ABSTRACT

Wear of screw flights and barrel of single-screw extruders can result in a considerable loss of extruder operating efficiency. Often wear cannot be accounted for in terms of normal "wear and tear" of the equipment and more subtle causes may be responsible. A study is made of the causes of mechanical wear of single-screw extruders. These causes include buckling and whirling, the weight of the screw, and lateral forces due to poor screw design and manufacture. The most important factors affecting the wear of screw flights and barrel are determined. It appears that wear can largely be reduced by proper design and manufacture of extruders.

Whatever the cause of wear of extruders, it is important that metal to metal contact between the screw flights and barrel be avoided as much as possible. The possible hydrodynamic lubrication of the surfaces is investigated. Two designs for flight profiles which should improve the lubricating effect of the polymer melt in the clearance are proposed. By modifying the flight to take the form of a'step' or 'tapered-land' pad bearing, hydrodynamic pressures may be developed in the clearance. A numerical method for the rheodynamic lubrication of the screw flights and barrel is developed to determine the effectiveness of the designs for polymer melts which are highly non-Newtonian. Theoretical results obtained for a typical extruder and polymer melt indicate that adequate hydrodynamic lubricat-

ion of the surfaces can be provided with the new flight designs and that these designs can be optimized to reduce wear. Of these designs the 'step' appears to be the more effective.

To verify the calculated results, an experimental rig is built to measure the pressures developed in a preset clearance. Plain and stepped flight geometries are tested for a polymer solution with significant non-Newtonian behaviour. The results indicate that hydrodynamic pressures can be developed in the clearances with the higher pressures developed in the case of the modified flight. Very conservative pressures are predicted. The discrepency between the measured and predicted results is explained in terms of the effects of side-leakage which tends to relieve pressures.

A single-screw extruder is also built to determine whether hydrodynamic pressures can be developed in the clearance between an actual rotating screw and a barrel. The extent of the effects of the stepped flight profile on pressures developed and on the output of the extruder are determined. It is found that hydrodynamic pressures are not developed in the clearance with a plain flight profile but pressures can be developed in the clearance with the stepped flight profile. The flight modification produces a drop in the pressure developed at the output end of the extruder which is relatively small and therefore, the flow rate is unlikely to be significantly reduced with the new flight designs.