Reynolds number in Pipe Flow

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In Pipe Flow the Reynolds number can be written in simplified form:

(1) $$\mathrm{Re} = \frac{j_m \cdot d}{\mu(T,p)} = \frac{4\,\dot{m}}{\pi\, d} \cdot \frac{1}{\mu(T,p)}$$

where

$j_m = \frac{\dot{m}}{A}$	mass flux
$\dot{m} = \frac{dm}{dt}$	mass flowrate
$d = \sqrt{\frac{4A}{\pi}}$	characteristic linear dimension of the pipe (or exactly a pipe diameter in case of a circular pipe)
$\mu(T,p)$	dynamic viscosity as function of fluid temperature T and pressure p

(2) $$\mathrm{Re} = \frac{u \cdot d}{\nu} = \frac{\rho \cdot u \cdot d}{\mu} = \frac{j_m \cdot d}{\mu(T,p)}$$

where

u	average cross-sectional flow velocity
ρ	fluid density
ν	kinematic viscosity

The mass flowrate is constant along the pipe: $\dot{m} = \mathrm{const}$.

In many engineering application the pipeline is built from inter-connected pipes or ducts with constant cross-sectional area $A = \mathrm{const}$ which means that mass flux is also constant along pipes: $j_m = \mathrm{const}$.

Equation (1) shows that in this case a variation of Reynolds number along the pipe will be a function of fluid viscosity only: $\mathrm{Re} = \mathrm{Re}(\mu)$ which in turn is a function of fluid temperature $T(l)$ and pressure $p(l)$ along the pipe.

See also

Physics / Mechanics / Continuum mechanics / Fluid Mechanics / Fluid Dynamics / Fluid flow regimes / Reynolds number

[Pipe Flow / Pipe Flow Dynamics]