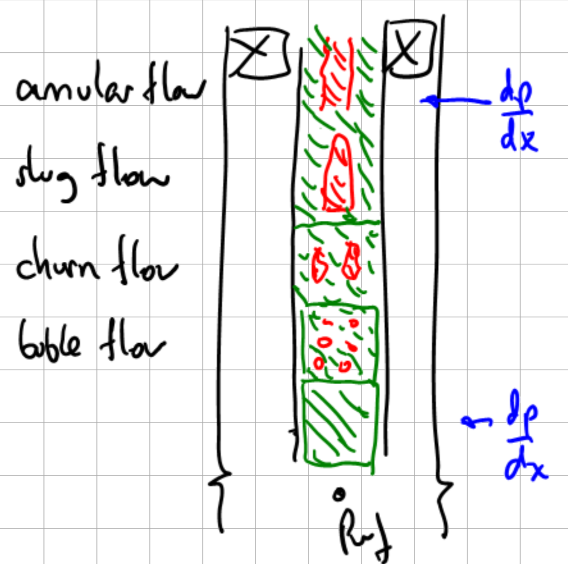
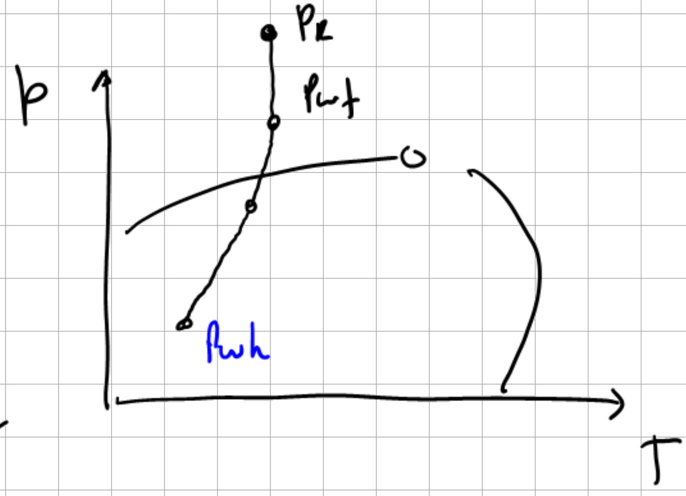
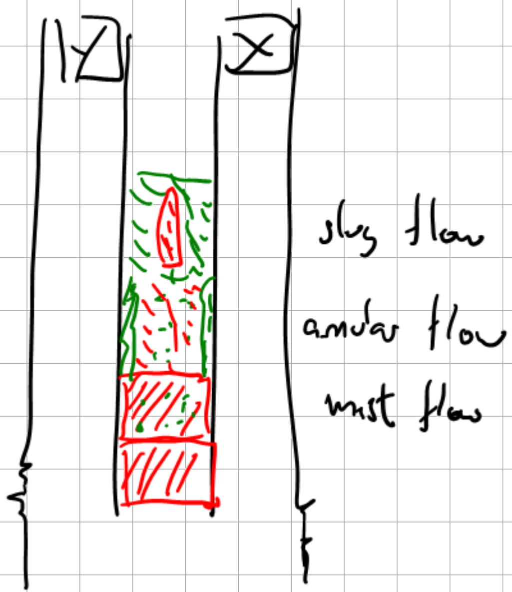
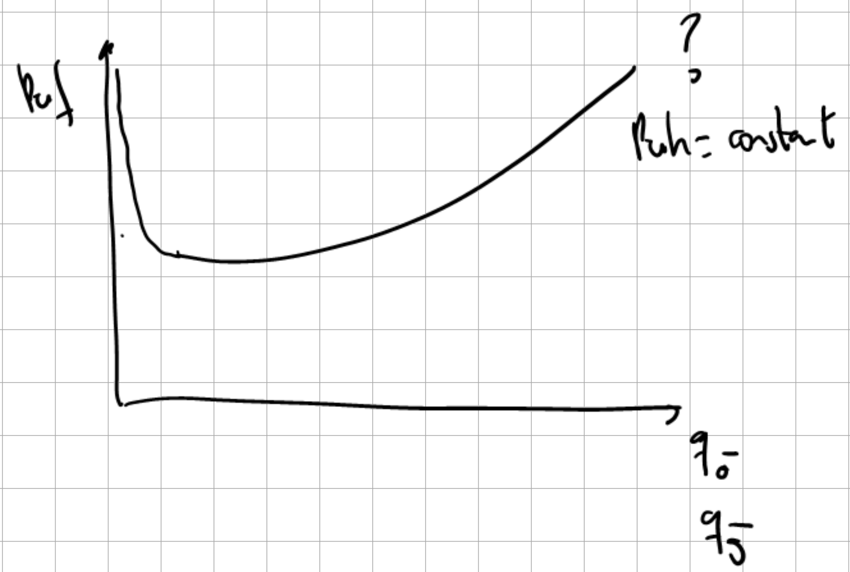
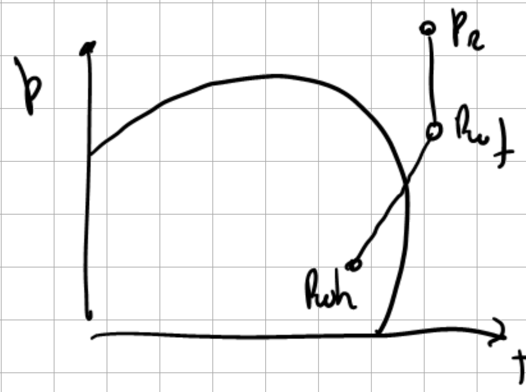






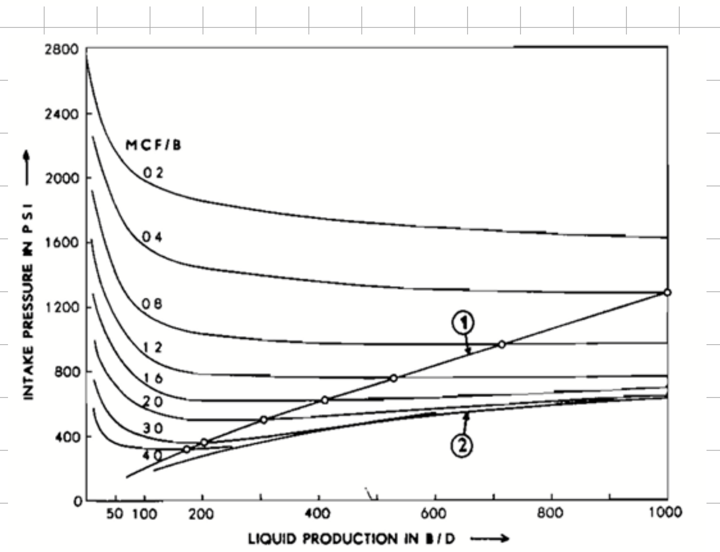
flow patterns





Flowing and Gas-lift Well Performance †

W. E. GILBERT*



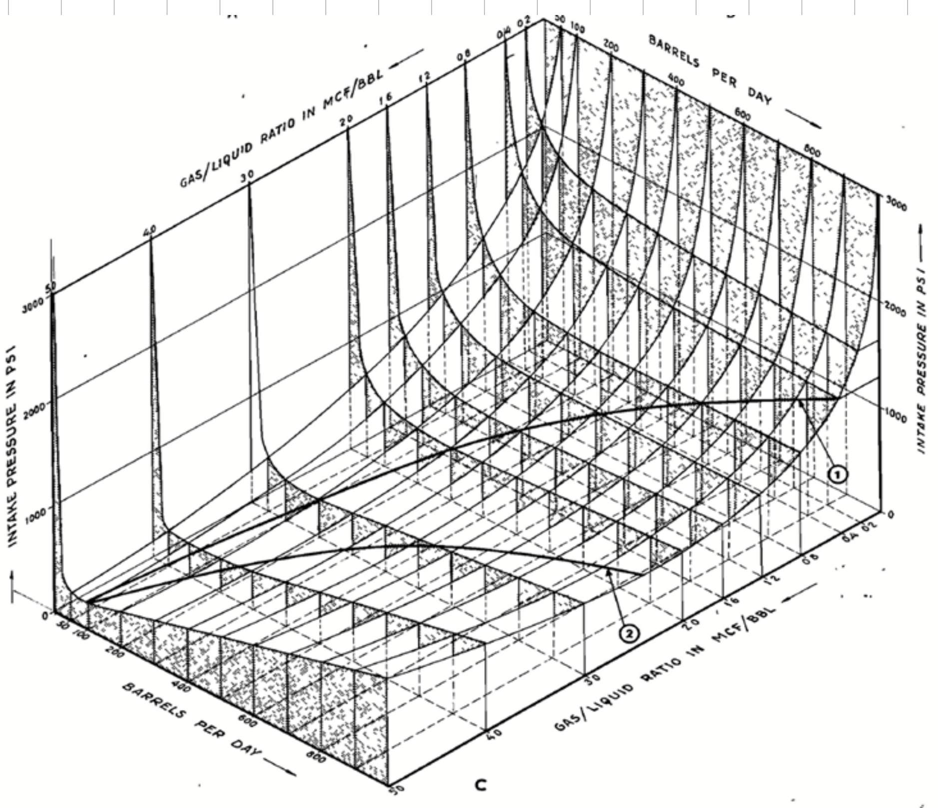
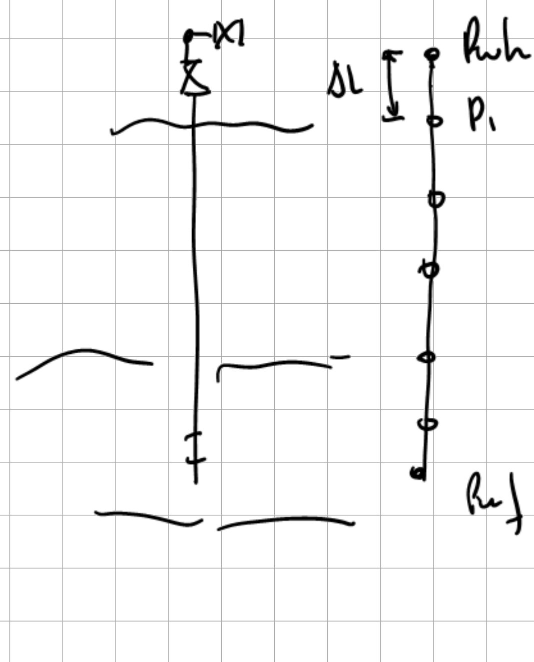


Fig. 6—The Two-phase Vertical-lift Function for 2.875-in. Tubing Set at 8,000 Ft
(Tubing Pressure = Zero Psi Gage)

$$\Delta p_{tubing} = \Delta p_{hydrostatic} + \Delta p_{friction}$$



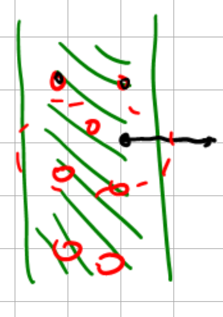
$$\left.\frac{dp}{dx}\right|_{P_{wh}} \rightarrow P_1$$

$$P_1 = P_{wh} + \left.\frac{dp}{dx}\right|_{P_{wh}} \cdot \Delta L \quad ?$$

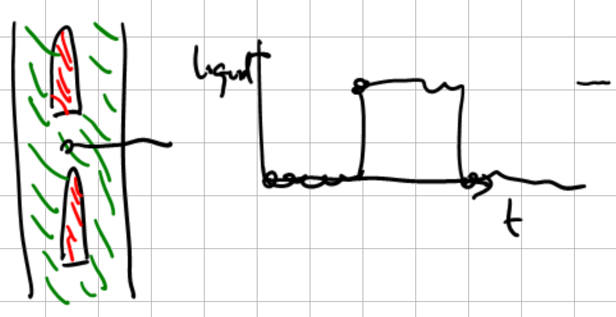
$$P_2 = P_1 + \left.\frac{dp}{dx}\right|_{P_1} \cdot \Delta L$$

integration

marching algorithm



$$\frac{d}{dt} \neq 0$$



$x \qquad \bar{x} \quad \int_t x \; dt \qquad \bar{x} = \int_A x \; dA$

$\frac{dp}{dx}$ → PVT properties $(\rho_L, \rho_g, \mu_L, \mu_g, \sigma_{Lg}, x_g)$ ← mass fraction

→ velocity (q_g, q_L)

→ A, ϕ, θ, e ← roughness

Steady-State Multiphase Flow—Past, Present, and Future, with a Perspective on Flow Assurance

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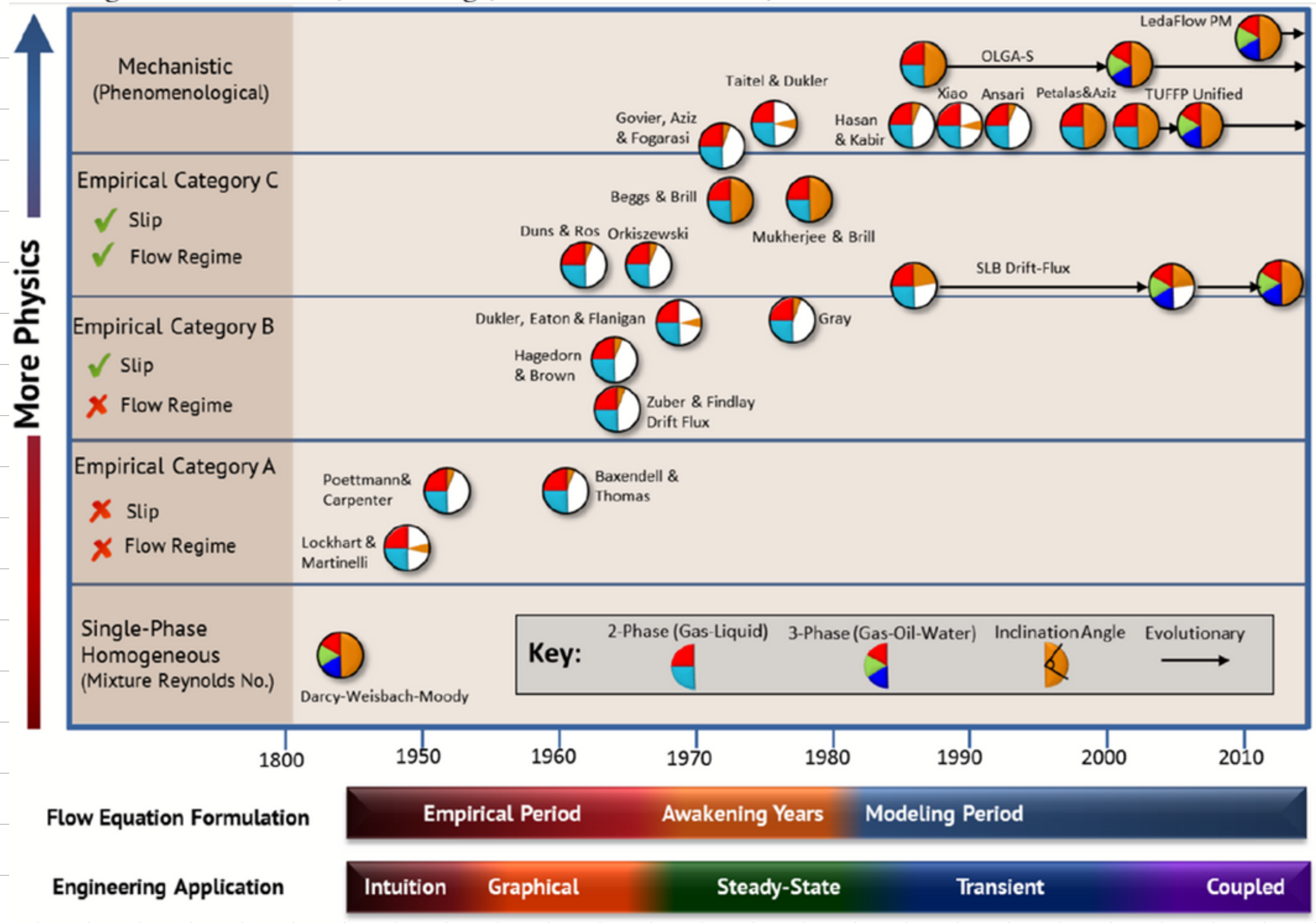
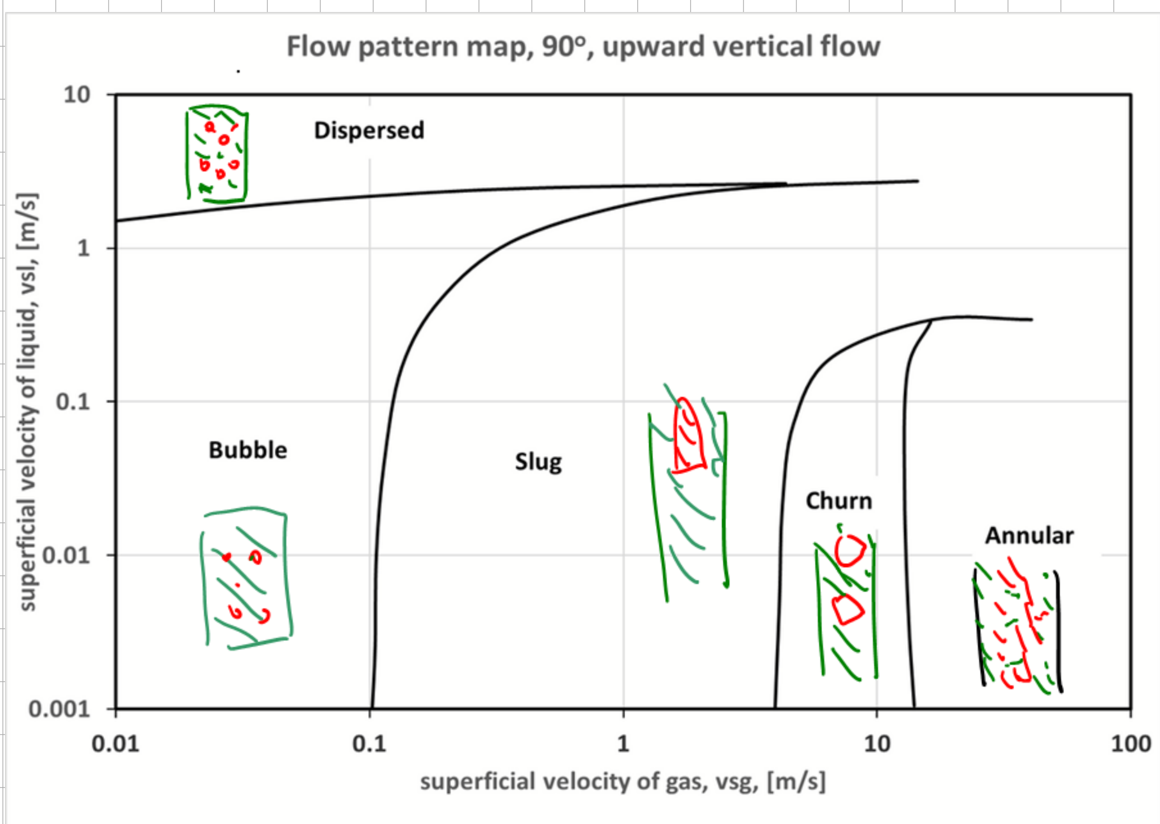


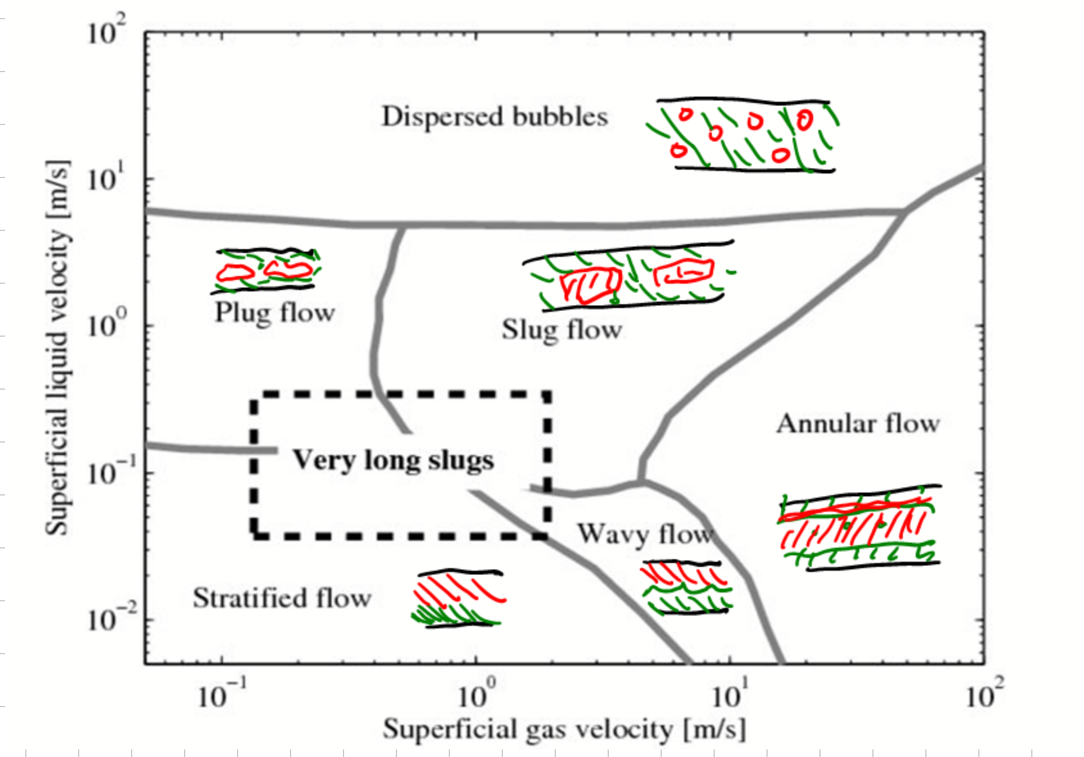
flow pattern map

← for a given fluid, pipe, inclination, etc



$u_{sL} = \frac{q_L}{A}$

$u_{sg} = \frac{q_g}{A}$


Dispersed bubbles
Plug flow
Slug flow
Very long slugs
Annular flow
Wavy flow
Stratified flow
Superficial liquid velocity [m/s]
Superficial gas velocity [m/s]
10^{2}
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}