NONCOMPRESSIBLE FLOW THROUGH A HOLE IN SHELL

BASIS: Flow of Liquid Through a Hole in a Tank; Chemical Process Safety: Fundamentals with Applications by Daniel A. Crowl / Joseph F. Louvar: 1990

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.) Enter the vessel identification at [C4].
2.) Enter the orifice diameter at [C6].
3.) Enter the orifice coefficient at [C7].
4.) Enter the vessel internal pressure (P1) at [C8].
5.) Enter fluid at [G6]. The specific gravity if in the look-up table will be automatically returned.
6.) Enter specific gravity at [G7] if not in the lookup table.
7.) Enter the height of the liquid above the leak/hole in inches (imperial) or millimeter (metric) at [H16].
8.) Enter the elevation of the leak/hole above the floor in inches (imperial) or millimeter (metric) at [H22].
9.) The "x" coordinate or horizontal distance (trajectory) of the leaking stream is shown at [F35].
10.) Enter the internal diameter of the tank in inches (imperial) or millimeter (metric) at [G41].
The drain-down time in seconds is calculated and shown at [G46], this value is based on a constant vessel pressure, constant cross-sectional area, as well as the liquid NOT being replenished during the drain period.

Print out using direct Excel commands. This application is provided by Chemical Engineers Resource Website, visit @ :heresources.con for additional selections.

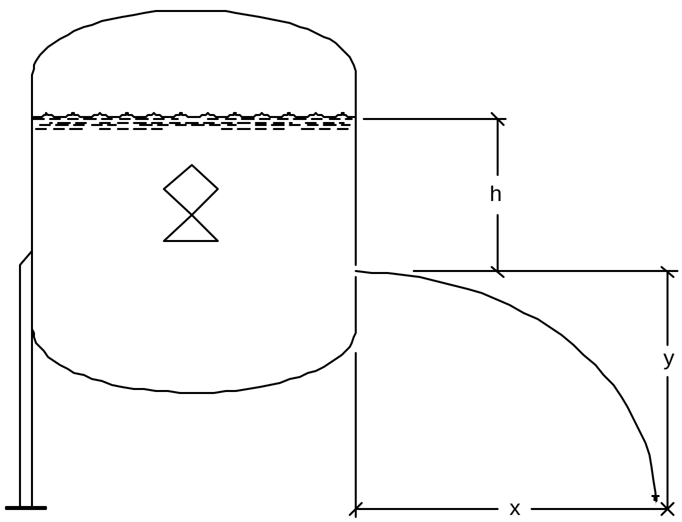
Print out using direct EXCEL commands.

04/17/04

NONCOMPRESSIBLE FLOW THROUGH A HOLE IN SHELL

Vessel: Hot Water Tank

..... **ORIFICE**			..... **FLUID**		
inside dia =	1	inches	fluid :	WATER	
K_o =	0.62	orifice coefficient	sp. gr.=	1.00	
P_1 =	50	psig	density =	62.40	ρ, lb/cu ft



h = 144 inches
= 12 feet

y = 48 inches
= 4 feet

. . . **Maximum discharge stream coordinate " x " in feet ...**

$$x := 2 \cdot K_o \cdot \sqrt{\left(P_1 + h \cdot \frac{\rho}{144} \cdot y\right)} = 10.433699 \text{ feet}$$

. . . **Tank drain down time, seconds (assumes constant dia., liq. is not being replenished) ...**

tank diameter, Td = 96 inches
= 8 feet

$$t := \left(\frac{1}{K_o \cdot g}\right) \cdot \left(\frac{\pi \cdot \frac{T_d^2}{4}}{\pi \cdot \frac{O_d^2}{\frac{144}{4}}}\right) \cdot \sqrt{\left[2 \cdot g_c \cdot \frac{(P_1 \cdot 144)}{\rho} + 2 \cdot g \cdot h\right]} = 41831.047 \text{ seconds}$$

11.619735 hours

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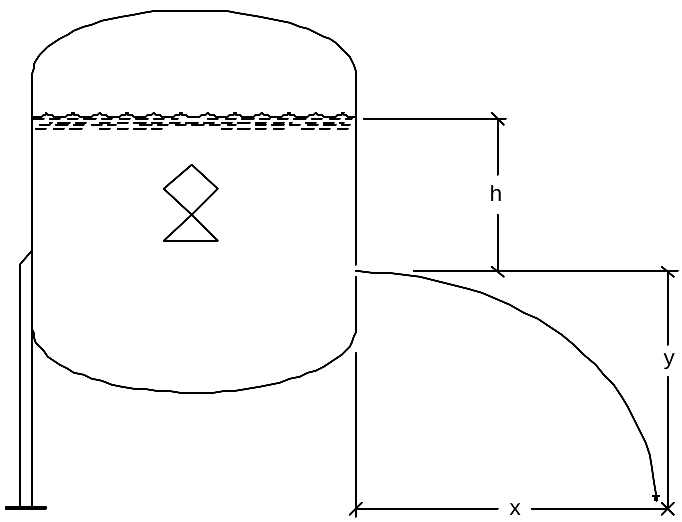
Vessel: Hot Water Tank

..... ORIFICE			..... FLUID		
inside dia =	25.4	mm	fluid :	WATER	
K_o =	0.62	orifice coefficient	sp. gr.=	1.00	
P_1 =	3.44738	bar g	density =	1000.00	ρ, kg/cu m



h = 3657.6 millimeter
= 3.6576 meter

y = 1219.2 millimeter
= 1.2192 meter

. . . **Maximum discharge stream coordinate " x " in feet ...**

$$x := 2 \cdot K_o \cdot \sqrt{\left(P_1 + h \cdot \frac{\rho}{10197.16}\right) \cdot y} \quad = 2.4439933 \text{ meter}$$

. . . **Tank drain down time, seconds (assumes constant dia., liq. is not being replenished) ...**

tank diameter, Td = 4572 millimeter
= 4.572 meter

$$t := \left(\frac{1}{K_o \cdot g}\right) \cdot \left(\frac{\pi \cdot \frac{T_d^2}{4}}{\pi \cdot \frac{\frac{O_d^2}{1000000}}{4}}\right) \cdot \sqrt{\left[2 \cdot g_c \cdot \frac{\left(P_1 \cdot 10197.16\right)}{\rho} + 2 \cdot g \cdot h\right]} \quad = 147020.58 \text{ seconds}$$

40.839049 hours

LIQUID	specific gravity	nominal diameter	ID Sched 10	ID Sched 40	ID Sched 80
AMMONIA 26%	0.890	1/2	0.674	0.622	0.546
AMMONIA 100%	0.682	3/4	0.884	0.824	0.742
BRINE 26%	1.190	1	1.097	1.049	0.957
CARBON DIOXIDE	1.102	1 1/4	1.422	1.380	1.278
CAUSTIC 3%	1.030	1 1/2	1.682	1.610	1.500
CAUSTIC 10%	1.100	2	2.157	2.067	1.939
CAUSTIC 20%	1.219	2 1/2	2.635	2.469	2.323
CAUSTIC 50%	1.525	3	3.260	3.068	2.900
CHLORINE	1.467	3 1/2	3.760	3.548	3.364
ETHANOL 40%	0.935	4	4.260	4.026	3.826
ETHANOL 95%	0.804	6	6.357	6.065	5.761
ETHANOL 100%	0.789	8	8.329	7.981	7.625
FUEL OIL #2	0.876	10	10.420	10.020	9.562
FUEL OIL #6	0.993	12	12.390	11.938	11.374
GASOLINE	0.751	14	13.624	13.124	12.500
HYDROCHLORIC 31.5%	1.159	16	15.624	15.000	14.312
ISOPROPYL ALCOHOL	0.785	18	17.624	16.867	16.124
KEROSENE	0.815	20	19.564	18.812	17.938
METHANOL 40%	0.937	24	23.500	22.624	21.562
METHANOL 90%	0.824				
METHANOL 100%	0.796				
NITROGEN	0.807				
PHOSPHORIC 50%	1.335				
PHOSPHORIC 75%	1.580				
SULPHUR DIOXIDE	1.434				
SULPHURIC 98%	1.830				
TURPENTINE	0.864				
WATER	1.000				