Turner Critical Velocity for Gas Wells

The Turner Equation correlated to well data with surface pressures generally much more than 1000 psi:

\[ u = 1.92 \frac{\sigma^{1/4}(\rho_L - \rho_g)^{1/4}}{\rho_g^{1/2}} \]

- **\( u \)** = Minimum gas velocity in units of \( \frac{ft}{s} \)
- **\( \sigma \)** = Surface Tension in units of \( \frac{dynes}{cm} \)
- **\( \rho_L \)** = Liquid Phase Density in units of \( \frac{lbm}{ft^3} \)
- **\( \rho_g \)** = Gas Phase Density in units of \( \frac{lbm}{ft^3} \)

Assuming that the surface tension, **\( \sigma \)**, of condensate is 20 \( \frac{dynes}{cm} \) and that of water is 60 \( \frac{dynes}{cm} \), and Liquid Phase Density, **\( \rho_L \)**, of condensate is 45 \( \frac{lbm}{ft^3} \) and that of water is 67 \( \frac{lbm}{ft^3} \), and assuming the gas gravity is 0.6 and gas temperature is 120° F, the above equation can be expressed as a function of pressure, where **\( p \)** is in units of \( psia \).

\[ u_{\text{water}} = 5.34 \frac{(67 - 0.0031p)^{1/4}}{(0.0031p)^{1/2}} \quad u_{\text{condensate}} = 4.02 \frac{(45 - 0.0031p)^{1/4}}{(0.0031p)^{1/2}} \]

When water and condensate both present, use the water equation.

When you flow above the critical velocity (see graphs on opposite side) it is predicted that droplets are being carried up by the gas velocity and are not accumulating in the well. If you are flowing below the critical velocity, then you are predicting that droplets are not being carried upward and are accumulating in the well. The well may or may not cease to flow even if you are below the critical rate but flowing below the critical rate, will decrease production.
