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President  
Cheresources, Inc.

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1422 Goswick Ridge Road  
Midlothian VA 23114

Fax: 561-658-6489  
Email: [support@cheresources.com](mailto:support@cheresources.com)

***Content Based  
Chemical Engineering***

CONTROL VALVES - find flow, pressures known

**BASIS:** Control Valve Key Equations, from Process Safety Practices & ISA-75.01-1985 (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 Cg, Cs, or 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.

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Consistent with GOOD ENGINEERING PRACTICE, the burden rests with the USER of these spreadsheets to review ALL calculations, and assumptions. The USER IS FULLY RESPONSIBLE for the results or decisions based on calculations.

This Spreadsheet Requires MACROS to be ENABLED to ASSURE proper operation. See the Workbook Help Sheet for Additional Instructions on Use.

dmcoffman@aol.com

CONTROL VALVES GAS - find flow, pressures known
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VALVE: PCV-950008; DESUPERHEAT SPRAY FROM FEEDWATER  
 FLUID: NITROGEN

$C_g =$	90		$MW =$	28.02
$P1 - in =$	100	psig	$P1_a =$	114.7 psia
$P2 - out =$	0	psig	$P2_a =$	14.7 psia
temp. =	70	°F	$T1_a =$	530 °R
$\Delta P =$	100	psi	$P2_a/P1_a =$	0.12816042

· Equation #1 - subcritical

$$W = \frac{242.1 \cdot C_g \cdot (P_1 - P_2)^{0.4425} \cdot MW^{0.5} \cdot P1_a^{0.5575}}{T^{1.5}}$$

$W = 0$  lb/hr or 0.00 SCFH of NITROGEN

· Equation #2 - critical

$$W = \frac{168.1 \cdot C_g \cdot MW^{0.5} \cdot P1_a}{T^{1.5}}$$

$W = 752.91882$  lb/hr or 10,368.53 SCFH of NITROGEN

· **Critical lambda:  $P2_a/P1_a \leq 0.528$ , - Equation #2 Valid**

$W = 752.91882$  lb/hr or 10,368.53 SCFH of NITROGEN

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CONTROL VALVES GAS - find flow, pressures known
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VALVE: **PCV-950008; DESUPERHEAT SPRAY FROM FEEDWATER**  
 FLUID: **NITROGEN**

C <sub>g</sub> = <b>90</b>	MW = 28.02
P1 - in = <b>689475.7</b> Pa	P1 <sub>a</sub> = 790800.7 Pa-abs
P2 -out = <b>0</b> Pa	P2 <sub>a</sub> = 101325 Pa-abs
temp. = <b>21.1</b> °C	T1 <sub>a</sub> = 294.25 °K
ΔP = 689475.7 Pa	P2 <sub>a</sub> /P1 <sub>a</sub> = 0.12812963

· Equation #1 - subcritical  $1.83 \cdot C_g \cdot (P_1 - P_2)^{0.4425} \cdot MW^{0.5} \cdot P1_a^{0.5575} \cdot 10^{-6}$

$$W = \frac{\dots}{T^{1.5}}$$

W = 0 kg/s ... or 0 Nm<sup>3</sup>/s

· Equation #2 - critical  $1.27 \cdot C_g \cdot MW^{0.5} \cdot P1_a \cdot 10^{-6}$

$$W = \frac{\dots}{T^{1.5}}$$

W = 0.094792207 kg/s ... or 0.53208318 Nm<sup>3</sup>/s

· **Critical lambda: P2a/P1a <= 0.528, - Equation #2 Valid**

W = 0.094792207 kg/s ... or 0.53208318 Nm<sup>3</sup>/s

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CONTROL VALVES STEAM - find flow, pressures known

VALVE: PTCV-101, 2M Steam Conditioning (Desuperheating) Valve  
SERVICE: PCV-006

$C_s =$	47		$MW =$	18.04	
$P_1$ - in =	150	psig	$P_{1a} =$	164.7	psia
$P_2$ -out =	0	psig	$P_{2a} =$	14.7	psia
temp. =	365.70	°F	$T_{1a} =$	825.702826	°R
$\Delta P =$	150	psi	$P_{2a}/P_{1a} =$	0.08925319	

· Equation #1 - subcritical

$$W = 1.45 \cdot C_s \cdot (P_1 - P_2)^{0.4425} \cdot P_{1a}^{0.55}$$

$$W = 0 \quad \text{lb/hr}$$

· Equation #2 - critical

$$W = C_s \cdot P_{1a}$$

$$W = 7740.9 \quad \text{lb/hr}$$

· Critical lambda:  $P_{2a}/P_{1a} \leq 0.546$ , - Equation #2 Valid

#####

CONTROL VALVES STEAM - find flow, pressures known

VALVE: PTCV-101, 2M Steam Conditioning (Desuperheating) Valve  
SERVICE: PCV-006

$C_s =$	47	$MW =$	18.04
$P_1$ - in =	1034213.58 Pa	$P_{1a} =$	1135538.58 Pa-abs
$P_2$ -out =	0 Pa	$P_{2a} =$	101325 Pa-abs
temp. =	185.39 °C	$T_{1a} =$	458.540458 °K
$\Delta P =$	1034213.58 Pa	$P_{2a}/P_{1a} =$	0.08923079

· Equation #1 - subcritical

$$W = 2.65 \cdot C_s \cdot (P_1 - P_2)^{0.4425} \cdot P_{1a}^{0.5575} \cdot 10^{-8}$$

$$W = 0 \text{ kg/s}$$

· Equation #2 - critical

$$W = 1.83 \cdot C_s \cdot P_{1a} \cdot 10^{-8}$$

$$W = 0.97667673 \text{ kg/s}$$

· Critical lambda:  $P_{2a}/P_{1a} \leq 0.546$ , - Equation #2 Valid

CONTROL VALVES LIQUID - find flow, pressures known
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VALVE: PCV-950008; DESUPERHEAT SPRAY FROM FEEDWATER  
 FLUID: WATER

$C_v =$	25		SP. GR. =	1.00
P1 - in =	10	psig	P1 <sub>a</sub> =	24.7 psia
P2 -out =	0	psig	P2 <sub>a</sub> =	14.7 psia
temp. =	70	°F	T1 <sub>a</sub> =	530 °R

$\Delta P =$  10 psi

$$W = 500 \cdot C_v \cdot [(P_1 - P_2) \cdot \text{sp.gr.}]^{0.5}$$

W = 39487.3452 lb/hr ... or 79.1392782 gpm of WATER

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CONTROL VALVES LIQUID - find flow, pressures known

VALVE: PCV-950008; DESUPERHEAT SPRAY FROM FEEDWATER  
FLUID: WATER

$C_v =$	25		SP. GR. =	1.00
P1 - in =	68947.573	Pa	P1 <sub>a</sub> =	170272.573 Pa-abs
P2 -out =	0	Pa	P2 <sub>a</sub> =	101325 Pa-abs
temp. =	21.10	°C	T1 <sub>a</sub> =	481.1 °K

$\Delta P =$  68947.573 Pa

$$W = 7.6 \cdot C_v \cdot [(P_1 - P_2) \cdot \text{sp.gr.}]^{0.5} \cdot 10$$

W = 4.99928892 kg/s ... or 18.0717839 cu. meter of WATER

<b>GAS</b>	<b>MW</b>	<b>PRcrit</b>	control
ACETIC ACID	60.05	0.5744	0.527609
ACETYLENE	26.00	0.5531	0.528
AIR	28.97	0.5266	
AMMONIA	17.03	0.5439	
ARGON	39.90	0.4867	
BENZENE	78.11	0.5809	
BROMINE	159.83	0.5421	
BUTANE	58.10	0.5859	
CARBON DIOXIDE	44.01	0.5450	
CARBON DISULFIDE	76.13	0.5625	
CARBON MONOXIDE	28.01	0.5276	
CHLORINE	70.91	0.5360	
CHLOROFORM	119.39	0.5744	
CYANOGEN	52.02	0.5538	
CYCLOHEXANE	84.16	0.5889	
ETHANE	30.00	0.5606	
ETHYL ALCOHOL	46.07	0.5785	
ETHYL CHLORIDE	64.50	0.5785	
ETHYL ETHER	74.12	0.5889	
ETHYLENE	28.00	0.5540	
FREON 11	137.40	0.5826	
FREON 114a	170.90	0.5889	
FREON 12	120.90	0.5785	
FREON 22	86.50	0.5724	
FUEL OIL (#2)	96.00	0.5826	
GASOLINE	86.00	0.5945	
HELIUM	4.00	0.4881	
HEPTANE	100.20	0.5949	
HEXANE	86.17	0.5889	
HYDROCHLORIC ACID	36.47	0.5266	
HYDROGEN	2.02	0.5266	
HYDROGEN BROMIDE	80.92	0.5249	
HYDROGEN CHLORIDE	36.47	0.5266	
HYDROGEN CYANIDE	27.03	0.5439	
HYDROGEN IODIDE	127.91	0.5283	
HYDROGEN SULPHIDE	34.08	0.5421	
IODINE	253.84	0.5457	
ISOBUTANE	58.10	0.5826	
ISOPENTANE	72.10	0.5898	
MERCURY	200.60	0.4867	
METHANE	16.04	0.5439	
METHYL ACETATE	74.08	0.5764	
METHYL ALCOHOL	32.04	0.5639	
METHYL CHLORIDE	50.49	0.5645	
METHYL ETHER	46.07	0.5826	
NATURAL GAS	19.50	0.5512	
NEON	20.20	0.4909	
NITRIC OXIDE	30.01	0.5283	
NITROGEN	28.02	0.5276	
NITROUS OXIDE	44.02	0.5452	
OCTANE	114.22	0.5963	
OXYGEN	32.00	0.5281	
PENTANE	72.10	0.5932	
PHOSPHOROUS	30.97	0.5704	
POTASSIUM	39.10	0.4730	
PROPANE	44.10	0.5744	
PROPENE	42.10	0.5764	
SODIUM	22.99	0.4853	
STEAM	18.00	0.5457	
SULPHUR DIOXIDE	64.07	0.5475	
TOLUENE	92.13	0.5868	
?	?	?	