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Content Based
Chemical Engineering

CONTROL VALVES - find flow, pressures known

BASIS: Control Valve Key Equations, ISA-75.01-1985 (R1995) formerly ISA-S75.01-1985 (R1995)

NOTE: Always begin a new case by retrieving the original file. Direct entry of data in cells that originally contain table lookups could cause functions to be lost, or incorrect calculations. I format cells requiring entry colored **RED**; calculated values are black.

1.) Select the appropriate worksheet for the calculation needed.
2.) Enter instrument (control valve) identification at [C4].
3.) Enter fluid by using [=], then going to fluid name in the gas or liquid tables, and double-clicking the mouse or high-lighting and hitting ther [return key]. Fluid specifics will be returned via lookup tables. For fluids NOT in my tables enter values in the appropriate cells.
4.) Enter Cv values as appropriate for Process Safety Calculations these values should be the 100% open value as found in the control valve specification or from the vendors literature.

Print out using direct Excel commands. This application is provided by Chemical Engineers Resource Website, visit cheresources.com for additional selections.

Print out using direct EXCEL commands.

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ISA - Control Valve - Compressible Fluid; Flow of Gas or Vapor

VALVE : 1-1/4" FCV
VALVE TYPE : Ball / Standard Port (dia app 0.8d) - Either
FLUID : STEAM

C_V =	47		Mw =	18.02	mol. weight
valve ID =	1.250	in	k =	1.314451	
pipe ID =	2.000	in	v1 =	11.996933	ft^3/lb
P1 - in =	20	psig	$P1_a$ =	34.7	psia
P2 - out =	16.5	psig	$P2_a$ =	31.2	psia
temp. =	258.25991	°F	$T1_a$ =	718.3	°R
ΔP =	3.5	psi	Z =	1.000	

$$W = 19.3 \cdot F_p \cdot C_V \cdot P1_a \cdot Y \cdot (\Delta P / P1_a \cdot Mw / T1_a \cdot Z)^{0.5}$$

··· Determine Fp ···

$$Fp = [(\Sigma K \cdot C_V^2 / 890 \cdot d^4) + 1]^{-1/2}$$

reducer, K_1 = 0.424
increaser, K_2 = 0.371
ΣK = 0.795

Fp = 0.904

··· Determine Y ···

Y = 1-x/(3 * F_k * x_T ..or..x_{TP}

x_t = 0.1500

Y = 0.737955

x_{TP} = 0.1367

··· Calculation ···

$$W = 19.3 \cdot F_p \cdot C_V \cdot P1_a \cdot Y \cdot (\Delta P / P1_a \cdot Mw / T1_a \cdot Z)^{0.5}$$

W = 1056 lb/hr of steam

04/11/04

ISA - Control Valve - Compressible Fluid; Flow of Gas or Vapor

VALVE : 32-mm FCV
VALVE TYPE : Ball / Standard Port (dia app 0.8d) - Either
FLUID : STEAM

C_v =	47		Mw =	18.02	mol. weight
valve ID =	31.75	mm	k =	1.3	
pipe ID =	50.8	mm	v1 =	0.7490489	m^3/kg
P1 - in =	1.378952	barG	$P1_a$ =	2.378952	barA
P2 - out =	1.137635	barG	$P2_a$ =	2.137635	barA
temp. =	125.69499	°C	$T1_a$ =	398.8	°K
ΔP =	0.241317	bar	Z =	1.000	

$$W = 94.8 \cdot F_p \cdot C_v \cdot P1_a \cdot Y \cdot (\Delta P / P1_a \cdot Mw / T1_a \cdot Z)^{0.5}$$

··· Determine Fp ···

$$Fp = [(\Sigma K \cdot C_v^2 / 0.00214 \cdot d^4) + 1]^{-1/2}$$

reducer, K_1 = 0.424
increaser, K_2 = 0.371
ΣK = 0.795

Fp = 0.904

··· Determine Y ···

Y = 1-x/(3 * F_k * x_T ..or..x_{TP}

x_T = 0.1500

Y = 0.733732

x_{TP} = 0.1368

··· Calculation ···

$$W = 94.8 \cdot F_p \cdot C_v \cdot P1_a \cdot Y \cdot (\Delta P / P1_a \cdot Mw / T1_a \cdot Z)^{0.5}$$

W = 476 kg/hr of steam

ISA - Control Valve - Incompressible Fluid; Flow of Nonvaporizing Liquid

VALVE : FV-5501; DEAERATOR FEEDWATER
VALVE TYPE : Globe Single Port / Characterized Cage - Open
FLUID : WATER

valve ID =	1.250	in	C_v =	20	
pipe ID =	2.000	in	γ_1 =	57.42073	lb/ft^3
P1 - in =	20	psig	$P1_a$ =	34.7	psia
P2 - out =	16.5	psig	$P2_a$ =	31.2	psia
ΔP =	3.5	psi	ν =	0.2008491	centistokes
			temp. =	298	°F

··· Determine Fp ···

$$Fp = [(\Sigma K \cdot C_v^2 / 890 \cdot d^4) + 1]^{-1/2}$$

reducer, K_1 = 0.424
increaser, K_2 = 0.371
ΣK = 0.795

Fp = 0.4361633

··· Determine Re_v, F_r, & q_t ···

F_d = 1.00
F_L = 0.90

Re_v = 819,884
F_r = 1.00
q_t = 39.01

··· Predicted Flow Rate ···

$W = F_r \cdot q_t$

W = 39.005151 gpm

ISA - Control Valve - Incompressible Fluid; Flow of Nonvaporizing Liquid

VALVE : FV-5501; DEAERATOR FEEDWATER
VALVE TYPE : Globe Single Port / Characterized Cage - Open
FLUID : WATER

valve ID =	31.75	mm	C_v =	20	
pipe ID =	50.8	mm	γ_1 =	920.204	kg/m^3
P1 - in =	1.378952	barG	$P1_a$ =	2.378952	barA
P2 - out =	1.137635	barG	$P2_a$ =	2.137635	barA
ΔP =	0.241317	bar	ν =	0.2008491	centistokes
temp. =	147.77778	°C	temp. =	298	°F

··· Determine Fp ···

$$Fp = [(\Sigma K \cdot C_v^2 / 0.00214 \cdot d^4) + 1]^{-1/2}$$

reducer, K_1 = 0.424
increaser, K_2 = 0.371
ΣK = 0.795

Fp = 0.4362093

··· Determine Re_v, F_r, & q_t ···

F_d =	1.00	Re_v =	819,779
F_L =	0.90	F_r =	1.00
		q_t =	39.00

··· Predicted Flow Rate ···

$$W = F_r \cdot q_t \cdot 0.227$$

W = 8.85 m^3/hr

ISA - Control Valve - Incompressible Fluid; Choked Flow of Vaporizing Liquid

VALVE : PCV-950008; DESUPERHEAT SPRAY FROM FEEDWATER
VALVE TYPE : Angle / Characterized Cage - Close
FLUID : Water

valve ID =	4.000	in	C_v =	90	
pipe ID =	6.000	in	G_f =	0.998	sp. wt.
P1 - in =	200	psig	$P1_a$ =	214.7	psia
P2 - out =	124	psig	$P2_a$ =	138.7	psia
ΔP =	76	psi	temp. =	70	°F

··· Determine F_{LP} ···

F_L = 0.80 inlet reducer, K_i = 0.401

$$F_{LP} = F_L \cdot [(K_i \cdot F_L^2 \cdot C_V^2 / 890 \cdot d^4) + 1]^{-1/2}$$

F_{LP} = 0.3963814

··· Determine Re_v, F_r, & q_t ···

p_v =	0.36	psia	p_c =	3198.72
F_F =	0.96		p_{vc} =	0.344107

··· Predicted Flow Rate ··· $q_{max} = 1.00 \cdot F_{LP} \cdot C_v \cdot [(p_1 - p_{vc}) / G_f]^{0.5}$

q_{max} = 522.8272 gpm

ISA - Control Valve - Incompressible Fluid; Choked Flow of Vaporizing Liquid

VALVE : PCV-950008; DESUPERHEAT SPRAY FROM FEEDWATER
VALVE TYPE : Angle / Characterized Cage - Close
FLUID : Water

valve ID =	101.600	mm	C_V =	90	
pipe ID =	152.400	mm	G_f =	0.998	sp. wt.
P1 - in =	13.7931	barG	$P1_a$ =	14.8	barA
P2 - out =	8.55172	barG	$P2_a$ =	9.6	barA
ΔP =	5.24138	barG	temp. =	21.11	°C

··· Determine F_{LP} ···

F_L = 0.80 inlet reducer, K_i = 0.401

$$F_{LP} = F_L \cdot [(K_i \cdot F_L^2 \cdot C_V^2 / 0.00214 \cdot d^4) + 1]^{-1/2}$$

F_{LP} = 0.3963843

··· Determine Re_v, F_r, & q_t ···

p_v = 18.59 mmHg p_c = 3198.72

F_F = 0.96 p_{vc} = 0.344083

··· Predicted Flow Rate ···

$$q_{max} = 0.865 \cdot F_{LP} \cdot C_V \cdot [(p_1 - p_{vc}) / G_f]^{0.5}$$

q_{max} = 117.4703 m^3/hr