Choke

A choke is a constriction in a pipe that limits the flow rate through the pipe. The fluid velocity increases through the constriction and for compressible fluids can reach the sonic velocity. As the pressure difference across the choke increases the flow rate through the choke increases and the flow velocity increases too. At this point the velocity becomes sonic, the flow is said to be critical, and is independent of the down stream pressure. See Brill and Mukerjee (1999) for a good description of flow through chokes and restrictions.

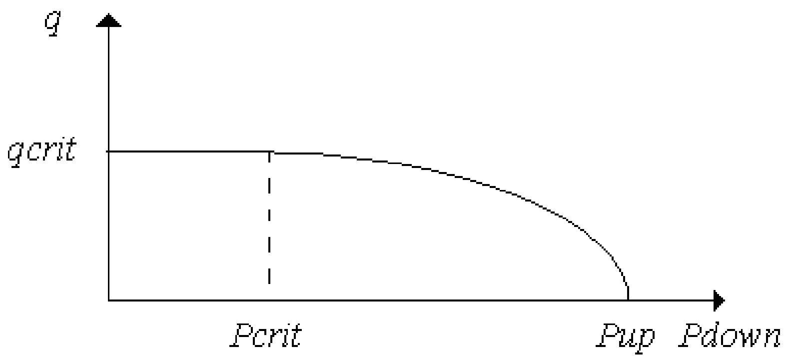

Figure 228.1. Typical flow-pressure relationship for a choke

The choke is modeled by splitting the flow into two regimes:

flow is subcritical	$P_{crit} < P_{down} < P_{up}$	$q < q_{crit}$
flow is critical	$0 < P_{down} < P_{up}$	$q = q_{crit}$

where

P_{up}	is the upstream pressure	psi or lbf / in^2	N / m^2
P_{down}	is the downstream pressure	psi or lbf / in^2	N / m^2
P_{crit}	is the critical (downstream) pressure	psi or lbf / in^2	N / m^2
q	is the flow rate	lb / s	kg / s
q_{crit}	is the critical flow rate	lb / s	kg / s

The choke performance is determined by the following:

1. The choke geometry and fluid properties
2. The subcritical flow correlation
3. The critical pressure ratio
4. The critical flow correlation

Choke geometry

The main choke parameters are:

d_{up}	upstream diameter	in
d_{bean}	constriction (bean) diameter	in
c_v	flow coefficient (used in the Ashford & Pierce correlation)	
c_{vL}	liquid flow coefficient (used in the Mechanistic correlation)	
c_{vG}	gas flow coefficient (used in the Mechanistic correlation)	
c_d	discharge coefficient (used for calculating the flow coefficients)	

The flow coefficients can either be specified or calculated from the discharge coefficient:

$$c_v = \frac{c_d}{\sqrt{1 - \delta^4}}$$ [Eq. 228.1]

where:

$\delta = \frac{d_{bean}}{d_{up}}$	is the diameter ratio	dimensionless

Subcritical flow correlations

There are essentially two subcritical flow models used in PIPESIM, the Mechanistic correlation and Ashford & Pierce (1975) correlation . A third correlation API-14B is a modification of the Mechanistic correlation

Critical pressure ratio

For single phase liquids, the sonic velocity is high and flow is always subcritical. For single phase gas flow and multiphase flow, the critical pressure is given by

$$P_{crit} = C_{PR} \cdot P_{up}$$ [Eq. 228.2]

The value of the critical pressure ratio C_{PR} can be set by the user or calculated.

Critical flow correlations

A critical flow correlation can be used to set the critical flow rate q_{crit} . There is a danger that this will not match the subcritical flow at the critical pressure ratio. PIPESIM therefore adjusts the subcritical flow correlation to ensure the flow is correct at the critical pressure. To do this it first calculates the subcritical flow at the critical pressure:

$q_{\lim} = q_{sub}(P_{up}, P_{down})$ evaluated at $P_{down} = P_{crit}$

The choke downstream pressure is then calculated from the subcritical correlation using the upstream pressure and a scaled flow rate $(q_{\lim}/q_{crit})q$. This matching can be turned off, in which case the critical flow correlation is ignored when calculating the pressure drop, although it is used for reporting purposes.

One of twelve correlations of four distinct types can be selected for the critical flow:

1. Mechanistic, API-14B
2. Ashford Pierce, A-P Tulsa, Poettmann-Beck
3. Omana
4. Achong, Baxendale, Gilbert, Pilehvari, Ros, User defined

Engine keywords

See Choke keyword