The object of this paper is to develop a background for optimum design and operation of the polycondensation reactor based on real time measuring the flow behaviour of molten polymers.

The capillary rheometer illustrated in Fig. 1 consists of a metering pump (3) developing flow rates from 6 to 300 cm\(^3\)/s and an interchangeable capillary block (4) with the capillary tube (5). The two blocks are heated at the temperature \(T_4\) that is close to the level of \(T_2\) and \(T_3\). The polymer melt from the main line at the temperature \(T_1\) and pressure \(P_1\) flows through the inelt valve (1) into the pump (3) and enters in the inlet reservoir where pressure \(P_2\) and temperature \(T_2\) are measured. After passing the capillary tube (5) the pressure \(P_3\) and temperature \(T_3\) are measured and the polymer melt is either returned to the main line (on-line operation) or removed from the system (off-line operation). The overall accuracy and repeatability of the measurements are 1 percent of full scale and the reponse time is less than 1 min. for the illustrated configuration.

Figure 1. Process Capillary Rheometer
The principal factors that have to be taken into consideration by real time measuring of viscosity are: the capillary tube and reservoirs size and geometry, the metering pump speed and flow rate, the pressure measurement, the pressure in the main line and the isothermal flow through the capillary tube. The energy losses due to sudden contraction and enlargement by entering and leaving the capillary tube are neglected. The chosen capillary tubes have a length to radius ratio of at least 100 and the pressure sensors are installed very close to the capillary edges. The isothermal flow of polymer melt through the capillary tube depends on the actual viscosity of the polymer and the shear rate. In the case of a disk ring continuous polycondensation reactor (CPR) for manufacturing of polyethylene terephthalate (PET) the polymer viscosity is maintained constant so that the isothermal flow is attained at so called "isothermal shear rate" (see Fig. 2).

The melt viscosity is affected by the fluctuation of the polymer pressure in the process line. Fig. 3 illustrates the strong dependency of the apparent viscosity of PET melt from the pressure in the main line for off-lines and on-line operations of the capillary rheometer.

A few on-line capillary rheometers are provided with a second discharge metering pump assuring a linear proportionality between apparent viscosity and shear stress. The discharge pump keeps the pressure $P_3$ equal to the melt vapor pressure.