

# COMPACT, WIDE RANGE ROTATING VISCOMETER

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*Abstract : A rotary viscometer using an eddy current brake for the measurement of momentum. The instrument covers a range of 0.5 to 30000 mPa.s without changing the measuring cell. The resolution is better than 0.1% and the accuracy 0.2%. A Peltier thermostat controls the measuring temperature from -20°C to 100°C with 0.01°C accuracy. Fast response and a short measuring time are the benefits of this instrument.*

*Keywords: rotary viscometer, momentum measurement, eddy current brake*

## 1 INTRODUCTION

Capillary viscometry is widely used in the oil industry. Even if the measuring procedure is performed automatically, one measurement takes 20 to 30 minutes due to the large amount of sample to be thermostatted. Since one capillary covers a relatively small range, different instruments have to be used to cover a larger range. A small rotating viscometer will be presented which reduces the amount of sample needed and the measuring time by a factor of 10.

## 2 PRINCIPLE

A cylinder floats in a rotating tube filled with a sample to be investigated. This cylinder is lighter than the surrounding sample and is therefore pushed to the centerline by centrifugal forces. No other disturbing suspension is needed. The cylinder carries a small permanent magnet which acts in combination with the surrounding copper housing as an eddy current brake. The momentum of the eddy current brake is equal to the momentum of the viscosity depending on the shear force in the space between the cylinder and the bore of the rotating tube. The viscosity ( $\eta$ ) is calculated from the ratio of the speed of revolutions of the tube ( $n_2$ ) and the cylinder ( $n_1$ ).

$$\eta = K/(n_2/n_1 - 1)$$

The constant K is calculated by the measurement of one viscosity standard liquid.

## 3 REALIZATION

The glass tube rotates, driven by a synchronous motor, at a constant speed of 3500 rpm in the bore of a copper housing, where the temperature is controlled by Peltier elements. A hollow cylinder made of titanium fits into the glass tube leaving a space of 0.4 mm. Inside the cylinder there is a small Cobalt-Samarium magnet. This acts as the eddy current brake and detects the revolutions by means of a Hall-sensor. Spherical bearings at both ends of the tube are both support and seal at the same time.

## 4 RESULTS

The ratio of speeds of revolution varies between 10.00 and 1.0002000 according to the measured viscosity. Due to digital evaluation this wide range is covered without loss of precision. This precision depends on temperature stability and the surface finish of the wetted parts - it does not depend on the user's skill.

## 5 FEATURES

viscosity range : 0.5 - 30000 mPa.s

temperature range : 0°C -100°C

precision :  $1 \cdot 10^{-3}$

accuracy :  $2 \cdot 10^{-3}$

amount of sample:  $\sim 1 \text{ cm}^3$

measuring time including temperature equilibrium : 2 - 3 min. typ.

temperature change : 5 K/min.