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DISCUSSION

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The siloxane series of fluids offers unique opportunities to observe the influence of structural variations on rheological properties of interest in thin film lubrication. There is always danger in overgeneralization, but the results of this paper offer tempting guidelines for speculating on the behavior of other fluid types in concentrated contacts. Can the authors indicate the extent to which such generalization might hold up?

One of the anomalies of concentrated contact lubrication has been the general acceptance of the importance of pressure-viscosity coefficients in analytical studies but the inability to demonstrate that effect experimentally. The observation in the present paper is that differences in pressure-viscosity coefficient disappear at higher temperatures (e.g., 149 deg C), which are still modest for many applications. When we add to the high ambient temperatures the very substantial transient increases in fluid temperature in the contacts [12], it becomes apparent that our real knowledge of lubricant conditions in concentrated contacts is very weak. We hope that IR analysis methods will allow a much better definition of fluid state in concentrated contacts in the near future.

The authors have pointed out the deficiency of Roelands' chart for correlating pressure-temperature-viscosity behavior of fluids. Are there alternate correlation methods that are more accurate or otherwise more useful than that of Roelands'?

Several years ago, two of the authors obtained some pressure-viscosity data at relatively high shear stresses for NASA-Lewis with fluids of interest in our lubrication research program. At that time we were concerned about viscous heating in the capillary as the potential origin of non-Newtonian behavior, as mentioned by the present authors. Data on the same fluids obtained with an oscillating crystal method at the University of Oklahoma Research Institute (NASA CR-120786) gave similar results. Both evaluation methods showed non-Newtonian effects, and the oscillating-crystal method was not subject to the capillary viscous heating influence.

The structural rearrangements of the present paper deal with side chain effects and polymeric chain lengths, but without modification to the structure of the chain. Can the authors provide general guidelines as to the effects of other type of structures (e.g., aromatic) in the molecules backbone on pressure viscosity.

Additional References

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The authors are to be congratulated on a careful piece of work that is a significant contribution to our understanding of the behavior of silicone fluids.

Data presented clearly indicate that chemical composition is the dominant factor governing the pressure-viscosity characteristics of these materials. However, it appears to this discussor that the significant differences observed between alkylmethyl, phenylmethyl trifluoropropylmethyl, and methylhydrogen polysiloxanes probably reflect basic differences in intermolecular interactions, rather than mere differences in bulk of the substituent as the authors suggest. If size of the substituent alone were the governing factor, greater differences might be expected between dimethylpolysiloxane and decylmethylpolysiloxane than are actually observed.

The conclusion that degree of polymerization has little effect on the pressure-viscosity behavior was arrived at by considering a series of octylmethylpolysiloxanes endblocked with trimethylsiloxy moieties in which the minimum degree of polymerization was four to five. This conclusion may not hold for shorter chains when the trimethylsiloxy groups become a significant portion of the molecule.

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This paper is a welcome addition to the literature at a time when silicone fluids are being used in mechanical applications to a much greater degree. Several of the fluids tested have been checked in our laboratories and by Wolveridge. The agreement is well within the experimental error.

From a practical standpoint, we find it interesting that there is very little correlation between pressure-viscosity and sliding-friction lubricity. This is quite clear as we notice that the authors find no difference in viscosity-pressure characteristics as the alkyl group increases in length, but all authors (Tabor, Archard, Brown, etc.) find a sharp decrease in friction and wear when the alkyl side group reaches 6 to 8 carbons in length. Likewise, the materials with the greatest viscosity-pressure dependence (phenyl fluids) have the poorest lubricity.

Since the same characteristics hold in a disk tester, we must conclude that pressure-viscosity alone has little effect on lubricity, except in homologous series.

The data presented by the author, coupled with lubricity experience with the fluids, should serve as a starting point for most interesting studies.

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