

The Effect of Ethylene Glycol and Methoxypropanol-Based Coolants on Elastomers

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SEALING THE COOLANT PASSAGES in a liquid-cooled internal combustion engine is becoming more and more difficult as coolant temperatures and pressures increase and as the expected service life from all engine components is extended. This paper attempts to explain what happens when different coolants contact nonmetallic components of the cooling system and how this relates to field performance.

Of particular concern in this paper is the effect of alternate exposure of elastomers to water and to antifreeze/coolant solutions. Year-around use of an antifreeze/coolant is the exception rather than the rule in heavy-duty equipment such as trucks, buses, and off-highway vehicles, so this alternate exposure must be considered.

In 1965 an antifreeze/coolant based on methoxypropanol rather than the traditional ethylene glycol or methanol was introduced for use in heavy-duty equipment under the name Dowtherm® 209 coolant. During the development of Dowtherm 209 coolant, the effect of solutions of methoxypropanol on commonly used hose and seal materials was thoroughly studied. This investigation has continued and was

expanded recently to include a re-evaluation of ethylene glycol - based antifreeze products with respect to the alternate use of water in warm weather and antifreeze/coolant in cold weather.

THEORY BEHIND "RUBBER SWELL"

NONPOLAR ELASTOMERS - The simplest case is that of a nonpolar elastomer, such as natural rubber or GR-S, in contact with an organic liquid. The equilibrium swelling depends upon the degree of cross-linking of the rubber and upon the thermodynamic affinity of the liquid for the hydrocarbon chains.

The latter factor can be simply related to the solvent cohesive-energy-density (CED) or its square root, the "solubility parameter (SP)."

$$CED = \frac{\Delta E_{\text{vap}}}{\text{Molar volume}} = \frac{\Delta H_{\text{vap}} - RT}{\text{Molar volume}}$$

$$SP = (CED)^{1/2}$$

The best swelling agents for a given (nonpolar) elastomer are those which match the polymer in CED and hence in SP.

*Registered trademark.

ABSTRACT

The effect of different coolants on common hose and seal formulations currently in use in heavy-duty engines has been studied. Water, ethylene glycol, and methoxypropanol coolants have been studied in contact with seven

different types of elastomers. A brief discussion of the theory behind rubber swell is presented, as are laboratory and field test data. The data indicate that seasonal failure of hoses and seals may be caused by a sudden change in the composition of the coolant.

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