THERMAFIN SUPERGAP™

THERMAX INC. Ambient Vaporizers

Ambient Vaporizer Sizing - Nominal Parameters

Vaporizer type	Surface m^2	Nominal capacity in Nmł/hr				Nominal capacity CO_2 in kg/hr	K_d
		LIN Mw=28	LOX Mw=32	LAR Mw=40	CH4 Mw=16		
SG25HF	18	63	59	74	51	47	0.4
SG35HF	27	94	89	118	77	70	1.3
SG50HF	36	125	118	156	101	94	3
SG70HF	54	188	177	235	152	141	10.3
SG110HF	81	281	265	351	228	211	4.3
SG140HF	108	374	353	468	304	280	10.2
SG216HF	162	559	527	659	453	419	4.2
SG270HF	202	695	656	869	564	521	4.2
SG360HF	270	925	873	1156	751	694	9.8
SG500HF	378	1285	1212	1606	1042	965	9.6
SG670HF	503	1701	1605	2126	1380	1.275	22.3
SG860HF	647	2169	2046	2711	1760	1.626	21.7
SG1150HF	863	2856	2695	3369	2318	2.140	8.8
SG1300HF	971	3190	3009	3988	2588	2.392	8.6
SG1500HF	1150	3742	3530	4678	3036	2.802	19.9
SG1700HF	1294	4174	3938	5218	3387	3.125	19.4

Operating time de-rating for Air Gases and LNGs

Operatring time	Summer	Winter
1 h	1.45	1.27
2 hrs	1.32	1.22
4 hrs	1.17	1.15
8 hrs	1	1.05
16 hrs	0.84	0.94
1 day	0.75	0.87
2 days	0.6	0.74
3 days	0.53	0.67
1 week		0.52
10 days		0.47
2 weeks		0.42
3 weeks		0.37

Pressure drop formula for Air Gases and LNG

$$dp = K \cdot \left(\frac{F}{F_{nom}}\right)^2 \cdot \left(\frac{Mw}{28}\right) \cdot \frac{1}{1+p}$$

dp ... vaporizer pressure drop in bar
K_dp ... pressure drop coefficient
F ... actual flowrate in Nmł/hr
Fnom ... vaporizer rating in Nmł/hr LIN
Mw ... fluid molecular weight
p ... fluid pressure in barg

Notes

For air gases and LNG:

1. Data for 15 barg fluid pressure, 10°C temperature approach and 75% relative humidity.
2. Summer data for 20°C, winter data for -5°C.
3. For approach 15°C - multiply nominal capacity by 1.1, for approach 5°C - by 0.86.

CO_2:

1. Data for 10°C temperature approach and 75% relative humidity.

Operating time de-rating for CO_2 at 10 barg

Operating time	20°C	5°C	-10°C
1 hr	1.5	0.99	0.58
2 hrs	1.38	0.94	0.56
4 hrs	1.23	0.87	0.54
8 hrs	1.06	0.79	0.52
16 hrs	0.89	0.69	0.48
1 day	0.8	0.63	0.45
2 days	0.65	0.53	0.4
3 days	0.57	0.48	0.37
1 week		0.37	0.3
10 days			0.27
2 weeks			0.25
3 weeks			0.21

Operating time de-rating for CO_2 at 15 barg

Operating time	20°C	5°C	-10°C
1 hr	1.4	0.81	0.34
2 hrs	1.28	0.78	0.34
4 hrs	1.15	0.73	0.33
8 hrs	1	0.66	0.32
16 hrs	0.85	0.59	0.3
1 day	0.76	0.54	0.29
2 days	0.6	0.46	0.26
3 days	0.54	0.41	0.324
1 week		0.32	0.21
10 days		0.29	0.19
2 weeks			0.17
3 weeks			0.16

Operating time de-rating for CO_2 at 20 barg

Operating time	20°C	5°C	-10°C
1 hr	1.26	0.62	N/A
2 hrs	1.17	0.6	
4 hrs	1.05	0.56	
8 hrs	0.92	0.52	
16 hrs	0.78	0.47	
1 day	0.7	0.43	
2 days	0.58	0.37	
3 days	0.51	0.34	
1 week		0.27	
10 days		0.24	
2 weeks		0.21	
3 weeks			

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Specifications

THERMAX INC. Ambient Vaporizers

Installation Notes

- site vaporizers away from areas of persistent high humidity or mist
- space individual modules apart for at least 1/3 of module height
- do not install modules with their cold faces (liquid ends) adjacent to each other
- consider manifolding flexibility to accommodate thermal contractions

Basic vaporizer selection rules:

a) **If experience is not available, always refer to these rules.**

b) **If vaporizer is supposed to operate less than 16 hours per day, single unit vaporizer should be sufficient. If the daily service is longer, always use two 100% capacity units in parallel arrangement.**

c) **Every vaporizer needs defrost period from time to time, even if it seems to be greatly oversized it will eventually freeze in continuous service.**

d) **It is generally not possible to defrost the vaporizer in winter when ambient temperature is below 0 °C. This condition could persist for some days which is generally called a freeze period. A vaporizer should be able to cope with this without a need for defrost.**

Example one:

A vaporizer shall deliver a flow of 100 for 16 hours a day. The longest expected freeze period is 2 weeks.

a) **with single unit**

- freeze period is 14 days, but the vaporizer is operated only 2/3 of a day, so total time-to-defrost would only be about 10 days. The winter de-rating factor for 10 days operation is 0.47, and vaporizer nominal capacity shall then be 100/0.47 = 213

b) **with 1+1 parallel and switched units**

- each of the vaporizer pair would be on-stream only 5 days or so during the winter freeze period. Then the de-rating factor is about 0.6, and 2off 170 sized units would be needed.

1off vaporizer with a nominal capacity of about 2.2 required flowrate is foreseen.

Example two:

A vaporizer shall deliver 100 continuously. Considered freeze period is three weeks.

- each vaporizer of the pair will be on-stream for about 10 days during the freeze period. Winter de-rating factor for 10 days is 0.47 and vaporizer nominal capacity should then be 100/0.47 = 213
- the switching between parallel units can then occur every 3 days.

1+1 vaporizers with nominal capacity of about 2.2x required flowrate are foreseen.

Example three:

A vaporizer shall deliver average 100 continuously with peaks of 500. Considered freeze period is two weeks.

- a vaporizer shall be able to evaporate 500 over entire freeze period, however the ice accumulation will correspond only to flow of 100. Considered operation time can be thus reduced as 14 days x 100/500 = about 3 days.
- winter de-rating factor for 3 days is 0.67 and vaporizer nominal capacity should then be 500/0.67 = 750
- the switching between parallel units can occur every 24 hours.

1+1 vaporizers with nominal capacity of about 1.5x peak flowrate are foreseen.

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