**ASSIGNMENT**

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**COURSE CODE:** PTE 516

**COURSE TITLE:** MULTIPLE PHASE FLOW IN PIPES

**QUESTIONS**

1. Summarize all the horizontal multiphase flow regimes from the attached document.
2. Solve the question "10-4" on the attached document.
3. Solve the question "10-6" on the attached document.
4. Summarize flow through restriction on both single-phase liquid flow and single-phase gas flow and solve the question "10-11" on the attached document.

**10-4:** Using the Baker, Mandhane and Beggs and Brill flow regime maps, find the flow regime for the flow of 500bbl/d oil and 1000SCF/bbl of associated gad in a 2-in flow line. The oil and gas are those described in Appendix B, σl=20 dynes/cm, the temperature is 120°F and the pressure is 1000psia.

**10-6:** Using the Beggs & Brill, Eaton and Dukler correlations, calculate the pressure gradient for the flow of 4000bbl/d of oil and 500SCF/bbl of associated gas (Appendix B oil and gas) flowing in a 3-in I.D. line with a relative roughness of 0.001. T=150°F, P=200psia and σl=20dynes/cm. Neglect the kinetic energy pressure gradient.

**10-11:** Construct choke performance curves for flowing tubing pressures up to 1000psi for the well of Appendix B for choke sizes of 8/64, 12/64, and 16/64in.

**ANSWERS**

QUESTION 1

**FLOW REGIMES**

According to Brill and Beggs (1978), 3 types of horizontal multiphase flow regimes were described;

**SEGREGATED FLOWS:** In this type of flow, the two phases are separate for the most part. It is further classified into stratified smooth, stratified wavy (ripple flow) and annular.

**Stratified smooth** flow consists of liquid flowing along the bottom of the pipe, with a smooth interface between the phases. This flow regime occurs at relatively low rates of both phases. At higher gas rates, the interface becomes wavy and **stratified wavy flow** results. **Annular flow** occurs at high gas rates and relatively high liquid rates and consists of annulus liquid droplets entrained in gas.

**INTERMITTENT FLOWS:** In this type of flow, the phases (gas and liquid) are alternating. The intermittent flow regimes are slug flow and plug (also called elongated bubble) flow. **Slug flow** consists of large liquid slugs alternating with high-velocity bubbles of gas that fills almost the entire pipe. In **plug flow**, large gas bubbles flow along the top of the pipe which is otherwise filled with liquid.

**DISTRIBUTIVE FLOWS:** This type of flow is that in which one phase is dispersed in the other phase. The types of distributive flow regimes described by Brill and Beggs are bubble, dispersed bubble, mist and froth flow.

The **bubble flow** regimes differ from those described for vertical flow in that the gas bubbles in a horizontal flow will be concentrated on the upper side of the pipe. **Mist** flow occurs at high gas rates and low liquid rates and consists of gas with liquid droplets entrained. Mist flow will often be similar to annular flow and many flow regime maps use the term “annular mist” to denote both of these regimes. **Froth flow** is used by some authors to describe the mist or annular mist flow regime.

QUESTION 4

**FLOW THROUGH RESTRICTION ON BOTH SINGLE-PHASE LIQUID FLOW AND SINGLE-PHASE GAS FLOW**

Flow through chokes

A wellhead choke is a device that places a restriction in a flowline and is used to control the flowrate for most flowing wells.

A single phase liquid rarely passes through a well head choke because the flowing tubing pressure is almost always below bubble point.

QUESTION 2 AND 3

