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R. H. Seiple
University of Akron

G. Hamed
University of Akron

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COMPATIBILITY OF REFRIGERANTS AND LUBRICANTS WITH ELASTOMERS

Robert H. Seiple
Dr. Gary Hamed
University of Akron

RESEARCH GOALS

The research focuses on the compatibility and change of properties when elastomers are immersed in refrigerants and refrigeration lubricants. A wide variety of new materials have been proposed that may replace existing refrigerants and refrigeration lubricants in the near future. This study has been initiated to determine systematically the effect of a selected group of refrigeration materials on the properties of elastomers that now are used as seals and hoses in refrigeration systems. Data generated in this study will be useful to refrigeration equipment manufacturers.

INTRODUCTION

The most important factor affecting the absorption of solvent is the elastomer type. Swelling is maximized when the solubility parameter of the elastomer and solvent are matched. Filler type and amount also influences solvent resistance. Strong polymer-filler interactions will reduce swelling, as will a high degree of crosslinking. Other ingredients such as plasticizers and processing aids will influence since they may be extracted during immersion.

A wide variety of elastomers have been proposed for this study including silicones, poly(vinylidene fluoride:hexafluoropropylene) copolymer, polyisoprenes, styrene butadiene rubbers, nitrile rubbers, butyl rubbers, poly (chlorobutadiene), epichlorohydrins rubbers, polysulfide rubbers, polyurethanes, chlorosulfonated polyethylene rubbers, ethylene propylene rubbers as well thermoplastic elastomers (TPE's) (Santoprenes, Geolasts, Hytrel and butyl TPE).

Compounding ingredients have been chosen to give representative compositions. Liquids, such as plasticizers have been virtually eliminated due to their extractability. As is typical, carbon black has been added in most cases. Where appropriate, several cure systems have been employed.

TEST METHODOLOGY (PHASE I)

A total of 84 formulations will be compounded, cure characterized and molded. Compounding is accomplished using 2 roll mills and internal mixers. Cure characteristics are determined with an oscillating disk rheometer (ODR). Tensile test sheets and swelling test buttons are compression molded at optimum cure.

Polyurethane test sheets and swell test buttons are manufactured using standard casting practices.

It was suggested by the manufacturers that TPE's either be tested as received or after injection molding. Monsanto has provided sheets of both the Santoprene and the Geolast. Hytrel is requested in the same form as the other TPE's. Suitable test samples will be prepared from materials received from the manufacturer without further processing.
Ring samples are cut from a sheet and tested according to ASTM D412. This data is baseline information to compare to results after heat aging (phase II).

Sample buttons are molded for phase I compatibility screening tests. The buttons are accurately weighed and measured prior to testing. Buttons are placed in a test apparatus that will allow measurements to be taken at specified intervals during 14 day immersion in the refrigerant materials. The test apparatus contains a polycarbonate/glass window so that in situ observation and dimensional change measurements can be obtained at normal pressures for the refrigerant under study. Additional sample buttons are placed in tightly sealed 1 ounce jars containing the various lubricants and are also monitored for 14 days.

Aged samples in both the refrigerant and the lubricant materials are removed from the test medium and weight and dimensions are recorded. The samples are allowed to remain at normal laboratory pressure and temperature for 24 hours and these measurements are again recorded.

**TEST METHODOLOGY (PHASE II)**

Materials from phase I which swell less than 30% are selected for further evaluation. Tensile rings are prepared as described in ASTM D412. Rings are placed in a mixture of refrigerant and lubricant (1:7 mixtures) as specified by the ARTI Work Statement. Each is subjected to heat aging tests at 100°C (212°F) in the refrigerant/lubricant mixture, such that pressures remain in the 275 to 300 PSI range.

After 14 days, the test samples are removed from the test chambers and immediately tensile properties (tensile strength, elongation at break, modulus) and hardness are determined. Percent change of properties is reported.