**MUTU EMMANUELLA TOMBRAPADE**

**15/ENG07/029**

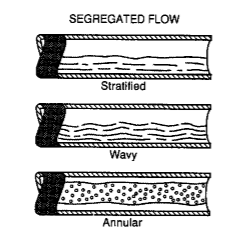
**PETROLEUM ENGINEERING**

**PTE 516**

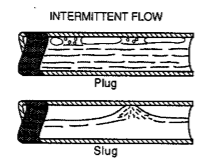
**1. Multiphase flow** in horizontal pipes differs markedly from that in vertical pipes, except for the Beggs and Brill correlation which can be applied for any flow direction, completely different correlations are used for horizontal flow than for vertical flow.

**Flow Regimes**

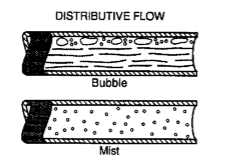
1. **Segregated Flow** (the two phases are for the most part separate): Classified as stratified smooth, stratified wavy or annular. Stratified smooth flow consists of liquid flowing along the bottom of the pipe and gas flowing along the top of the pipe, with a smooth interface between the phases. This 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 an annulus of liquid coating the wall of the pipe and a central core of gas flow with liquid droplets entrained in the gas.



1. **Intermittent Flow** (gas and liquid are alternating): These are slug flow and plug (elongated bubble) flow. Slug flow consists of large liquid slugs alternating with high-velocity bubbles of gas that fill almost the entire pipe. In plug flow, large gas bubbles flow along the top of the pipe, which is otherwise filled with liquid.



1. **Distributive Flow** (one phase is dispersed in the other phase): It includes bubble, dispersed bubble, mist, and froth flow. The bubble flow regimes differ from the 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 indistinguishable from annular flow, and many flow regime maps use “annular mist” to denote both of these regimes. Froth flow is used by some authors to describe the mist or annular mist flow regime.



**4. Flow Through Restrictions**: the flow rate from almost all flowing wells is controlled with a wellhead choke, a device that places a restriction in the flow line. A variety of factors may make it desirable to restrict the production rate from a flowing well, including the prevention of coning or sand production, satisfying production rate limits set by regulatory authorities, and meeting limitations of rate or pressure imposed by surface equipment.

1. **Single-Phase Liquid Flow**: The flow through a wellhead choke will rarely consist of single-phase liquid, since the flowing tubing pressure is almost always below the bubble point. However, when this does occur, the flow rate is related to the pressure drop across the choke by

Where C = flow coefficient of choke

A = cross-sectional area of choke

The equation above is derived by assuming that the pressure drop through the choke is equal to the kinetic energy pressure drop divided by the square of a drag coefficient. This equation applies for subcritical flow, which will usually be the case for single-phase liquid phase.

1. **Single-Phase Gas Flow**: When a compressible fluid passes through a restriction, the expansion of the fluid is an important factor. For isentropic flow of an ideal gas through a choke, the rate is related to the pressure ratio, p2/p1,

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Which can be expressed in oilfield units as

Where qg is in MSCF/d, D64 is the choke diameter (bean diameter) in 64ths of inches, T1 is the temperature upstream of the choke in oR, γ is the heat capacity ratio, Cp/Cv, is the flow coefficient of the choke, γg is the gas gravity, psc is standard pressure, and p1 and p2 are the pressure upstream and downstream of the choke, respectively.

The equations above apply when the pressure ratio is equal to or greater than the critical pressure ratio, given by

When the pressure ratio is less than the critical pressure ratio, p2/p1 should be set to (p2/p1)c and the equation above used, since the flow rate insensitive to the downstream pressure whenever the flow is critical. For air and other diatomic gases, γ is approximately 1.4, and the critical pressure ratio is 0.53; in petroleum engineering operations, it is commonly assumed that flow through a choke is critical whenever the downstream pressure is less than about half of the upstream pressure.

