Evaporation Rate

If the liquid stored in the tank is stored at a temperature > 40°C (104°F) or has vapor pressure > 5kPa (0.73 psi), it is necessary to perform a calculation to determine the Evaporation Rate of the liquid in the tank. This evaporation rate must be converted to equivalent air flow in appropriate units of measure (for example – SCFH of air) and then manually entered in, or added to, the “Additional Product Specific Pressure Venting” box of the ProFlow screen. ProFlow then includes this amount when determining the total, normal pressure venting requirement.

There are a number of methods available for the calculation of Evaporation Rates of stored liquids. The results obtained from these methods vary somewhat depending on the variables that are taken into account and the accuracy of the input data. The end user must review the literature and choose an appropriate method for calculation of the Evaporation Rate for their system.

Two useful information sources are API Bulletin 2523 (Petrochemical Evaporation Loss From Storage Tanks), and EPA Document AP-42 Section 7.1 (Emission Factor Documentation for Organic Liquid Storage Tanks). The reader is encouraged to review these documents in detail to determine if they are suitable for use in calculating the Evaporation Rates for their storage systems.

API Bulletin 2523 employs the basic equation:

\[ L_y = 0.024(P/(14.7-P))^{0.68}D^{1.73}H^{0.51}T^{-0.5}F_{p}C \]

- \( L_y \) = estimated breathing loss, in barrels per year (42 gallons/barrel) of gasoline at vapor pressure equal to chemical vapor pressure at the liquid temperature in the tank
- \( P \) = true vapor pressure at bulk liquid temperature, in pounds per square inch absolute
- \( D \) = tank diameter, in feet
- \( H \) = average outage of tank, in feet
- \( T \) = average daily temperature change, in degrees Fahrenheit.
- \( F_{p} \) = paint factor, dimensionless
- \( C \) = adjustment factor for small-diameter tanks (\( C = 1 \) for tanks 30 feet in diameter or larger)

To calculate an initial breathing loss from the tank. Breathing loss is defined as – Vapors expelled from a tank as a result of additional vaporization (exclusive of boiling) and/or expansion of vapor caused by an increase in temperature, a decrease in barometric pressure, or both.

The breathing loss is converted to barrels/year of the chemical through the formula:

\[ L = ((0.08M)/W)L_y \]

- \( L \) = breathing loss in barrels (42 gallons/barrel) per year of chemical
- \( M \) = molecular weight of chemical
- \( W \) = density of the condensed liquid, in pounds per gallon
The volume of vapors per gallon of liquid can be determined by:

\[ E = \frac{10.73TW}{PM} \]

- \( E \) = volume of vapor per gallon of equivalent condensed liquid, in cubic feet per gallon
- \( T \) = temperature of vapor, in degrees Rankine
- \( W \) = density of condensed liquid, in pounds per gallon
- \( P \) = partial pressure of chemical vapor, in pounds per square inch absolute
- \( M \) = molecular weight of the chemical vapor

The number of cubic feet/hour of vapor equivalent to the barrels per year loss can then be calculated:

\[ V = (L)(E)(42 \text{ gallons/barrel})(\text{year}/8760 \text{ hours}) \]

- \( V \) = volume of vapor at temperature and pressure inside tank in cubic feet per hour

The value of \( V \) can then be converted to an equivalent volume flow of air at standard conditions of 0 PSIG and 60° F using the “Vapor Flow Conversion” tool in the ProFlow pull down menus. This equivalent standard air flow value should be entered in, or added to, the “Additional Product Specific Pressure Venting” box of the ProFlow screen.

**EPA Document AP-42**

The EPA document AP-42, Section 7.1 includes methods and formulae for estimating the amount of a pollutant released to the atmosphere relative to an activity associated with that pollutant. One such activity is the storage of volatile organic liquids in fixed roof tanks. Among the factors taken into consideration are: vapor space volume, vapor density of product, tank diameter, average tank outage, daily temperature variations, product vapor pressure, atmospheric pressure, tank surface color and condition, etc. Losses are typically calculated in units of measure such as pounds/year. This value must then be converted to the appropriate units of measure such as equivalent standard cubic feet per hour of air for entry, or addition to the “Additional Product Specific Pressure Venting” box of the ProFlow screen. The following link to the Environmental Protection Agency web site may be used to review Chapter 7 of AP-42: [http://www.epa.gov/ttn/chief/ap42/ch07/](http://www.epa.gov/ttn/chief/ap42/ch07/).

Each end user must determine the best method for estimating the evaporation rate for their storage tank systems. Calculations such as those noted above may be used to estimate the rates. Corporate directives may dictate use of a fixed percentage of tank throughput, rather than individual analysis of tank systems. Whatever method is chosen, entry of a positive, non-zero number in the ProFlow “Additional Product Specific Pressure Venting” box will allow completion of the sizing and Vent selection process.

Note: If appropriate, the manual entry into ProFlow may include the equivalent flow of both evaporation rate and flashing emissions.