Practice problem on Heterogeneous Slurry Transport

Modified Durand equation for heterogeneous slurry flow in horizontal direction through a cylindrical pipe with uniform cross-section is given by:

$$\frac{-\Delta P_m}{-\Delta P_L} = 1 + 150(1-\varepsilon)\left(\frac{Dg(\rho_s - \rho_L)}{V_{avg}^2 \rho_L \sqrt{f_D}}\right)^{1.5}$$

Where, V_{avg} = superficial velocity of slurry

ΔP_m = pressure drop for transporting slurry

ΔP_L = pressure drop for transporting carrying liquid at the same superficial velocity at which slurry transport takes place.

f_D = Drag co-efficient of particle

ε = volume fraction of carrying liquid in slurry

ρ_s and ρ_l are solid and carrying liquid density respectively.

D = diameter of pipe.

Calculate the power consumption for horizontal slurry transport of ore particles (density, ρ_s =3000 Kg/m^3) across a pipe of length 50m. The mass flow rate of solid particles is 30kg/min. Mass wise ratio of carrying liquid to solid in inlet stream is 2:5. Other important data are following: Diameter of pipe (D) =0.07m, Mean particle diameter (d) = 0.45 m, Viscosity of carrying liquid = 1X10^{-3} Pa.s, density of carrying liquid =1000 Kg/m^3. Roughness of pipe (ζ) = 0.0112, Mechanical efficiency of power source (motor/pump)= 0.7. You have to use Moody's plot and Drag-coefficient plot (assume particles are spherical).

Moody Diagram