

OXYFUME® 2002 Sterilant Gas

Oxyfume 2002 is a non-flammable sterilizing gas containing 10% ethylene oxide by weight. The product also contains a mixture of two hydrochlorofluorocarbons

(HCFCs) which act as a carrier gases and flame suppressants. The composition of the mix is defined in *Table 1*. HCFC-22 is more commonly known as refrigerant-22.

Both HCFCs are relatively inert, and exhibits very low acute and subchronic inhalation toxicity (TWA - 8 = 1,000 ppm).

Table 1: Composition of Oxyfume 2002

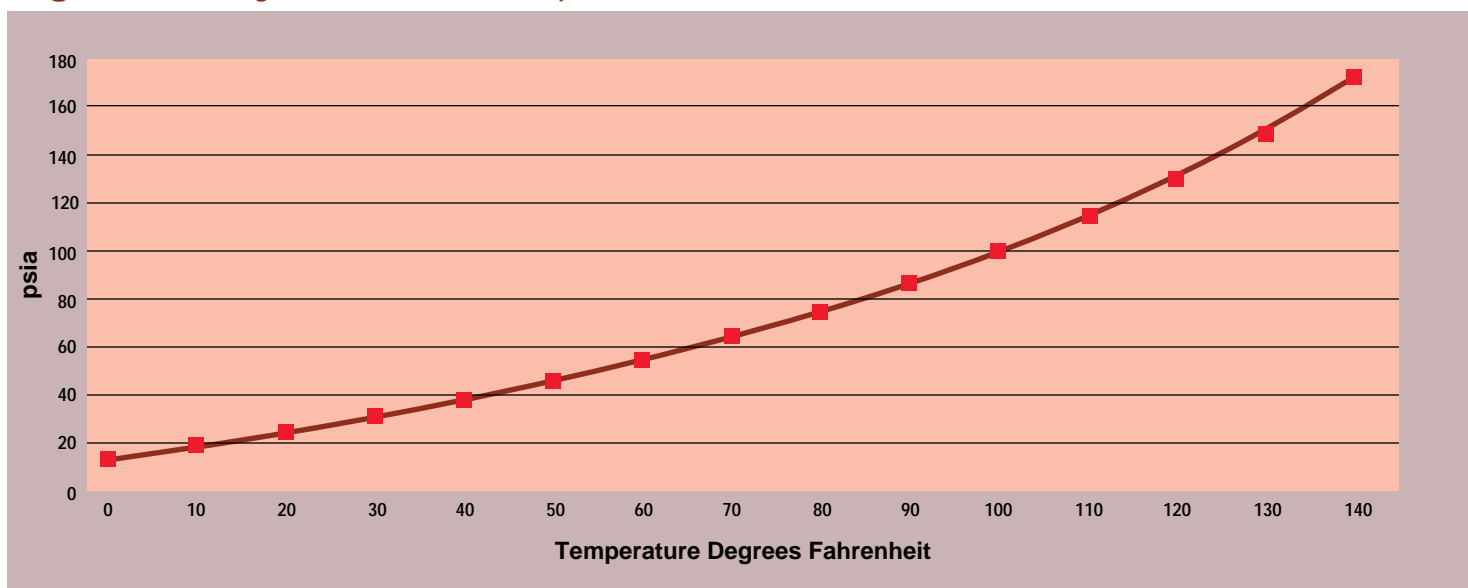
| COMPONENT | MOLECULAR WEIGHT | WEIGHT PERCENT | MOLE PERCENT |
|----------------|------------------|----------------|--------------|
| Ethylene Oxide | 44.05 | 10% | 22.68% |
| HCFC-124 | 136.5 | 63% | 46.12% |
| HCFC-22 | 86.47 | 27% | 31.20% |
| TOTAL | | 100% | 100% |

Thus, for every 100 molecules of gas mixture used, 22.7 molecules are EO. The average molecular weight of the Oxyfume 2002 mixture is 99.92.

Oxyfume 2002 is a liquefied compressed gas at it's own vapor pressure. The normal vapor pressure of Oxyfume 2002 at 70° F is 48 psig. The vapor

pressure varies with temperature as shown in *Figure 1*.

Figure 1: Oxyfume 2002 Vapor Pressure



Over the range of temperature shown, the vapor pressure can be estimated from the equation: $\ln(P) = 12.668 - 2511.3/T$ where P is in psia, and T is in degrees Kelvin.

Vapor pressure is the pressure exerted by a material at a given temperature when pure liquid and pure vapor are both present in a container. Knowing the product's vapor pressure will not help you determine the pressure in a sterilization chamber during the

exposure phase of a sterilization cycle. The pressure in a sterilization chamber will depend on the amount of gas compressed into the chamber to reach the desired concentration of ethylene oxide (see reverse side).

Oxyfume 2002 Sterilant Gas Calculations

Simple calculations can be performed to determine approximate EO chamber concentrations, pounds of gas used, change in chamber pressure due to gas addition, and so on. Most sterilizer engineers estimate these values by treating the entire system as if it were ideal. That is, gases are assumed to be at their nominal concentrations, they behave as ideal gases, the steril-

ization chamber is assumed to be empty (so no space is occupied by medical products, and there is no absorption of gas by the load), the chamber considered to be at constant temperature, and the chamber is free of any leaks.

AAMI¹ has detailed a method of performing these calculations using the equation:

C = K x P / (R x T) where:

C = EO concentration

R = Gas constant

K = Constant for a given sterilant gas

T = Absolute temperature of the sterilant gas mixture

P = Difference in total pressure due to gas addition

For Oxyfume 2002 sterilant gas, the value of K is 9.989 mg/gm-mole, or 9.989 lb/lb-mole. The table below displays chamber concentration in mg/liter as a function of chamber temperature and delta P (pressure rise due to gas addition).

Table 2: Theoretical Chamber Concentration

| T .Deg. C | CHANGE IN P (PSI) | | | | | | | |
|-----------|-------------------|-----|-----|-----|-----|-----|-----|-----|
| | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 |
| 30 | 437 | 492 | 547 | 601 | 656 | 711 | 765 | 820 |
| 32 | 434 | 489 | 543 | 597 | 652 | 706 | 760 | 815 |
| 34 | 432 | 486 | 540 | 593 | 647 | 701 | 755 | 809 |
| 36 | 429 | 482 | 536 | 590 | 643 | 697 | 750 | 804 |
| 38 | 426 | 479 | 533 | 586 | 639 | 692 | 746 | 799 |
| 40 | 423 | 476 | 529 | 582 | 635 | 688 | 741 | 794 |
| 42 | 421 | 473 | 526 | 578 | 631 | 684 | 736 | 789 |
| 44 | 418 | 470 | 522 | 575 | 627 | 679 | 731 | 784 |
| 46 | 415 | 467 | 519 | 571 | 623 | 675 | 727 | 779 |
| 48 | 413 | 464 | 516 | 568 | 619 | 671 | 722 | 774 |
| 50 | 410 | 462 | 513 | 564 | 615 | 667 | 718 | 769 |
| 52 | 408 | 459 | 510 | 561 | 612 | 663 | 713 | 764 |
| 54 | 405 | 456 | 507 | 557 | 608 | 658 | 709 | 760 |
| 56 | 403 | 453 | 503 | 554 | 604 | 654 | 705 | 755 |
| 58 | 400 | 450 | 500 | 550 | 600 | 651 | 701 | 751 |
| 60 | 398 | 448 | 497 | 547 | 597 | 647 | 696 | 746 |
| 62 | 396 | 445 | 494 | 544 | 593 | 643 | 692 | 742 |
| 64 | 393 | 442 | 491 | 541 | 590 | 639 | 688 | 737 |

To estimate the number of pounds Oxyfume 2002 that will be required to attain a certain EO concentration in a chamber of a certain size, use the equation:

Pounds required = C x V x 0.00062435 where, C = the concentration of EO in mg/liter, and V = the chamber volume in cubic feet. The table below illustrates the usefulness of this equation.

Table 3: Pounds of Oxyfume 2002 Sterilant Gas Required

| C mg/l | CHAMBER VOLUME, CUBIC FEET | | | | | | | | | |
|--------|----------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | 100 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1,000 |
| 300 | 18.7 | 37.5 | 56.2 | 74.9 | 93.7 | 112.4 | 131.1 | 149.8 | 168.6 | 187.3 |
| 350 | 21.9 | 43.7 | 65.6 | 87.7 | 109.3 | 131.1 | 153.0 | 174.8 | 196.7 | 218.5 |
| 400 | 25.0 | 49.9 | 74.9 | 99.9 | 124.9 | 149.8 | 174.8 | 199.8 | 224.8 | 249.7 |
| 450 | 28.1 | 56.2 | 84.3 | 112.4 | 140.5 | 168.6 | 196.7 | 224.8 | 252.9 | 281.0 |
| 500 | 31.2 | 62.4 | 93.7 | 124.9 | 156.1 | 187.3 | 218.5 | 249.7 | 281.0 | 312.2 |
| 550 | 34.3 | 68.7 | 103.0 | 137.4 | 171.7 | 206.0 | 240.4 | 274.7 | 309.1 | 343.4 |
| 600 | 37.5 | 74.9 | 112.4 | 149.8 | 187.3 | 224.8 | 262.2 | 299.7 | 337.1 | 374.1 |
| 650 | 40.6 | 81.2 | 121.7 | 162.3 | 202.9 | 243.5 | 284.1 | 324.7 | 365.2 | 405.8 |
| 700 | 43.7 | 87.4 | 131.1 | 174.8 | 218.5 | 262.2 | 305.9 | 349.6 | 393.3 | 437.0 |
| 750 | 46.8 | 93.7 | 140.5 | 187.3 | 234.1 | 281.0 | 327.8 | 374.6 | 421.4 | 468.3 |
| 800 | 49.9 | 99.9 | 149.8 | 199.8 | 249.7 | 299.7 | 349.6 | 399.6 | 449.5 | 499.5 |
| 850 | 53.1 | 106.1 | 159.2 | 212.3 | 265.3 | 318.4 | 371.5 | 424.6 | 477.6 | 530.7 |
| 900 | 56.2 | 112.4 | 168.8 | 224.8 | 281.0 | 337.1 | 393.3 | 449.5 | 505.7 | 561.9 |
| 950 | 59.3 | 118.6 | 177.9 | 237.3 | 296.6 | 355.9 | 415.2 | 474.5 | 533.8 | 593.1 |
| 1,000 | 62.4 | 124.9 | 187.3 | 249.7 | 312.2 | 374.6 | 437.0 | 499.5 | 561.9 | 624.4 |



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