Rotary Viscosimeter (Viscometer)

1.   TECHNICAL DESCRIPTION, BACKGROUND

In the pharmaceutical industry a company asked the department to make a CFD (Computational Fluid Dynamics) simulation of their process. In order to do this, the department required the material properties of the fluids being made. Being that the pharmaceutical company could not provide this data, nor was the department allowed to obtain a sample of the fluids for investigation in the lab (security reasons), the department took a mobile viscosimeter measurement rig out to the company.
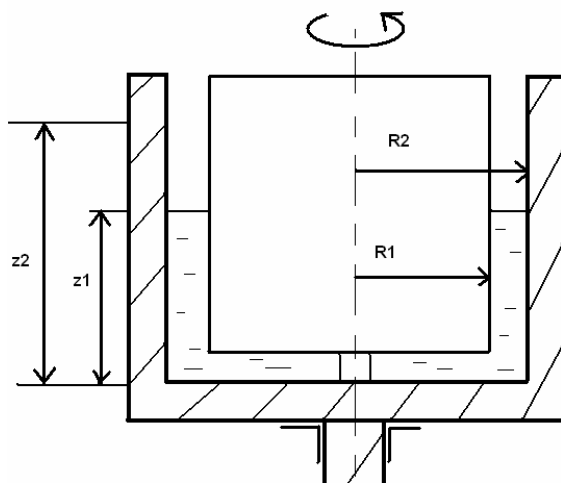

Figure 1

2.   HOW DOES THE VISCOSIMETER FUNCTION?

- We stop the inner cylinder of the apparatus, and then spin the outer cylinder at a constant speed.

- How can the viscosity of the fluid be measured?

- Calculate the kinematic viscosity of the fluid being examined.

Data:

Properties of fluid: density ρ=800 [kg / m^3]

$R1$= 50 [mm]

$R2$= 52 [mm]

$Z1$= 150 [mm]

$Z2$= 200 [mm]

ω =20 [$1/s$]

The torque which is measured for $z1$ $M1t$= 0.1142 [Nm]

The torque which is measured for $z2$ $M2t$= 0.1456 [Nm]

3.   **ANSWER**

$M=?$

$M=rF+Mf$

(Mf is the torque caused by the shear stress resulting on the bottom of the cylinder.)

$r=?$

$r=R1$

$F=?$

$F=\tau A$

$A=?$

$A1=2\pi R1z1$ or $A2=2\pi R1z2$

$M1t= \tau 2\pi R1^2z1+Mf$

$M2t= \tau 2\pi R1^2z2+Mf$

How should *Mf* be eliminated from the equation?

$M2t- M1t$

$M2t- M1t= \tau 2\pi R1^2(z2-z1)$

Solving for the shear stress

$\tau = (M2t- M1t)/ 2\pi R1^2(z2-z1)$

Solving for the kinematic viscosity

$\tau =\mu(du/dr)$

$(du/dr)=?$

$(du/dr)=(R2\ \omega)/(R2-R1)$

$v =?$

$v= (\tau/\rho)(dr/du)= 0.000096[m^2/s]$