Quarterly Report – Public Page

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Project Title: Effect of Concentration and Temperature of Ethanol in Fuel Blends on Microbial and Stress Corrosion Cracking of High-Strength Steels

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For quarterly period ending: *September 15, 2008*

Kick-Off Meeting:

The project kick-off meeting was held at the Colorado School of Mines on August 7, 2008. Representatives of industrial partners and government attended the meeting and offered guidance and advice about the project.

Technical Status:

Technical efforts for the first quarter of the project period included designing experimental parameters for the first segment of the project, conducting biological viability studies in reagent grade ethanol, and securing materials and equipment for the initial testing phase.

Experimental Design:

A servo-hydraulic MTS 20 kip loading frame located in the NIST mechanical testing lab in Boulder, CO has been selected for initial testing. Cyclic loading has been set at a frequency of 0.01 Hz. Loading has been determined to operate with a max load of 75 pct of the material yield stress with a loading ratio of 0.1. Figure 1 describes the maximum theoretical stress at the upper surface of the steel sample throughout an arbitrary number of loading cycles for an X70 steel sample.

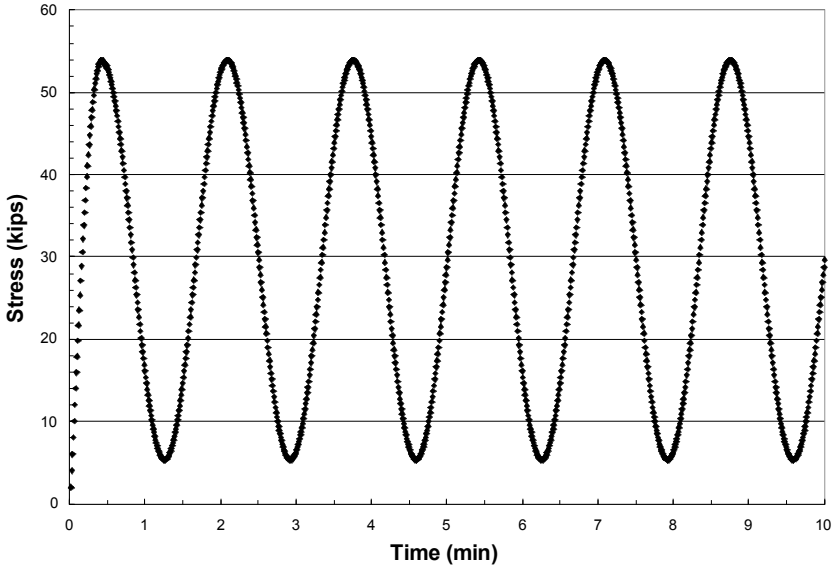

Figure 1: Theoretical tensile stress at the specimen surface undergoing cyclic loading for X70 linepipe steel.

A four-point bending system will be used. Four point bend testing methods defined in ASTM E 855 and ASTM C 1161 have been studied to determine testing parameters. Figure 2 from ASTM E 855 is a basic representation of the apparatus that will be used.

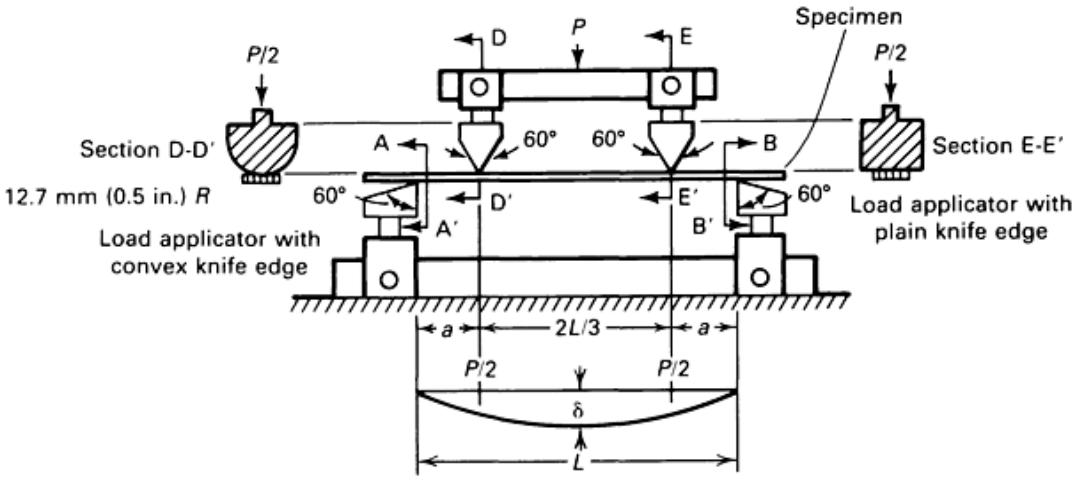

Figure 2: "Standard Test Methods of Bend Testing of Metallic Flat Materials for Spring Applications Involving Static Loading," ASTM E 855, Annual Book of ASTM Standards, Vol 03.01

The actual design will differ from the ASTM schematic shown above in that the points of contact on the upper surface of the sample will have a greater spacing than the contact points on the lower surface of the sample. This will result in tension in the upper half of the sample and compression in the lower half of the sample. Under maximum load, an X70 steel sample would have a theoretical stress profile as described in Figure 3.

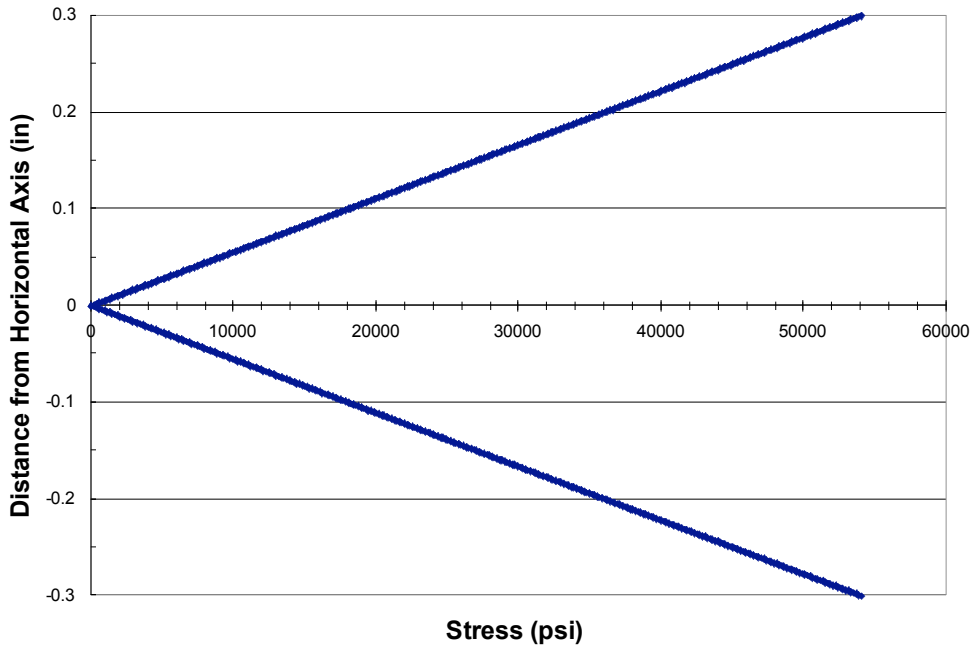

Figure 3: Theoretical vertical stress distribution through a specimen of X70 linepipe steel.

A steel bath constructed at the Colorado School of Mines will be used to contain the steel samples submerged in a liquid corrosive environment. Three steels have been selected for testing; X52, X70, and ASTM A 36. The steel samples are to be submerged in a standard synthetic fuel grade ethanol (SFGE). The solution is to be aerated with forced breathing air. Methanol, chloride, and sulfate content are to be maintained at the upper limits of the ASTM D 4806 specifications for fuel grade ethanol. SFGE water content is to be maintained both at the upper limits of ASTM D 4806 and at an SCC inducing value higher than ASTM D 4806 specification. Synthetic ethanol fuel blends (SEFB) E95, E85 and E50 have been selected for use. Non-cracked and pre-cracked specimens are to be evaluated. In some tests biological contaminants will be added to the submerged steel surface under loading conditions.

Steels	Synthetic Fuel Grade Ethanol (SFGE)	Denaturant (nat. gasoline)	Synthetic EtOH Fuel Blends	Sample Design
1) X52 2) X70 3) A36	1) ASTM upper limits 2) ASTM upper limits w/ high water content	1) 2 pct. 2) 5 pct.	1) E95 2) E85 3) E50	1) Non-cracked 2) Pre-cracked

Table 1: Initial testing variables

Mechanical Testing at NIST:

Experimentation by NIST will consist of mechanical testing using compact tension (CT) specimen according to the procedures in ASTM E 647.

Material Procurement:

Linepipe steel material was provided for testing. Four feet of 20 inch diameter .260 Wall Grade X70 ERW with FBE coating and five feet of 12 inch diameter - standard wall - Grade X42/52 with FBE coating are being shipped to the Colorado School of Mines. Ethyl alcohol (200 proof, absolute ACS/UPS grade) has been attained for preparing the SFGE.

Biological Viability Studies in Ethanol:

Preliminary biological growth experiments have been conducted to evaluate the potential of microorganisms to survive in environments in which fuel-grade ethanol is present. Soil samples exposed to 100 pct ethanol (for up to several weeks) produced viable cells evidenced by growth on a general biological growth media. Clone libraries from these initial growth experiments will be produced to identify what microbes may survive in fuel-grade ethanol infrastructure, and this knowledge will aid in future cultivation efforts.

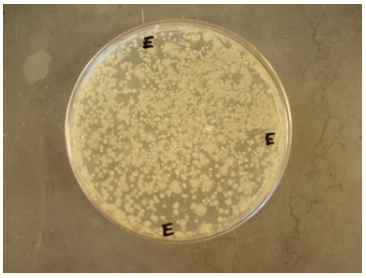

Figure 4: Microbial growth on culture media after exposure to 100% EtOH.

Field Contacts and Visits:

An ethanol plant was toured to gain insight into the ethanol production industry and to evaluate potential sampling sites for collection of biological samples. Other potential sampling sites in Colorado and around the U.S. have also been identified. Collected samples will be analyzed via molecular biology techniques including DNA sequencing, and these samples may provide evidence of biological activity in the fuel-grade ethanol infrastructure.