Exam Date & Time: 17-Nov-2022 (02:00 PM - 05:00 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

VII Semester End Semester Examination
Non-Newtonina Flow in Process Industries (CHE 4067)

NON-NEWTONIAN FLOW IN THE PROCESS INDUSTRIES [CHE 4067]

Marks: 50 **Duration: 180 mins.**

Descriptive Questions

Answer all the questions. Section Duration: 180 mins

1) Distinguish the different mathematical models used to represent the viscoplastic fluid behaviour? (3)

A)

B) Classify the non-Newtonian fluids (3)

C) Distinguish the different mathematical models used to represent the shear thinning fluid behaviour and their limitations? (4)

2) Compare the concentric cylinder rheomoter with parallel plate rheometer. (3)

A)

B) Solve for flow behavior index of given non-Newtonian fluid where the shear stress vs shear rate data provided below and flow consistency coefficient is 7.5 Pas^n (5)

shear rate, s^{-1}	0.443	0.7	2.22	3.52	5.2	7.2	8.9	10.2
shear stress, Pa	3.5	5.35	16.3	25.3	35.2	48.7	58.1	65.7

C) Define the non-Newtonian fluid (minimum four points) (2)

3) Calculate the Reynolds number of the non-Newtonian fluid, flows in circular pipe with an internal diameter of 20 mm. The average velocity is 1.2 m/s and the solution density is 1010 Kg/m^3. The consistency index and flow behavior index are 2 Pa s^n and 0.7 (2)

A)

B) Bingham plastic fluid is flowing in a pipe with velocity 0.21 m/s. The ID of pipe is 12.7 mm, fluid viscosity and density are 2.1 cP, density of 1200 kg/m^3 respectively. At (4)

particular shear stress of 30 Pa, the rate of shear is 9000 s^{-1}. Calculate the friction factor offered by the pipe.

C) Calculate the maximum velocity at which non-Newtonian fluid will be flowing down a wide inclined surface (30^0 degrees from horizontal) as a 3 mm thick film. The shear stress and shear rate behaviour of this polymer solution may be approximated as power law equation with m=3 Pa.s^n and n=0.7 and density 1006 kg/m^3. Tabulate the $V_z/V_{z,max}$ and y/H (atleast 5 values). (4)

4) A non-Newtonian polymer solution (density 1028 kg/m^3) is in steady flow through 25.4 mm internal diameter and 200 m long pipe at the mass flow rate of 1000 kg/min. The solution follows the power law mathematical model, its flow behavior index is 0.7 and

A) flow consistency coefficient is 0.3 Pa .s^n. Determine the power required for this flow in pipe line. (5)

B) Define the gas and liquid holdup in two phase flow? (2)

C) Compare the various flow regimes of two phase flow in gas-non-Newtonian fluid flow (3)

5) The rheological properties of a non-Newtonian fluid is approximated with power law model (shear rate range of 10 to 90 s^{-1} with shear stress range of 15 and 110 Pa respectively). Estimate the pressure drop where the fluid flow in a 40 mm diameter pipe

A) with 200 m long when the centreline/ maximum velocity is 0.6 m/s. (3)

B) Bingham plastic fluid is flowing in 25.7 mm ID pipe with 0.1 m/s velocity with a density of 1030 kg/m^3 with a Reynolds number of 1250 & Headstrom number is 500000. Calculate the yield shear stress of Bingham fluid (2)

C) Air is injected into a horizontal pipe of 40 mm internal diameter carrying a non-Newtonian fluid of density 1400 kg/m^3. The rheological properties of fluid are m=5 Pa.s^n and n=0.4. The velocity of air and liquid are 0.5 and 0.35 m/s respectively. The air is introduced in the pipe with density of 1.5 kg/m^3 and viscosity of $1.8x10^{-5}$ Pa.s. The correction factor "J=0.296". Estimate the two phase flow pressure drop in the pipe. (5)

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