tyco
Flow Control

ANDERSON
GREENWOOD

Sizing

When sizing for tank blanketing, it is imperative to consider both:

a. blanketing gas replacement for liquid loss during pump-out, and
b. the condensation/contraction of tank vapors during atmospheric thermal cooling.

Required amount of blanketing gas and correct size of valve must be determined on the basis that both conditions could occur simultaneously.

The maximum flow rate through the blanketing valve will determine the size of relief valve. If a flow rate less than that listed in Table C is required, restricted nozzles are available to limit the flow to 70, 50, 30 or 10 percent of the 100 percent rated capacity. Use of restricted nozzles, where applicable, will minimize the size of safety relief valve required. The BV1 is also available with a 110 percent piston for increased capacity.

To Size a Blanketing Valve

1. Determine the gas flow rate due to pump-out (from Table A, page 2).
2. Determine the gas flow rate due to atmospheric thermal cooling (from Table B, page 2).
3. Add the requirements of 1 and 2 and select valve size based on air capacity (from Table C, pages 3).

Excerpt From API 2000[1]

For tanks with a capacity of 20,000 bbl or more, the requirements for the vacuum condition are very close to the theoretically computed value of 2 SCFH of air, per square foot of total shell and roof area.

For tanks with a capacity of less than 20,000 bbl, the requirements for the vacuum condition have been based on 1 SCFH of air, for each barrel of tank capacity. This is substantially equivalent to a mean rate of vapor space temperature change of 38°C [100°F] per hour. (See Table B, page 2)

Note

1. API 2000, Section 2.4 Table 2.

Gas Formula

English Units

$$V = 907\, C_2 C_v P_1 \sqrt{\frac{X}{GT}}$$

V = SCFH
C_2 = Correction factor for specific heat ratio
C_v = Valve sizing coefficient
P_1 = Pressure at valve inlet, (psia)
X = 0.66 for $P_1 \leq 47.7$ psia
0.69 for $P_1 > 47.7$ psia
G = Specific gravity
T = Temperature, °R (°F + 460)

Metric Units

$$V = 263\, C_2 C_v P_1 \sqrt{\frac{X}{GT}}$$

V = Nm^3/hr
C_2 = Correction factor for specific heat ratio
C_v = Valve sizing coefficient
P_1 = Pressure at valve inlet, (bara)
X = 0.66 for $P_1 \leq 3.288$ bara
0.69 for $P_1 > 3.288$ bara
G = Specific gravity
T = Temperature, °K (273 + °C)

Values C_2 and G

Gas	C_2	G
Air	1.00	1.00
Natural Gas (0.60G)	0.98	0.60
Nitrogen	1.00	0.97

Cv Valve Sizing Coefficients

Valve	Size		Nozzle Size	C_v
RA:	[1/2-inch]	15 mm	No Options	0.385
BV-1:	[1-inch]	25 mm	110%	14.5
BV-1:	[1-inch]	25 mm	100%	13.2
BV-1:	[1-inch]	25 mm	70%	9.2
BV-1:	[1-inch]	25 mm	50%	6.6
BV-1:	[1-inch]	25 mm	30%	4.0
BV-1:	[1-inch]	25 mm	10%	1.3
Y1:	[2-inch]	50 mm	100%	43.6
Y1:	[2-inch]	50 mm	70%	30.5
Y1:	[2-inch]	50 mm	50%	21.8
Y1:	[2-inch]	50 mm	30%	13.1
Y1:	[2-inch]	50 mm	10%	4.4

Table A (English) - In Breathing Rate Due to Pump-Out

Multiply Maximum Pump-Out Rate In:	By	To Obtain
U.S. GPM	8.021	SCFH air required
U.S. GPH	0.134	SCFH air required
Barrels/hr	5.615	SCFH air required
Barrels/day	0.234	SCFH air required
Liters/min	2.118	SCFH air required
m^3/hr	35.30	SCFH air required

Table A [Metric] - In Breathing Rate Due to Pump-Out

Multiply Maximum Pump-Out Rate In:	By	To Obtain
U.S. GPM	0.215	Nm^3/hr air required
IMP GPM	0.258	Nm^3/hr air required
Barrels/hr	0.151	Nm^3/hr air required
Barrels/day	0.0063	Nm^3/hr air required
Liters/min	0.057	Nm^3/hr air required

Table B[1] - In Breathing Rate Due to Thermal Cooling

Tank Capacity			In Breathing Air Required	
Barrels	Gallons	[m^3]	SCFH	[Nm^3/hr]
60	2,500	[9.5]	60	[1.6]
100	4,200	[15.9]	100	[2.7]
500	21,000	[79.5]	500	[13.4]
1,000	42,000	[159]	1,000	[26.8]
2,000	84,000	[318]	2,000	[53.6]
3,000	126,000	[477]	3,000	[80.4]
4,000	168,000	[636]	4,000	[107.2]
5,000	210,000	[795]	5,000	[134]
10,000	420,000	[1590]	10,000	[268]
15,000	630,000	[2385]	15,000	[402]
20,000	840,000	[3180]	20,000	[536]
25,000	1,050,000	[3975]	24,000	[643]
30,000	1,260,000	[4770]	28,000	[750]
35,000	1,470,000	[5560]	31,000	[830]
40,000	1,680,000	[6360]	34,000	[911]
45,000	1,890,000	[7150]	37,000	[992]
50,000	2,100,000	[7950]	40,000	[1070]
60,000	2,520,000	[9540]	44,000	[1180]
70,000	2,940,000	[11130]	48,000	[1290]
80,000	3,360,000	[12700]	52,000	[1400]
90,000	3,780,000	[14300]	56,000	[1500]
100,000	4,200,000	[15900]	60,000	[1600]
120,000	5,040,000	[19100]	68,000	[1800]
140,000	5,880,000	[22300]	75,000	[2000]
160,000	6,720,000	[25400]	82,000	[2200]
180,000	7,560,000	[28600]	90,000	[2400]

Note

1. API 2000, Section 2.4, Table 2.

Table C (English) - Flow Capacities in SCFH @ 60°F Gas Temperature, 100% Nozzle

Inlet Pressure (psig)	Outlet Pressure	Type RA, 1/2-inch			BV-1, 1-inch			Y1, 2-inch		
		0.60G Natural Gas	0.97G Nitrogen	Air	0.60G Natural Gas	0.97G Nitrogen	Air	0.60G Natural Gas	0.97G Nitrogen	Air
15	1 psig or less	468	375	369	16027	12862	12688	—	—	—
20		547	439	432	18725	15028	14801	—	—	—
25		625	502	494	21424	17193	16933	—	—	—
30		704	565	556	24122	19359	19066	79675	63942	62975
40		880	706	696	30182	24222	23856	99691	80005	78796
50		1042	835	823	35699	28650	28217	117916	94631	93201
60		1203	966	951	41217	33078	32578	136141	109258	107606
70		1363	1095	1078	46735	37506	36939	154366	123884	122011
80		1525	1224	1205	52252	41934	41300	172591	138510	136416
90		1685	1353	1333	57770	46362	45662	190816	153136	150822
100		1847	1482	1460	63288	50790	50023	209041	167762	165227
110		2008	1611	1587	68805	55219	54384	227266	182388	179632
120		2168	1740	1713	74323	59647	58745	245491	197015	194037
130		2330	1870	1841	79840	64075	63106	263715	211641	208442
140		2490	1999	1968	85358	68503	67467	281940	226267	222847
150		2651	2128	2095	90876	72931	71829	300165	240893	237252
160		2813	2257	2223	96393	77359	76190	318390	255519	251657
170		2973	2386	2350	101911	81787	80551	336615	270145	266062
180		3135	2515	2477	107429	86215	84912	354840	284772	280468
190		3296	2644	2605	112946	90643	89273	373065	299398	294873
200		3456	2773	2732	118464	95071	93635	391290	314024	309278

Note

1. To obtain capacities at a temperature other than 60°F, multiply capacity in Table C by appropriate temperature correction factor in Table D.

Table D - Correction Factors

Actual Temperature °F	Correction Factor	Actual Temperature °F	Correction Factor
-20	1.087	100	0.9636
0	1.063	120	0.9469
20	1.041	150	0.9233
40	1.020	200	0.8876
60	1.000	250	0.8558
80	0.9813		

Table C [Metric] - Flow Capacities in Nm^3/hr @ 0°C Gas Temperature, 100% Nozzle

Inlet Pressure [barg]	Outlet Pressure	Type RA, 1/2-inch [15 mm]			BV-1, 1-inch [25 mm]			Y1, 2-inch [50 mm]		
		0.60G Natural Gas	0.97G Nitrogen	Air	0.60G Natural Gas	0.97G Nitrogen	Air	0.60G Natural Gas	0.97G Nitrogen	Air
1.0	70 mbarg or less	13	10	10	435	349	344	—	—	—
2.0		19	15	15	651	522	514	—	—	—
3.0		26	21	20	886	711	700	2927	2349	2313
4.0		32	26	26	1107	888	875	3656	2934	2890
5.0		39	31	31	1325	1066	1049	4386	3520	3466
6.0		45	36	36	1549	1243	1224	5115	4105	4043
7.0		52	41	41	1769	1420	1399	5844	4690	4619
8.0		58	47	46	1990	1597	1573	6574	5276	5196
9.0		64	52	51	2211	1774	1748	7303	5861	5772
10.0		71	57	56	2432	1952	1922	8032	6446	6349
11.0		77	62	61	2653	2129	2097	8762	7032	6925
12.0		84	67	66	2873	2306	2271	9491	7617	7502
13.0		90	72	71	3094	2483	2446	10220	8202	8078
14.0		97	78	76	3315	2660	2620	10950	8788	8655

Note

1. To obtain capacities at a temperature other than 0°C, multiply capacity in Table C by appropriate temperature correction factor in Table D.

Table D - Correction Factors

Actual Temperature [°C]	Correction Factor	Actual Temperature [°C]	Correction Factor
[-30]	1.060	[30]	0.949
[-20]	1.039	[40]	0.934
[-10]	1.019	[50]	0.919
[0]	1.000	[100]	0.855
[10]	0.982	[150]	0.803
[20]	0.965		