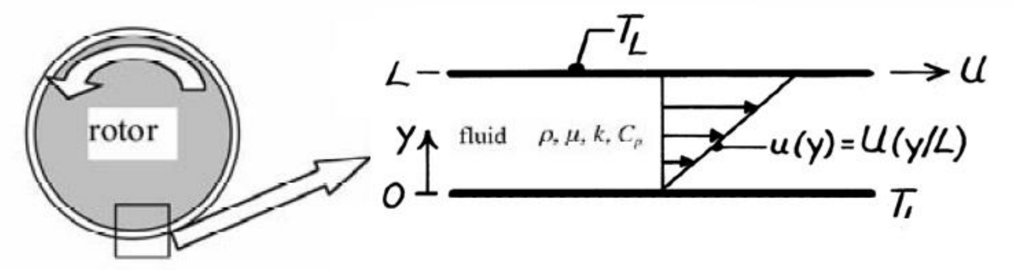
1. Couette flow is generated by the relative motion of two parallel plane walls. One of the walls is moving in its own plane with the constant velocity *U*. The other wall is assumed to be at rest. The wall motion drives the fluid filling the gap of spacing L between the two walls (Figure). This situation is relevant to lubrication, where a rotor rotates in a bearing. The gap spacing is assumed to be very small compared to the rotor/bearing radii so that curvature effects may be ignored.

(i) Determine the temperature profile, expressing your result in terms of fluid properties and the temperature and speed of the moving plate.

(ii) Obtain an expression for the heat flux at the moving plate.

(iii) Determine the influence of dissipation on the velocity profile and heat transfer between the walls and the fluid.



We have solved this problem in class

2. In problem 1 with solve the following,

(i) Determine the velocity profile and plot the same, when the fluid viscosity varies linearly as a function of temperature in the range defined by the walls' temperature.

(ii) Determine the temperature profile and plot the same, expressing your result in terms of fluid properties and the temperature and speed of the moving plate.

(iii) Determine the heat flux at the moving and the stationary plate.

(iv) Determine the influence of dissipation on the velocity profile and heat transfer between the walls and the fluid. Plot the temperature profile for different Brinkman number (0 to 10)

Data: An experiment is carried out with oil in the gap between the two walls: L = 1 cm, T_1 = 27°C, T_L = 37°C, ν (27°C) = 5.5 ×10^{-4} m^2 s^{-1}, ν (37°C) = 3.63 × 10^{-4} m^2 s^{-1}.

Ans: (i) $\dfrac{u(\eta)}{U}=\dfrac{\ln\left(1-\dfrac{2\lambda\eta}{1+\lambda}\right)}{\ln\left(\dfrac{1-\lambda}{1+\lambda}\right)}$; Where $\lambda=\dfrac{\Delta\mu}{\mu_m}=\dfrac{\mu(T_1)-\mu(T_L)}{\mu(T_1)+\mu(T_L)}$ and $\eta=\dfrac{y}{L}$;

The fluid viscosity at the mean temperature (T_1 + T_2)/ 2 is denoted as μ_m. and

$\Delta\mu=\mu_m-\mu(T_2)=\mu(T_1)-\mu_m$

3. In problem 1 if we have a Plane Poiseuille flow instead of Couette flow then solve the following,

(Assume the flow to be thermally fully developed)

(i) Determine the temperature profile and plot the same, expressing your result in terms of fluid properties and the temperature.

(ii) Obtain an expression for the heat flux at the moving plate.

(iii) Determine the influence of dissipation on the velocity profile and heat transfer between the walls and the fluid.

Note: You have to solve problem 2 and 3 only.