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COMPRESSIBLE (GAS / VAPORS) ORIFICE, Calculations

REFERENCES: MARKS' MECHANICAL ENGINEERS HANDBOOK; PERRY'S CHEMICAL ENGINEERS HANDBOOK; FLUID FLOW by Sabersky & Acosta. Critical pressure ratios and lambda are based on perfect gas. The 'k' value for steam is at average of inlet and outlet pressures.

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.

···· Find Flow Imperial & Metric ····

1.) Enter identification at [C4].
2.) Enter fluid at [C6], use [=], then go to the fluid name in the table located below the worksheet at (A46..D106) eg. [=A48] is AIR. k, and MW will automatically be looked up in the table if the fluid is listed. If not enter these at [F7] and [F8].
3.) Enter temperature at [C8].
4.) Enter inlet pressure at [C33].
5.) Enter outlet pressure at [C34].
6.) Enter orifice diameter at [C35].
7.) Enter the orifice Ko at [C36].

Calculated flow `W' is indicated at H40 (Imperial) & G42 (Metric).

···· Find Area Imperial & Metric ····

1.) Enter identification at [C4].
2.) Enter fluid at [C6], use [=], then go to the fluid name in the table located below the worksheet at (A37..D97) eg. [=A39] is AIR. k, and MW will automatically be looked up in the table if the fluid is listed If not enter these at [C9] and [G8].
3.) Enter flow `W' at [C8].
4.) Enter orifice coefficent `Ko' at [G9].
5.) Enter inlet temperature `T1' at [C10].
6.) Enter inlet pressure `P1' at [C11].
7.) Enter outlet pressure `P2' at [C12].
Area `A' (sq in) is calculated and shown at [E21].
Diameter `D' (in) is calculated and shown at [G30].

NOTE: When using this program to find the required area of a rupture disk, the flow coefficient `Ko' must be 0.62, and the back pressure 'P2' must not exceed 10% of the MAP.

···· Flow 2 Orifices Imperial & Metric ····

1.) Enter identification at [C4].
2.) Enter fluid at [C6], use [=], then go to the fluid name in the table located below the worksheet at (A53..D113) eg. [=A55] is AIR. k, and MW will automatically be looked up in the table if the fluid is listed If not enter these at [C7] and [F7].
3.) Enter temperature at [C8].
4.) Enter inlet pressure 'P1' at [F24].
5.) Enter outlet pressure 'P3' at [H30].
6.) Enter Ko for first orifice at [F33].
7.) Enter first orifice diameter at [F34].
8.) Enter Ko for second orifice at [H33].
9.) Enter second orifice diameter at [H34].

NOTE:! **The calculation REQUIRES the pressures to ascend from P1 to P2 to P3; this may require a manual random number entry of P1 or P3 to iterate P2 to within the desired range. Depress the Calculate button to converge the equation.**

Calculated flow `W' is indicated at F44.

···· Flow Orifice/Control Valve Imperial & Metric ····

1.) Enter identification at [C4].
2.) Enter fluid at [C6], use [=], then go to the fluid name in the table located below the worksheet at (A55..D115) eg. [=A57] is AIR. k, and MW will automatically be looked up in the table if the fluid is listed If not enter these at [C7] and [F7].
3.) Enter temperature at [C8].
4.) Enter inlet pressure 'P1' at [F24].
5.) Enter outlet pressure 'P3' at [H30].
6.) Enter Ko for first orifice at [F33].
7.) Enter first orifice diameter at [F34].
8.) Enter the Control Valve Cv at [H33].

NOTE:! **The calculation REQUIRES the pressures to ascend from P1 to P2 to P3; this may require a manual random number entry of P1 or P3 to iterate P2 to within the desired range. Depress the Calculate button to converge the equation.**

Calculated flow `W' is indicated at C46 or F46 dependant upon reaching critical flow conditions.

···· Flow thru Perforated Screen Imperial & Metric ····

REFERENCES: **INDUSTRIAL PERFORATORS ASSOCIATION; TESTING BY BOYLE ENGINEERING LABORATORIES and MARKS' MECHANICAL ENGINEERS HANDBOOK**

BACKGROUND: In many applications of perforated plate the estimated energy loss or pressure loss through perforated plates is one of the design considerations. This spreadsheet was developed based upon loss information from a battery of tests conducted on a laboratory air flow system at Boyle Engineering. This system maintained a non-swirling flow impacting perpendicularly on the sample. Various perforated thin gage plates were inserted into a uniform velocity air flow stream. Pressure loss for ambient air flow was then measured at a series of velocities for each flow. This data therefore presents the best flow condition value of loss. In applying this data consideration must be given to the actual anticipated characteristics of the flow impacting on the perforated plate. Distorted flow patterns with high velocity zones will increase the loss of the plate, as will directional flow not perpendicular to the plat surface.

1.) Enter the service condition at [C4].
2.) Enter the fluid at [G6], use '=' and scroll the fluid database, eg. AIR is (=A48).
3.) Enter the supply pipe id [C6], this assists in determining the velocity.
4.) Enter (W) the calculated mass flow thru the supply pipe at [C7].
5.) The impact velocity is calculated and shown at [C8].
6.) Enter the fluid temperature at [C9].
7.) Enter the upstream pressure at [C10].
8.) Enter the downstream pressure at [C11].
9.) Enter the per cent "open area" of the perforated plate at [C12].
10.) The specific gravity and molecular weight will be looked up and inserted in cells G7 & G8, if in the database If not enter directly.
11.) The appropriate equation is selected from the % open area and shown at [C16].

The delta P is calculated and shown at [C18] and [C20].

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

Print out using direct EXCEL commands.

<<<<<<<< Psafety © January 2001, by Don Coffman >>>>>>>>

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

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04/23/04

Compressible Flow Thru Orifice, Find Flow

SERVICE: BACK-SOLVE To Find Design Flow Coefficient to Match Honeywell

fluid: AIR

k = 1.41 MW = 28.97 mol. weight

T1 = 70 ºF $T1_a$ = 529.6 ºR

···· critical pressure ratio ····

$$PR_{crit} := \left(\frac{2}{k+1}\right)^{\left(\frac{k}{k-1}\right)}$$

PR_{crit} = 0.527

···· lambda at critical pressure ratio ····

$$crit_{lambda} := 2415 \cdot \sqrt{\left(\frac{k}{k-1}\right) \cdot PR_{crit}^{\left(\frac{2}{k}\right)} - PR_{crit}^{\left(\frac{k+1}{k}\right)}}$$

$crit_{lambda}$ = 1172

···· determine lambda ····

$P1_a$ = P1 + 14.7

PR = $P2_a$ / $P1_a$ = 0.986

$$lambda := 2415 \cdot \sqrt{\frac{k}{(k-1)} \cdot \left[\left(\frac{P2_a}{P1_a}\right)^{\left(\frac{2}{k}\right)} - \left(\frac{P2_a}{P1_a}\right)^{\left(\frac{k+1}{k}\right)}\right]}$$

lambda = 282.39

···· flow calculation ····

	psig	psia
P_1	0	14.7
P_2	-0.2	14.496
Dia =	0.20	inches
K_o =	0.60	coefficient

···· determine specific volume ····

$$v_1 := \frac{10.73 \cdot T1_a}{M_w \cdot P1_a}$$

v_1 = 13.344 ft^3/lb

$$Area := \left(\frac{\pi}{4}\right) \cdot D^2 = 0.031 \quad in^2$$

$$W := K_o \cdot A \cdot \lambda \cdot \sqrt{\left(\frac{P1_a}{V_1}\right)} = 6 \quad lb/hr$$

Compressible Flow Thru Orifice, Find Flow

SERVICE: BACK-SOLVE To Find Design Flow Coefficient to Match Honeywell

fluid: STEAM

k = 1.3 | MW = 18.00 mol. weight

T1 = 201.6667 ºC | $T1_a$ = 474.8167 ºK

···· critical pressure ratio ····

$$PR_{crit} := \left(\frac{2}{k+1}\right)^{\left(\frac{k}{k-1}\right)}$$

PR_{crit} = 0.546

···· lambda at critical pressure ratio ····

$$crit_{lambda} := 2415\cdot\sqrt{\left(\frac{k}{k-1}\right)\cdot PR_{crit}^{\left(\frac{2}{k}\right)} - PR_{crit}^{\left(\frac{k+1}{k}\right)}}$$

$crit_{lambda}$ = 1139

···· determine lambda ····

$P1_a$ = P1 + 101325

PR = $P2_a$ / $P1_a$ = 0.800

$$lambda := 2415\cdot\sqrt{\frac{k}{(k-1)}\cdot\left[\left(\frac{P2_a}{P1_a}\right)^{\left(\frac{2}{k}\right)} - \left(\frac{P2_a}{P1_a}\right)^{\left(\frac{k+1}{k}\right)}\right]}$$

lambda = 949.06

···· flow calculation ····

	Pa	Pa
P_1	1516846.6	1618171.6
P_2	1192793	1294118
Dia =	42.16	millimeter
K_o =	0.70	coefficient

···· determine specific volume ····

$$v_1 := \frac{8314\cdot T1_a}{M_w\cdot P1_a}$$

v_1 = 0.1355 m^3/kg

$$Area := \left(\frac{\pi}{4}\right)\cdot D^2 = 0.0013963\ m^2$$

$$W := 5.88\cdot K_o\cdot A\cdot\lambda\cdot\sqrt{\frac{P1_a}{v_1}}\cdot 10^{-4} = 1.8924783\ \text{kg/sec}$$

Compressible Flow Thru Orifice, Find Area

SERVICE: Steam Turbine, Determination of Nozzle Diameter

fluid: STEAM

W =	6000	lb/hr	MW =	18.000	mol. weight
k =	1.320		Ko =	0.60	
T1 =	258.0	ºF	T1a =	717.6	ºR
P1 =	25.00	psig	P1a =	39.7	psia
P2 =	15.0	psig	P2a =	29.7	psia
			υ1 =	10.78	cu ft/lb

lambda, λ:	1026
critical λ:	1146
PR:	0.7481
Prcrit:	0.5421

···· Area ····

$$A := \frac{W}{\left(K_O \cdot \lambda \cdot \sqrt{\frac{P1_a}{v_1}}\right)} = 5.077 \text{ in}^2$$

···· Diameter ····

$$\text{Diameter} := \sqrt{4 \cdot \frac{A}{\pi}} = 2.543 \text{ inch}$$

Compressible Flow Thru Orifice, Find Area

SERVICE: Steam Turbine, Determination of Nozzle Diameter

fluid: STEAM

W =	0.7559873	kg/sec	MW =	18.000	mol. weight
k =	1.310		Ko =	0.60	
T1 =	207.8	ºC	T1a =	480.9278	ºK
P1 =	1723689.3	Pa	P1a =	1825014.3	Pa abs
P2 =	103421.36	Pa	P2a =	204746.4	Pa abs
			υ1 =	0.121717	cu meter/kg

lambda, λ:	1143
critical λ:	1143
PR:	0.1122
Prcrit:	0.5439

···· Area ····

$$A := \frac{\left(W \cdot 10^4\right)}{5.88 \cdot K_O \cdot \lambda \cdot \sqrt{\left(\frac{P1_a}{v_1}\right)}} = 0.00048435 \text{ m}^2$$

···· Diameter ····

$$\text{Diameter} := \sqrt{4 \cdot \frac{A}{\pi}} = 0.0248333 \text{ meter}$$

Compressible Flow - Two Orifices In Series

SERVICE: Two Orifices in Series - Prior PTCV to 4M Steam Hood

fluid: STEAM
k = 1.300
T1 = 395 °F
MW = 18.000 mol. weight
T1a = 854.6 °R

···· critical pressure ratio ····

$$PR_{crit} := \left(\frac{2}{k+1}\right)^{\left(\frac{k}{k-1}\right)}$$

PR_{crit} = 0.5457

···· lambda at critical pressure ratio ····

$$crit_{lambda} := 2415 \cdot \sqrt{\left(\frac{k}{k-1}\right) \cdot PR_{crit}^{\left(\frac{2}{k}\right)} - PR_{crit}^{\left(\frac{k+1}{k}\right)}}$$

$crit_{lambda}$ = 1139

		Orifice #1		Orifice #2
Upstream Pressure, [psig]	P1	220		
Upstream Pressure, [psia]	$P1_a$	234.7		
Upstream Specific Volume, [ft^3/lb]	$\upsilon 1$	2.1705861		
Intermediate Pressure, [psig]	P2		180.56298	
Intermediate Pressure, [psia]	$P2_a$		195.26298	
Intermediate Spec Vol, [ft3/lb]	$\upsilon 2$		2.6089767	
Downstream Pressure, [psig]	P3			123
Downstream Pressure, [psia]	$P3_a$			137.7
Downstream Spec Vol, [ft3/lb]	$\upsilon 3$			3.6996119
Orifice Coefficient,	K_o	0.8		0.8
Orifice Internal Diameter,	inches	0.875		0.875
Orifice Area,	in^2	0.6013205		0.6013205
Pressure Ratio, ($P2_a$/$P1_a$)	PR	0.8319684		0.7052028
Lambda,	λ	889.67346		1069.3597
Flow Rate W,	lb/hr	4450.3549		4450.355

···· flow calculation ····

error, Δ lb/hr = 0.00%

$$W := K_o \cdot A \cdot \lambda \cdot \sqrt{\left(\frac{P1_a}{V_1}\right)} = 4450.4$$ lb/hr of steam

Compressible Flow - Two Orifices In Series

SERVICE: Two Orifices in Series - Prior PTCV to 4M Steam Hood

fluid: STEAM

k = 1.300 MW = 18.000 mol. weight

T1 = 201.6667 °C T1a = 474.8167 °K

···· critical pressure ratio ····

$$PR_{crit} := \left(\frac{2}{k+1}\right)^{\left(\frac{k}{k-1}\right)}$$

PR_{crit} = 0.5457

···· lambda at critical pressure ratio ····

$$crit_{lambda} := 2415 \cdot \sqrt{\left(\frac{k}{k-1}\right) \cdot PR_{crit}^{\left(\frac{2}{k}\right)} - PR_{crit}^{\left(\frac{k+1}{k}\right)}}$$

$crit_{lambda}$ = 1139

		Orifice #1		Orifice #2
Upstream Pressure, [Pa]	P1	1516846.6		
Upstream Pressure, [Pa] Abs.	$P1_a$	1618171.6		
Upstream Specific Volume, [m^3/kg	υ1	0.1355311		
Intermediate Pressure, [Pa]	P2		1244939.7	
Intermediate Pressure, [Pa] Abs.	$P2_a$		1346264.7	
Intermediate Spec Vol, [m3/kg]	υ2		0.1629045	
Downstream Pressure, [Pa]	P3			848055.15
Downstream Pressure, [Pa] Abs.	$P3_a$			949380.15
Downstream Spec Vol, [m3/kg]	υ3			0.231006
Orifice Coefficient,	K_o	0.8		0.8
Orifice Internal Diameter,	meter	0.022225		0.022225
Orifice Area,	m^2	0.0003879		0.0003879
Pressure Ratio, ($P2_a$/$P1_a$)	PR	0.8319666		0.7051957
Lambda,	λ	889.67701		1069.3662
Flow Rate W,	kg/sec	0.561004		0.561004

···· flow calculation ····

error, Δ kg/sec = 0.00%

$$W := 5.88 \cdot K_o \cdot A \cdot \lambda \cdot \sqrt{\frac{P1_a}{v_1}} \cdot 10^{-4} \quad = \quad 0.561004 \text{ kg/sec of steam}$$

04/23/04

Compressible Flow - Two Flow Restrictions In Series

SERVICE: Low-Pressure Steam Flow to #4 Paper Machine Steam Hood

fluid:	STEAM				
k =	1.320		MW =	18.000	mol. weight
T1 =	302	°F	T1a =	761.6	°R

···· critical pressure ratio ····

$$PR_{crit} := \left(\frac{2}{k+1}\right)^{\left(\frac{k}{k-1}\right)}$$

···· lambda at critical pressure ratio ····

$$crit_{lambda} := 2415 \cdot \sqrt{\left(\frac{k}{k-1}\right) \cdot PR_{crit}^{\left(\frac{2}{k}\right)} - PR_{crit}^{\left(\frac{k+1}{k}\right)}}$$

$PR_{crit} =$ 0.5421

$crit_{lambda} =$ 1146

		Flow Orifice		Cntrl Valve
Upstream Pressure, [psig]	P1	50		
Upstream Pressure, [psia]	$P1_a$	64.7		
Upstream Specific Volume, [ft^3/lb]	υ1	7.0169741		
Intermediate Pressure, [psig]	P2		45.388754	
Intermediate Pressure, [psia]	$P2_a$		60.088754	
Intermediate Spec Vol, [ft3/lb]	υ2		7.5554608	
Downstream Pressure, [psig]	P3			16.5
Downstream Pressure, [psia]	$P3_a$			31.2
Downstream Spec Vol, [ft3/lb]	υ3			14.551225
Orifice Coefficient,	K_o	0.6	C_v	23
Orifice Internal Diameter,	inches	1.25		
Orifice Area,	in^2	1.2271846		
Pressure Ratio, ($P2_a$/$P1_a$)	PR	0.9287288		0.5192319
Lambda,	λ	618.13405		
Flow Rate W,	lb/hr	1382.0413		1382.0413

···· flow calculation ····

· Equation #1 - subcritical

$$W = 1.45 \cdot C_s \cdot (P_1 - P_2)^{0.4425} \cdot P1_a^{\ 0.5575}$$

W = 0 lb/hr

· Equation #2 - critical

$$W = C_s \cdot P1_a$$

W = 1382.0413 lb/hr

error, Δ lb/hr = 0.00% **Calculate**

Compressible Flow - Two Flow Restrictions In Series

SERVICE: Low-Pressure Steam Flow to #4 Paper Machine Steam Hood

fluid: STEAM
k = 1.320 | MW = 18.000 mol. weight
T1 = 150 ºC | T1a = 423.15 ºK

···· critical pressure ratio ····

$$PR_{crit} := \left(\frac{2}{k+1}\right)^{\left(\frac{k}{k-1}\right)}$$

PR_{crit} = 0.5421

···· lambda at critical pressure ratio ····

$$crit_{lambda} := 2415 \cdot \sqrt{\left(\frac{k}{k-1}\right) \cdot PR_{crit}^{\left(\frac{2}{k}\right)} - PR_{crit}^{\left(\frac{k+1}{k}\right)}}$$

$crit_{lambda}$ = 1146

		Flow Orifice		Cntrl Valve
Upstream Pressure, [Pa]	P1	344737.86		
Upstream Pressure, [Pa] Abs.	$P1_a$	446062.86		
Upstream Specific Volume, [m^3/kg]	υ1	0.4381631		
Intermediate Pressure, [Pa]	P2		312892.1	
Intermediate Pressure, [Pa] Abs.	$P2_a$		414217.1	
Intermediate Spec Vol, [m3/kg]	υ2		0.4718499	
Downstream Pressure, [Pa]	P3			114452.97
Downstream Pressure, [Pa] Abs.	$P3_a$			215777.97
Downstream Spec Vol, [m3/kg]	υ3			0.9057842
Orifice Coefficient,	K_o	0.6	C_v	23
Orifice Internal Diameter,	meter	0.03175		
Orifice Area,	m^2	0.0007917		
Pressure Ratio, ($P2_a$/$P1_a$)	PR	0.928607		0.5209297
Lambda,	λ	618.61564		
Flow Rate W,	kg/sec	0.174344		0.174344

···· flow calculation ····

· Equation #1 - subcritical

$$W = 2.65 \cdot C_s \cdot (P_1 - P_2)^{0.4425} \cdot P1_a^{\ 0.5575} \cdot 10^{-8}$$

W = 0 kg/sec

· Equation #2 - critical

$$W = 1.83 \cdot C_s \cdot P1_a \cdot 10^{-8}$$

W = 0.174344 kg/sec

error, Δ kg/sec = 0.00% **Calculate**

Compressible Flow Thru A Perforated Screen - Find ΔP

SERVICE: Mix Vessel Eq.#2301-12; Flow thru Gooseneck Vent & Bug Screen

.... Screen			.... Fluid		
Internal Diameter:	12	inches	fluid:	AIR	
Flow Rate:	50000	W, lb/hr	Specfic Gravity:	1.000	
impact velocity:	7182.7	fpm	Mol. Weight:	28.970	
Temperature:	265.0	T1, ºF	Temperature, Abs:	724.6	T1a, ºR
Upstream Press:	25.00	P1, psig	Pressure, Abs:	39.7	P1a, psia
Downstream Press:	2.0	P2, psig	Pressure, Abs:	16.7	P2a, psia
Open Area:	65	%	Specific Volume:	6.76	υ1, cu ft/lb

$$\Delta P = 0.19717 + -5.65E\text{-}06 \cdot \text{velocity} + 1.95E\text{-}08 \cdot \text{velocity}^2$$

ΔP = 1.163 in. w.c.

ΔP = 0.042 psig

Compressible Flow Thru A Perforated Screen - Find ΔP

SERVICE: Mix Vessel Eq.#2301-12; Flow thru Gooseneck Vent & Bug Screen

.... **Screen**			.... **Fluid**		
Internal Diameter:	304.8	mm	fluid:	AIR	
Flow Rate:	6.299894	W, kg/sec	Specfic Gravity:	1.000	
impact velocity:	2185.41	m/min	Mol. Weight:	28.970	
Temperature:	129.4	T_1, °C	Temperature, Abs:	402.5944	T_{1a}, °K
Upstream Press:	172368.9	P_1, Pa	Pressure, Abs:	273721.9	P_{1a}, Pa
Downstream Press:	13789.52	P_2, Pa	Pressure, Abs:	115142.5	P_{2a}, Pa
Open Area:	65	%	Specific Volume:	0.42	υ_1, m^3/kg

$$\Delta P = 0.19717 + -5.65E\text{-}06 \cdot \text{velocity} + 1.95E\text{-}08 \cdot \text{velocity}^2$$

$\Delta P =$ 29.442 mm H2O

$\Delta P =$ 0.289 kPa

ORIFICE PLATES & FLANGES

SPEC NO:				SHT 1 of 8	
NO	BY	DATE	REVISION	DATE	REV
A	DMC	4/12/2002	Purchase	4/12/2002	A
				CONTRACT	
				BY	CHK	APPR
				DMC		

Orifice Plates

1.	Plate Type :	Sanitary Orifice Plate
2.	Concentric : ✓	Other :
3.	Bore: Maximum Rate : ✓	Nearest 1/8 in. Drill :
4.	Material: 304SS :	316SS : ✓ Other :
5.	Ring Material & Type	Bonded Silicone (White) Plate Gasket
6.	Mfr. & Model No.	Newman Model A80MP-XW

Orifice Flanges

7.	Tap Type :	NA
8.	Tap Size :	NA
9.	Flange Type :	1-1/2" Sanitary Tri-Clamp
10.	Material :	316 Stainless Steel
11.	Flanges :	Included : By Others : ✓
12.	Rating :	

GENERAL	13.	Tag Number	**FO-0526**	
	14.	Service	32% Sodium Hydroxide to V-1070	
		P&ID	X-26004.2LO	
	15.	Line Number	1-1/2"-CAUS-001-004	
FLUID DATA	16.	Fluid	32% Sodium Hydroxide	
	17.	Fluid State	Liquid	
	18.	Maximum Flow	4-GPM	
	19.	Normal Flow	2-GPM	
	20.	Pressure (max/norm)	29/11	
	21.	Temp (max/norm)	AMB	
	22.	Specific Gravity @ Base	1.34	
	23.	Operating Specific Gravity	1.34	
	24.	Supercomp. factor	NA	
	25.	Mol. Weight Cp/Cv		
	26.	Operating Viscosity (cp)	30 CPS	
	27.	Quality % or °Superheat	NA	
	28.	Base Press. Base Temp.	68	
	29.	Differential Pressure	10.14-PSIG	
METER	30.	Type of Meter	NA	
	31.	Diff. Range - Dry	NA	
	32.	Seal sp. Gr. @ 60°F	NA	
	33.	Static Press. Range	NA	
	34.	Chart or Scale Range	NA	
	35.	Chart Multiplier	NA	
PLATE & FLANGE	36.	Beta = d/D	0.13686	
	37.	Orifice Bore Diameter	0.1875	
	38.	Line Size/Sched/I.D.	1-1/2" / Tube / 0.065 Wall Thk.	
	39.	Flange Rating	1-1/2" Sanitary Tri-Clamp	
	40.	Vent or Drain Hole	NA	
	41.	Plate Thickness	1/16"	
	42.	Manufacturer	Newman Sanitary Gasket Company	
	43.	Model No.	A80MP-XW	

Notes:

1.) Electropolish to 50 Ra

2.) Permanently Affix SS Tag. Use minimum 3/16" Lettering.

3.)

4.)

Physical Properties			
fluid	form	K	MW
ACETIC A	CH3COOH	1.15	60.05
ACETYLEN	C2H2	1.26	26.00
AIR		1.41	28.97
AMMONIA	NH3	1.31	17.03
ARGON	A	1.67	39.90
BENZENE	C6H6	1.12	78.11
BROMINE	Br2	1.32	159.83
BUTANE	C4H10	1.09	58.10
CARBON D	CO2	1.30	44.01
CARBON D	CS2	1.21	76.13
CARBON M	CO	1.40	28.01
CHLORINE	CL2	1.36	70.91
CHLOROF	CHCl3	1.15	119.39
CYANOGE	(CN)2	1.26	52.02
CYCLOHE	C6H12	1.08	84.16
ETHANE	C2H6	1.22	30.00
ETHYL AL	C2H5OH	1.13	46.07
ETHYL CH	C2H5CL	1.13	64.50
ETHYL ET	(C2H5)2O	1.08	74.12
ETHYLENE	C2H4	1.26	28.00
FREON 11	F-11	1.11	137.40
FREON 11	F-114a	1.08	170.90
FREON 12	F-12	1.13	120.90
FREON 22	F-22	1.16	86.50
FUEL OIL (#2)		1.11	96.00
GASOLINE		1.06	86.00
HELIUM	He	1.66	4.00
HEPTANE	C7H16	1.05	100.20
HEXANE	C6H14	1.08	86.17
HYDROCH	HCl	1.41	36.47
HYDROGE	H2	1.41	2.02
HYDROGE	HBr	1.42	80.92
HYDROGE	HCl	1.41	36.47
HYDROGE	HCN	1.31	27.03
HYDROGE	HI	1.40	127.91
HYDROGE	H2S	1.32	34.08
IODINE	I2	1.30	253.84
ISOBUTAN	C4H10	1.11	58.10
ISOPENTA	C5H12	1.08	72.10
MERCURY	Hg	1.67	200.60
METHANE	CH4	1.31	16.04
METHYL A	H3COOCH	1.14	74.08
METHYL A	CH3OH	1.20	32.04
METHYL C	CH3Cl	1.20	50.49
METHYL E	(CH3)2 O	1.11	46.07
NATURAL	typical	1.27	19.50
NEON	Ne	1.64	20.20
NITRIC O	NO	1.40	30.01
NITROGEN	N2	1.40	28.02
NITROUS	N2O	1.30	44.02
OCTANE	C8H18	1.05	114.22
OXYGEN	O2	1.40	32.00
PENTANE	C5H12	1.06	72.10
PHOSPHO	P	1.17	30.97
POTASSIU	K	1.77	39.10
PROPANE	C3H8	1.15	44.10
PROPENE	C3H6	1.14	42.10
SODIUM	Na	1.68	22.99
STEAM	H2O	1.30	18.00
SULPHUR	SO2	1.29	64.07
TOLUENE	C6H5CH3	1.09	92.13

Pipe Data Table			
nominal diameter	ID schd 10S	ID schd 40	ID schd 80
1/2	0.674	0.622	0.546
3/4	0.884	0.824	0.742
1	1.097	1.049	0.957
1 1/4	1.422	1.380	1.278
1 1/2	1.682	1.610	1.500
2	2.157	2.067	1.939
2 1/2	2.635	2.469	2.323
3	3.260	3.068	2.900
3 1/2	3.760	3.548	3.364
4	4.260	4.026	3.826
6	6.357	6.065	5.761
8	8.329	7.981	7.625
10	10.420	10.020	9.562
12	12.390	11.938	11.374
14	13.624	13.124	12.500
16	15.624	15.000	14.312
18	17.624	16.867	16.124
20	19.564	18.812	17.938
24	23.500	22.624	21.562

Steam, k	
-15	1.32
50	1.31
150	1.30
300	1.29
600	1.28
10000	1.28