID LUBRICANTS (FALEX PIN and VEE BLOCK METHODS) ASTM D-3233

- **This Test Method is Used to Measure the Load Carrying Properties of Fluid Lubricants.**
- **The Test Method has Two Procedures That Can Be Used to Evaluate a Lubricant.**
- **The Test Method Has Been Found to Have Some Correlation to Field Service Applications Such as Open and Enclosed Gearing and Oil Lubricated Industrial Bearing Applications**
- **Procedure A is Referred to as the Falex Run-Up Test Method**
- **Both Test Methods Consists of Running a Rotating Steel Journal at 290rpm Against Two Stationary V-blocks that Are Immersed in 60ml of the Lubricant Being Tested.**

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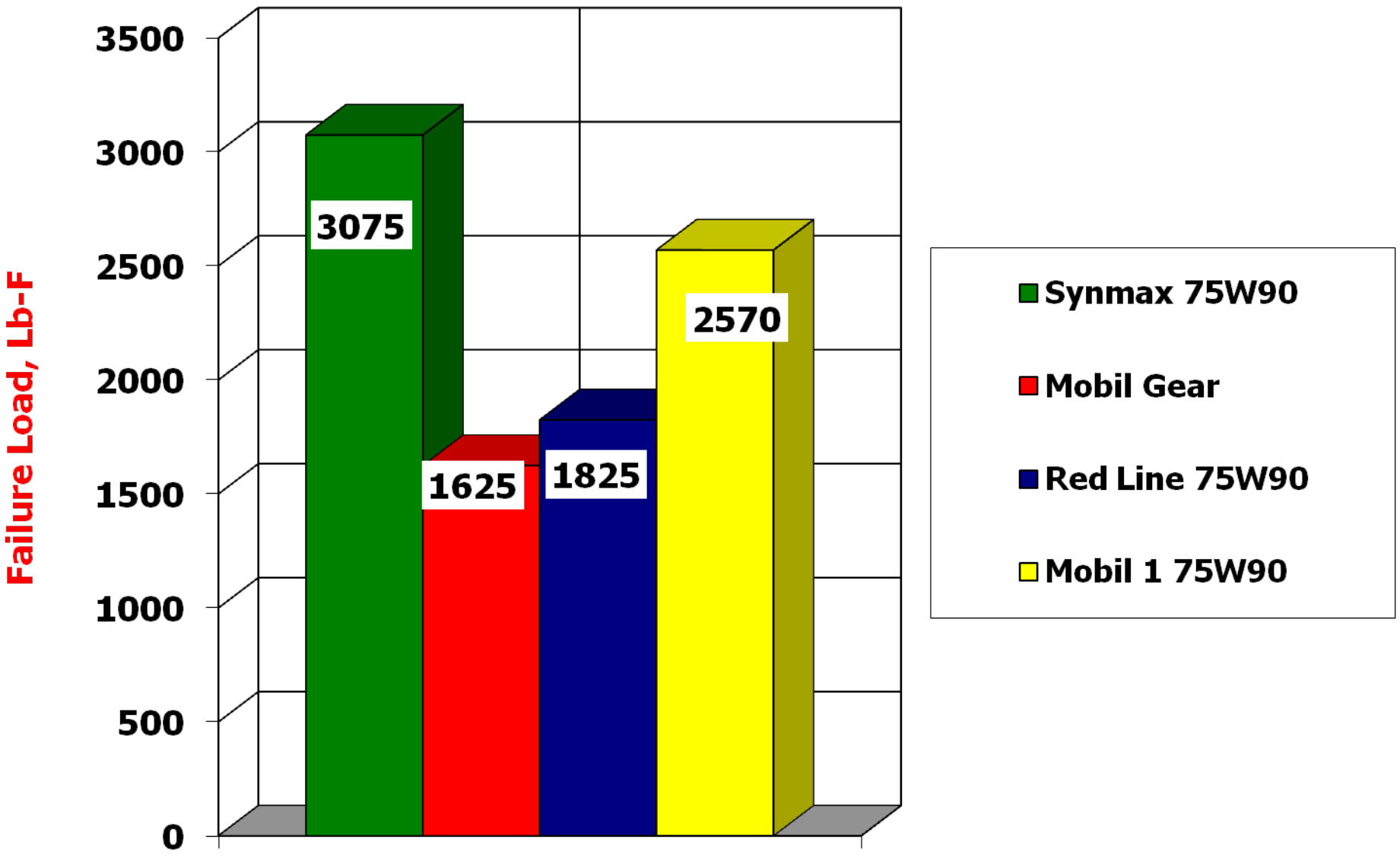
STANDARD TEST METHOD for MEASUREMENT of EXTREME PRESSURE PROPERTIES of FLUID LUBRICANTS (FALEX PIN and VEE BLOCK METHODS) ASTM D-3233

- **Load is Applied to the V-Blocks by a Ratchet Mechanism.**
- **In Test Method A Increasing Loads Starting at 300-Pounds Force (LBF) are Applied Continuously**
- **In Both Test Methods the Test is Ended When the Lubricant Being Tested Can No Longer Support the Applied Load, Resulting in Breakage of the Journal Pin or Seizure of the Pin to the V-Block.**
- **The Highest Load that Can be Applied Using this Method is 4,500LBF**

FALEX CONTINUOUS LOAD



FOAMING CHARACTERISTICS

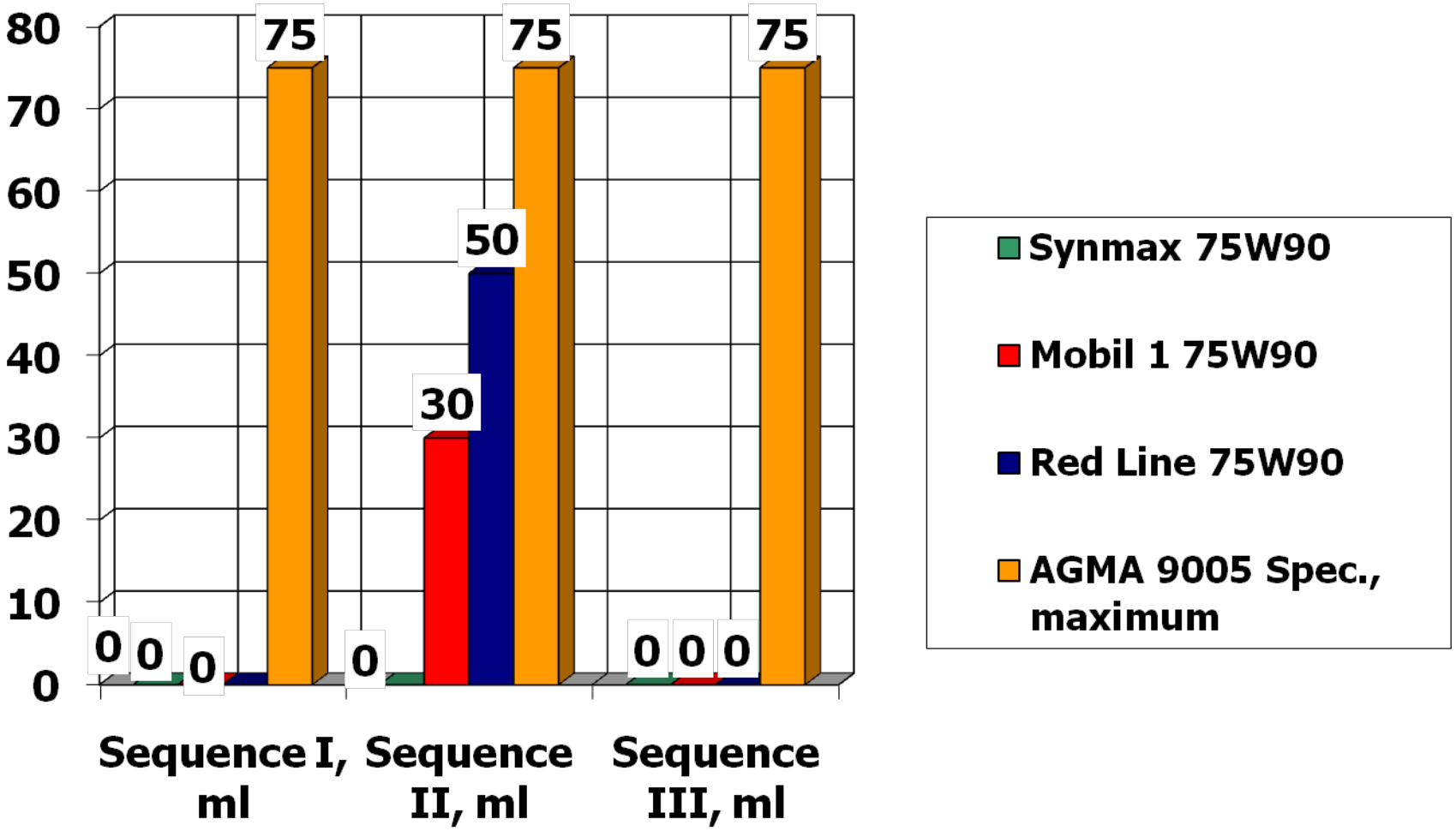
- The Churning Action of the Gears and Bearings Through the Lubricant Can Cause Air Entrainment or Foaming

- If a Gear Lubricant Begins to Foam This Can Result in
- - Increased Operating Temperatures
- - Inadequate Lubrication
- - Spongy and Erratic Operation
- - Loss of the Gear Lubricant Due to Overflow
- - Increased Oxidation of the Gear Lubricant
- - Erosion and Cavitation
- - Increased Gear and Bearing Noise

STANDARD TEST METHOD for FOAMING CHARACTERISTICS OF LUBRICATING OILS - ASTM D-892

- This test is used to determine the foaming tendency of lubricating oils.
- The test method consists of three sequences performed at different temperatures.The lubricant being evaluated is aerated by the use of a gas diffuser at the test temperature for that sequence with dry air at a flow rate of 94ml/minute.
- Before beginning the first sequence the oil sample is heated to 120 F/49 C and allowed to cool to 75 F/24 C. 190 ml of the sample is poured into a 1000ml graduated cylinder and the cylinder is immersed into a water bath that is maintained at the test temperature for that sequence.
- The sample is aerated for 5 minutes and the amount of foam generated at 5 seconds after disconnecting the gas diffuser is reported.
- At the end of a 10 minute settling time the amount of foam left is recorded.
- The foam is collapsed and for the next two sequences the same procedure is repeated except the test temperatures used are 200 F/93.5 C for Sequence II and 75 F/24 C.

FOAMING CHARACTISTICS
5 Minute Blowing Time



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PRESENTATION – END.

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