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Gasoline/Methanol Mixtures for Materials Testing

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Gasoline/Methanol Mixtures for Materials Testing

This report is a product of the SAE Cooperative Research Program, Project Group 2 (Table 1). The group operates in accordance with the 1984 Cooperative Research Act. The scope of Project Group 2 is to develop and exchange information relative to materials and test methods for use with blends of methanol and gasoline.

When one considers evaluation of materials for use in gasoline and gasoline/methanol mixtures, the question of appropriate test fuels is both an obvious and immediate concern. Because of the variability in fuel composition between manufacturers and batches from the same manufacturer as well as systematic changes for altitude and prevailing weather conditions, the use of real fuels poses unacceptable variability problems. Further, fuel grade methanol may contain more than just methanol. To address this issue, the SAE Cooperative Research Project Group 2 has arrived at a series of test fuels which should be used in comparing various materials to determine suitability for use in the broad spectrum of compositions ranging from gasoline to M85 (85% methanol). It should be stressed at the outset that the compositions specified by the Project Group 2 are solely for materials testing purposes and are not intended for use in other activities such as engine development. The purpose of this paper is to publish these compositions.

The basic fuel designations selected by the group are shown in Table 2 with specific recipes which can be readily prepared given in Tables 3 and 4. The selected compositions are intended for accelerated material testing. In order to distinguish the materials test fuels from engine test fuels (e.g. M85), the fuels throughout this paper are designated by CM followed by the percentage of methanol. This is shorthand for ASTM Fuel "C" blended with methanol. ASTM Reference Fuel "C" (50% toluene, 50% iso-octane) was chosen as a surrogate for gasoline. The high aromatic content provides a fuel which is aggressive for swelling polymeric materials. Using this fuel will also allow building on the large body of Fuel "C" materials testing data already in existence. Freshly opened reagent grade methanol is used to provide a source of methanol. Because it is anticipated that the methanol actually seen in the field will contain more water than is allowed by the definitions for reagent grade methanol, distilled water is to be added.

Various possible contaminants in an actual gasoline can aggravate material deterioration. In addition to the basic set of fuels (Table 2), aggressive fuels are needed to challenge potential fuel system materials. Chloride ions, formic acid and water are added to create an aggressive test fuel for metals (Table 4). Some of the components in gasoline can decompose by a process called auto-oxidation to form aggressive substances which can attack polymers and cor-

rode metals. The formation of free radicals from hydroperoxides is accelerated by the presence of trace metals, such as copper, in the fuel. Therefore, when determining the effect of auto-oxidized fuels on polymers, controlled amounts of copper ions and hydroperoxide are added to the test fuels (Table 3). For metals, hydroperoxide alone is added to the test fuels (Table 4).

The test fuels for polymeric materials, coupled with a decision tree shown in Table 5, minimize testing while leading the engineer to potentially suitable candidate materials. Of course, the choice of final material to be used is dependent on the application as well as the specific design and will likely involve the cooperative efforts of the component engineer, materials engineer, and the suppliers.

The test fuels for metals consist of two aggressive methanol blends and two optional auto-oxidized aggressive methanol blends (CM15A, CM85A, CM15AP, and CM85AP respectively). Tests should include immersion in the fuel and exposure to the vapor above the fuel. The test specimens should be examined for corrosion or any obvious chemical attack.

Swelling will be used as a screening test for elastomers with each of the five primary test fuel compositions. The worst case fuel will then be used for subsequent testing. This would allow comparing each material at its worst against other materials at their worst to indicate suitability for use in a particular application. However, if CM0 is the worst case, use both CM0 and CM15 so that effects of methanol may also be observed. It is also prudent to test elastomers with an auto-oxidized test fuel (Table 3).

Flex modulus will be used as a screening test for plastics with the aggressive version of each of the five primary test fuel compositions. The worst case fuel will then be used for subsequent testing. Again, if CM0 is the worst case, use both CM0 and CM15 so that effects of methanol may also be observed.

The set of test fuels specified in this paper are suitable for screening materials for use with gasoline/methanol fuel mixtures up to 85% methanol. It is recognized that additional test fuels may be needed in the future to deal with special circumstances such as permeability testing.