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### Popular Tracer Gases Leak Rate Summary

Specifications	R-12	Equivalent	R-22	Equivalent	R-134A	Equivalent	SF <sub>6</sub>	Equivalent	Time Required for
Grams/Year	Leak Rate	Helium Leak Rate	Leak Rate	Helium Leak Rate	Leak Rate	Helium Leak Rate	Leak Rate	Helium Leak Rate	One Bubble to Form
		For R-12		For R-22		For R-134A		For SF <sub>6</sub>	(Immersion Test)
0.5 (0.018 oz/yr)	3.21 x 10 <sup>-6</sup>	2.15 x 10 <sup>-6</sup>	4.48 x 10 <sup>-6</sup>	2.88 x 10 <sup>-6</sup>	3.80 x 10 <sup>-6</sup>	2.32 x 10 <sup>-6</sup>	2.65 x 10 <sup>-6</sup>	2.07 x 10 <sup>-6</sup>	135.0 min
1.0 (0.035 oz/yr)	6.41 x 10 <sup>-6</sup>	4.30 x 10 <sup>-6</sup>	8.97 x 10 <sup>-6</sup>	5.76 x 10 <sup>-6</sup>	7.60 x 10 <sup>-6</sup>	4.64 x 10 <sup>-6</sup>	5.31 x 10 <sup>-6</sup>	4.15 x 10 <sup>-6</sup>	69.0 min
2.0 (0.071 oz/yr)	1.28 x 10 <sup>-5</sup>	8.60 x 10 <sup>-6</sup>	1.79 x 10 <sup>-5</sup>	1.15 x 10 <sup>-5</sup>	1.52 x 10 <sup>-5</sup>	9.29 x 10 <sup>-6</sup>	1.06 x 10 <sup>-5</sup>	8.28 x 10 <sup>-6</sup>	34.0 min
2.8 (0.1 oz/yr)	1.80 x 10 <sup>-5</sup>	1.21 x 10 <sup>-5</sup>	2.51 x 10 <sup>-5</sup>	1.61 x 10 <sup>-5</sup>	2.13 x 10 <sup>-5</sup>	1.30 x 10 <sup>-5</sup>	1.49 x 10 <sup>-5</sup>	1.16 x 10 <sup>-5</sup>	24.0 min
7.0 (0.25 oz/yr)	4.49 x 10 <sup>-5</sup>	3.01 x 10 <sup>-5</sup>	6.28 x 10 <sup>-5</sup>	4.03 x 10 <sup>-5</sup>	5.32 x 10 <sup>-5</sup>	3.25 x 10 <sup>-5</sup>	3.72 x 10 <sup>-5</sup>	2.91 x 10 <sup>-5</sup>	10.0 min
14 (0.50 oz/yr)	8.98 x 10 <sup>-5</sup>	6.02 x 10 <sup>-5</sup>	1.26 x 10 <sup>-4</sup>	8.09 x 10 <sup>-5</sup>	1.06 x 10 <sup>-4</sup>	6.48 x 10 <sup>-5</sup>	7.43 x 10 <sup>-5</sup>	5.80 x 10 <sup>-5</sup>	290.0 sec
28 (1.0 oz/yr)	1.80 x 10 <sup>-4</sup>	1.21 x 10 <sup>-4</sup>	2.51 x 10 <sup>-4</sup>	1.61 x 10 <sup>-4</sup>	2.13 x 10 <sup>-4</sup>	1.30 x 10 <sup>-4</sup>	1.49 x 10 <sup>-4</sup>	1.16 x 10 <sup>-4</sup>	145.0 sec
56 (2.0 oz/yr)	3.60 x 10 <sup>-4</sup>	2.42 x 10 <sup>-4</sup>	5.02 x 10 <sup>-4</sup>	3.22 x 10 <sup>-4</sup>	4.26 x 10 <sup>-4</sup>	2.60 x 10 <sup>-4</sup>	2.98 x 10 <sup>-4</sup>	2.32 x 10 <sup>-4</sup>	72 sec
112 (4.0 oz/yr)	7.20 x 10 <sup>-4</sup>	4.84 x 10 <sup>-4</sup>	1.00 x 10 <sup>-3</sup>	6.44 x 10 <sup>-4</sup>	8.56 x 10 <sup>-4</sup>	5.20 x 10 <sup>-4</sup>	5.96 x 10 <sup>-4</sup>	4.64 x 10 <sup>-4</sup>	36 sec
224 (8.0 oz/yr)	1.44 x 10 <sup>-3</sup>	9.68 x 10 <sup>-4</sup>	2.01 x 10 <sup>-3</sup>	1.29 x 10 <sup>-3</sup>	1.70 x 10 <sup>-3</sup>	1.04 x 10 <sup>-3</sup>	1.19 x 10 <sup>-3</sup>	9.28 x 10 <sup>-4</sup>	18 sec
448 (16.0 oz/yr)	2.88 x 10 <sup>-3</sup>	1.94 x 10 <sup>-3</sup>	4.02 x 10 <sup>-3</sup>	2.58 x 10 <sup>-3</sup>	3.41 x 10 <sup>-3</sup>	2.08 x 10 <sup>-3</sup>	2.38 x 10 <sup>-3</sup>	1.86 x 10 <sup>-3</sup>	9 sec
896 (32.0 oz/yr)	5.76 x 10 <sup>-3</sup>	3.88 x 10 <sup>-3</sup>	8.03 x 10 <sup>-3</sup>	5.15 x 10 <sup>-3</sup>	6.82 x 10 <sup>-3</sup>	4.16 x 10 <sup>-3</sup>	4.77 x 10 <sup>-3</sup>	3.71 x 10 <sup>-3</sup>	4.5 sec
1792 (64.0 oz/yr)	1.15 x 10 <sup>-2</sup>	7.76 x 10 <sup>-3</sup>	1.61 x 10 <sup>-2</sup>	1.03 x 10 <sup>-2</sup>	1.36 x 10 <sup>-2</sup>	8.32 x 10 <sup>-3</sup>	9.54 x 10 <sup>-3</sup>	7.24 x 10 <sup>-3</sup>	2.25 sec
Specifications	R-404A	Equivalent	R-508B	Equivalent	R-410A	Equivalent	CO <sub>2</sub>	Equivalent	Time Required for
Grams/Year	Leak Rate	Helium Leak Rate	Leak Rate	Helium Leak Rate	Leak Rate	Helium Leak Rate	Leak Rate	Helium Leak Rate	One Bubble to Form
		For R-404A		For R-508B		For R-410A		For CO <sub>2</sub>	(Immersion Test)
0.5 (0.018 oz/yr)	3.97 x 10 <sup>-6</sup>	2.40 x 10 <sup>-6</sup>	4.07 x 10 <sup>-6</sup>	2.96 x 10 <sup>-6</sup>	5.35 x 10 <sup>-6</sup>	3.71 x 10 <sup>-6</sup>	8.80 x 10 <sup>-6</sup>	6.55 x 10 <sup>-6</sup>	135.0 min
1.0 (0.035 oz/yr)	7.94 x 10 <sup>-6</sup>	4.80 x 10 <sup>-6</sup>	8.13 x 10 <sup>-6</sup>	5.92 x 10 <sup>-6</sup>	1.07 x 10 <sup>-5</sup>	7.42 x 10 <sup>-6</sup>	1.76 x 10 <sup>-5</sup>	1.31 x 10 <sup>-5</sup>	69.0 min
2.0 (0.071 oz/yr)	1.59 x 10 <sup>-5</sup>	9.6 x 10 <sup>-6</sup>	1.63 x 10 <sup>-5</sup>	1.18 x 10 <sup>-5</sup>	2.14 x 10 <sup>-5</sup>	1.48 x 10 <sup>-5</sup>	3.52 x 10 <sup>-5</sup>	2.62 x 10 <sup>-5</sup>	34.0 min
2.8 (0.1 oz/yr)	2.22 x 10 <sup>-5</sup>	1.34 x 10 <sup>-5</sup>	2.28 x 10 <sup>-5</sup>	1.66 x 10 <sup>-5</sup>	3.00 x 10 <sup>-5</sup>	2.08 x 10 <sup>-5</sup>	4.93 x 10 <sup>-5</sup>	3.67 x 10 <sup>-5</sup>	24.0 min
7.0 (0.25 oz/yr)	5.56 x 10 <sup>-5</sup>	3.36 x 10 <sup>-5</sup>	5.69 x 10 <sup>-5</sup>	4.14 x 10 <sup>-5</sup>	7.49 x 10 <sup>-5</sup>	5.19 x 10 <sup>-5</sup>	1.23 x 10 <sup>-4</sup>	9.17 x 10 <sup>-5</sup>	10.0 min
14 (0.50 oz/yr)	1.11 x 10 <sup>-4</sup>	6.72 x 10 <sup>-5</sup>	1.14 x 10 <sup>-4</sup>	8.29 x 10 <sup>-5</sup>	1.50 x 10 <sup>-4</sup>	1.04 x 10 <sup>-4</sup>	2.46 x 10 <sup>-4</sup>	1.83 x 10 <sup>-4</sup>	290.0 sec
28 (1.0 oz/yr)	2.22 x 10 <sup>-4</sup>	1.34 x 10 <sup>-4</sup>	2.28 x 10 <sup>-4</sup>	1.66 x 10 <sup>-4</sup>	3.00 x 10 <sup>-4</sup>	2.08 x 10 <sup>-4</sup>	4.93 x 10 <sup>-4</sup>	3.67 x 10 <sup>-4</sup>	145.0 sec
56 (2.0 oz/yr)	4.45 x 10 <sup>-4</sup>	2.69 x 10 <sup>-4</sup>	4.55 x 10 <sup>-4</sup>	3.32 x 10 <sup>-4</sup>	5.99 x 10 <sup>-4</sup>	4.16 x 10 <sup>-4</sup>	9.86 x 10 <sup>-4</sup>	7.34 x 10 <sup>-4</sup>	72 sec
112 (4.0 oz/yr)	8.89 x 10 <sup>-4</sup>	5.38 x 10 <sup>-4</sup>	9.11 x 10 <sup>-4</sup>	6.63 x 10 <sup>-4</sup>	1.20 x 10 <sup>-3</sup>	8.31 x 10 <sup>-4</sup>	1.97 x 10 <sup>-3</sup>	1.47 x 10 <sup>-3</sup>	36 sec
224 (8.0 oz/yr)	1.78 x 10 <sup>-3</sup>	1.08 x 10 <sup>-3</sup>	1.82 x 10 <sup>-3</sup>	1.33 x 10 <sup>-3</sup>	2.40 x 10 <sup>-3</sup>	1.66 x 10 <sup>-3</sup>	3.94 x 10 <sup>-3</sup>	2.93 x 10 <sup>-3</sup>	18 sec
448 (16.0 oz/yr)	3.56 x 10 <sup>-3</sup>	2.15 x 10 <sup>-3</sup>	3.64 x 10 <sup>-3</sup>	2.65 x 10 <sup>-3</sup>	4.80 x 10 <sup>-3</sup>	3.32 x 10 <sup>-3</sup>	7.89 x 10 <sup>-3</sup>	5.87 x 10 <sup>-3</sup>	9 sec
896 (32.0 oz/yr)	7.11 x 10 <sup>-3</sup>	4.30 x 10 <sup>-3</sup>	7.29 x 10 <sup>-3</sup>	5.30 x 10 <sup>-3</sup>	9.59 x 10 <sup>-3</sup>	6.65 x 10 <sup>-3</sup>	1.58 x 10 <sup>-2</sup>	1.17 x 10 <sup>-2</sup>	4.5 sec
1792 (64.0 oz/yr)	1.42 x 10 <sup>-2</sup>	8.60 x 10 <sup>-3</sup>	1.46 x 10 <sup>-2</sup>	1.06 x 10 <sup>-2</sup>	1.92 x 10 <sup>-2</sup>	1.33 x 10 <sup>-2</sup>	3.15 x 10 <sup>-2</sup>	2.35 x 10 <sup>-2</sup>	2.25 sec

NOTE: All Leak Rates in Atm-cc/sec @ 25<sup>0</sup>C and assumes same pressure differential is used in all cases.

Specifications	R-507	Equivalent	R-407C	Equivalent	R-123	Equivalent	Time Required for
Grams/Year	Leak Rate	Helium Leak Rate	Leak Rate	Helium Leak Rate	Leak Rate	Helium Leak Rate	One Bubble to Form
		For R-507		For R-407C		For R-123	(Immersion Test)
0.5 (0.018 oz/yr)	3.92 x 10 <sup>-6</sup>	2.42 x 10 <sup>-6</sup>	4.50 x 10 <sup>-6</sup>	2.89 x 10 <sup>-6</sup>	2.54 x 10 <sup>-6</sup>	1.37 x 10 <sup>-6</sup>	135.0 min
1.0 (0.035 oz/yr)	7.84 x 10 <sup>-6</sup>	4.83 x 10 <sup>-6</sup>	8.99 x 10 <sup>-6</sup>	5.78 x 10 <sup>-6</sup>	5.07 x 10 <sup>-6</sup>	2.73 x 10 <sup>-6</sup>	69.0 min
2.0 (0.071 oz/yr)	1.57 x 10 <sup>-5</sup>	9.66 x 10 <sup>-6</sup>	1.80 x 10 <sup>-5</sup>	1.16 x 10 <sup>-5</sup>	1.01 x 10 <sup>-5</sup>	5.46 x 10 <sup>-6</sup>	34.0 min
2.8 (0.1 oz/yr)	2.20 x 10 <sup>-5</sup>	1.35 x 10 <sup>-5</sup>	2.52 x 10 <sup>-5</sup>	1.62 x 10 <sup>-5</sup>	1.42 x 10 <sup>-5</sup>	7.64 x 10 <sup>-6</sup>	24.0 min
7.0 (0.25 oz/yr)	5.49 x 10 <sup>-5</sup>	3.38 x 10 <sup>-5</sup>	6.29 x 10 <sup>-5</sup>	4.05 x 10 <sup>-5</sup>	3.55 x 10 <sup>-5</sup>	1.91 x 10 <sup>-5</sup>	10.0 min
14 (0.50 oz/yr)	1.10 x 10 <sup>-4</sup>	6.76 x 10 <sup>-5</sup>	1.26 x 10 <sup>-4</sup>	8.09 x 10 <sup>-5</sup>	7.09 x 10 <sup>-5</sup>	3.82 x 10 <sup>-5</sup>	290.0 sec
28 (1.0 oz/yr)	2.20 x 10 <sup>-4</sup>	1.35 x 10 <sup>-4</sup>	2.52 x 10 <sup>-4</sup>	1.62 x 10 <sup>-4</sup>	1.42 x 10 <sup>-4</sup>	7.64 x 10 <sup>-5</sup>	145.0 sec
56 (2.0 oz/yr)	4.39 x 10 <sup>-4</sup>	2.71 x 10 <sup>-4</sup>	5.03 x 10 <sup>-4</sup>	3.24 x 10 <sup>-4</sup>	2.84 x 10 <sup>-4</sup>	1.53 x 10 <sup>-4</sup>	72 sec
112 (4.0 oz/yr)	8.78 x 10 <sup>-4</sup>	5.41 x 10 <sup>-4</sup>	1.01 x 10 <sup>-3</sup>	6.47 x 10 <sup>-4</sup>	5.68 x 10 <sup>-4</sup>	3.06 x 10 <sup>-4</sup>	36 sec
224 (8.0 oz/yr)	1.76 x 10 <sup>-3</sup>	1.08 x 10 <sup>-3</sup>	2.01 x 10 <sup>-3</sup>	1.30 x 10 <sup>-3</sup>	1.14 x 10 <sup>-3</sup>	6.12 x 10 <sup>-4</sup>	18 sec
448 (16.0 oz/yr)	3.51 x 10 <sup>-3</sup>	2.16 x 10 <sup>-3</sup>	4.03 x 10 <sup>-3</sup>	2.59 x 10 <sup>-3</sup>	2.27 x 10 <sup>-3</sup>	1.22 x 10 <sup>-3</sup>	9 sec
896 (32.0 oz/yr)	7.03 x 10 <sup>-3</sup>	4.33 x 10 <sup>-3</sup>	8.06 x 10 <sup>-3</sup>	5.18 x 10 <sup>-3</sup>	4.54 x 10 <sup>-3</sup>	2.45 x 10 <sup>-3</sup>	4.5 sec
1792 (64.0 oz/yr)	1.41 x 10 <sup>-2</sup>	8.66 x 10 <sup>-3</sup>	1.61 x 10 <sup>-2</sup>	1.04 x 10 <sup>-2</sup>	9.09 x 10 <sup>-3</sup>	4.89 x 10 <sup>-3</sup>	2.25 sec

NOTE: All Leak Rates in Atm-cc/sec @ 25<sup>0</sup>C and assumes same pressure differential is used in all cases.

How are the leak rates in the above table calculated?

1.  $XLeakRate = (\text{grams/year}) \times (\text{1yr}/3.15^7) \times (22.4 \text{ Atm-liter/mole}) \times (1000 \text{ cc/liter}) \times (298^0\text{K}/273^0\text{K}) \times (1/\text{XMW})$

Which when simplified;  $XLeakRate = (\text{grams/year}) \times (775.3^{-6}) \times (1/\text{XMW})$

2. Equivalent He. Leak Rate =  $(XLeakRate) \times (X\text{viscosity}/\text{He. viscosity})$

- R-12, MW = 120.93, Viscosity = 13.42
- R-22, MW = 86.48, Viscosity = 12.82
- R-134A, MW = 102.03, Viscosity = 12.20
- SF<sub>6</sub>, MW = 146.054, Viscosity = 15.60
- Helium, MW = 4.0006, Viscosity = 19.97
- R-404A, MW = 97.6, Viscosity = 12.07
- R-508B, MW = 95.39, Viscosity = 14.55
- R-410A, MW = 72.6, Viscosity = 13.85
- CO<sub>2</sub>, MW = 44.01, Viscosity = 14.90
- R-507, MW = 98.9, Viscosity = 12.30
- R-407C, MW = 86.2, Viscosity = 12.83
- R-123, MW = 152.93, Viscosity = 10.75

(Viscosity values extrapolated from 1993 Ashrae Handbook Fundamental I-P Edition and Allied Signal Genetron Physical Properties Report)

3. When changing PSI pressures use the following formula to calculate new leak rate.

•  $[(\text{new pressure} + 14.7)^2 - (14.7)^2] / [(\text{existing pressure} + 14.7)^2 - (14.7)^2] = \text{conversion factor}$

• The conversion factor is multiplied against existing leak rate to find new leak rate value.

\* - Unless you are changing a PSI pressure to an evacuation and spray method use the following formula to calculate new leak rate.

•  $[(0)^2 - (14.7)^2] / [(\text{existing pressure} + 14.7)^2 - (14.7)^2] = \text{conversion factor}$

4. When changing mix % of helium, multiply the leak rate at 100% by the new %.

• ex: leak rate is  $5 \times 10^{-5}$  @ 100% He.; at 20% He. the new leak rate =  $1.0 \times 10^{-5}$ .

5. Generally helium flow through small leaks,  $1 \times 10^{-6}$  std-cc/sec or less, is 2.73 times the air leakage rate. Helium flow through larger leaks is generally 1.4 times the air flow rate.



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