

## DISCUSSION

W. Philippoff<sup>2</sup>

The authors state correctly the theory and the evaluation of the capillary experiment according to the present stand of science. Therefore the theoretical approach to the problem seems to be completely adequate. The experimental approach is equally adequate. However, the discussor does not consider the conclusions from their experiments to be fully substantiated by their own results. According to previous experience, the influence of high pressure on polymer solutions such as polymer-modified oils, is more or less equivalent to a decrease in temperature. This causes a small extension of the range of constant viscosity towards higher shear stresses. This seems to be present in the results reported in this paper. It would be a considerable improvement in the paper if instead of presenting absolute viscosities at different constant hydrostatic pressures, a curve of the *relative* viscosity = (viscosity of the blend)/(viscosity of base stock) at different constant hydrostatic pressures for one liquid as a function of shear stress be given. This would allow one to see if changes occur with higher hydrostatic pressures. The main conclusion of the authors, namely, the increase in viscosity in the "second Newtonian Region," does not seem warranted from this paper: the precision of the experiments does not allow an unambiguous plot of this asymptote. As seen especially in curve E, Fig. 4, the discrepancies between different capillaries are larger than the possible differences between a steadily decreasing curve and an asymptote. The same applies to curves D and E of Fig. 5. It would be better seen if an increase in this viscosity occurs, using the plot suggested above, possibly shifting along the  $\tau$ -axis.

W. A. Wright<sup>3</sup>

The existence and importance of elastic effects in polymer-blended lubricants is frequently discussed. The paper by Messrs. Novak and Winer contributes to this directly by measurements on lubricant polymer blends at temperatures and pressures of practical interest. The observation was made that elasticity, evaluated

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as recoverable shear strain, decreases with increase in pressure for at least one typical system. The low pressure recoverable shear strain was not large or even present in all systems, even though the oil-polymer blends studied contained distinctly more than the usual amount of polymer. A small amount of data taken in our own laboratory on some commercial polymer-containing lubricants also indicated the elasticity components of flow were not large at atmospheric pressure.

The authors' data do not cover all possibilities by any means, but the variations in polymer types and solvent oils are wide enough to have some significance. It might be possible that elastic effects will not be as prominent a factor for such lubricants as has been suggested in the past. It is also possible that distinctly different orders of time scale in evaluation might be required. Even then, the practical significance in lubrication would be narrowed. Only continued experience will answer these questions.

It is worth pointing out that the discussion and speculations based on less complete data in the past will certainly be better clarified by the extended range data from the authors' equipment. They have shown that their equipment is capable of extending our knowledge in both fundamental and practical areas. It is hoped that they will continue to further evaluate these important types of fluids.

## Authors' Closure

The authors wish to express their appreciation to Messrs. Philippoff and Wright for their comments which add to the value of the paper. However, Dr. Philippoff's criticism of our "main conclusion" may be confusing to the reader because the "main conclusion" being criticized cannot be found in the paper. This is because Dr. Philippoff's comments were made after reading the original manuscript which we subsequently modified because we felt that the criticism was justified on the basis of the data available at present. Although we notified him of the changes in the manuscript so that he could modify his discussion, apparently no changes in his discussion were made. Dr. Philippoff's suggestion of using a plot of relative viscosity versus shear stress or some reduced parameter shifting the data along the ordinate is currently being investigated.