# PTE Evaluation

**Equipment:** Three (3) 5,900 gal Storage Tanks
One (1) Storage Tank for Raw Material A
One (1) Storage Tank for Raw Material B
One (1) Storage Tank for Raw Material C

Four (4) 500 gal Blending Tanks for blending the raw materials above.

One (1) Drum Filling Station

**Process Description:**

The source makes ... The ... are made by blending various amounts of raw materials A, B, and C. The raw materials are pumped to the blend tanks from the raw material storage tanks. Then the materials are heated to 165° F, blended for 3 hours, then cooled before pumped to the drum filling station.

**Assumptions:**

*Tanks Program for Storage Tanks*

The Tanks program accounts for working (loading) and breathing (changes in daytime/nighttime temperature) losses from the storage tanks. Assuming tanks are gray/light and are in good condition.

Volumetric filling rate for storage tanks and blending tanks: 45 gpm

Turnovers for each storage tank:

(1 tank/5,900 gal)(45 gal/min)(60 min/hr)(8760 hr/yr) = 4009 turnover/yr per tank

Turnovers for each blending tank:

(500 gal blend tank)(1 min/45 gal) = 11.11 min to fill
product is heated to 165° F (Assuming 2 hr)
blended for 3 hours
<u>11.11 min to empty</u>
Total = 5.37 hr/batch

(8760 hr/yr)(batch/5.37 hr) = 1631 turnovers/yr per blend tank

Bottleneck: (4 blend tanks)(1631 batches/yr) = 6524 batches/yr total
(6524 batches/yr total)(500 gal/batch) = 3,262,000 gal/yr

*Blending & Heating*

To calculate these emissions utilize the equations in the EIIP document located at http://www.epa.gov/ttn/chief/eiip/

These equations utilize the following assumptions:

- Covers are closed during operation, but is possible for vapors to be vented during operation.
- Assuming 10% vapor space in the blender.

Step 1: Calculate the moles of each component using the molecular weight (MW):
Moles = Mass / MW

Step 2: Calculate the liquid mole fraction of each component = $\frac{\text{Moles of Component}}{\text{Total Moles}}$

Step 3: Calculate the partial pressure ($P_x$) of each VOC component before heating and after heating. $P_x$ (psi) = (Liquid Mole Fraction)(Vapor Pressure (psi))

Step 4: Calculate the vapor mole fraction ($y_x$) of each component before heating and after heating. $y_x = P_x$/Total of all the partial pressures of each component

Step 5: Calculate the vapor molecular weight: (MWv) = $\Sigma(y_x)$(MWx)

Step 6: Calculate the initial ($Pa_1$) and final ($Pa_2$) gas pressure in the vessel:

$Pa_1 = 14.7 - \Sigma(P_x)_{T1}$

$Pa_2 = 14.7 - \Sigma(P_x)_{T2}$

Step 7: Calculate the volume (V) of free space in the blender:

V = (10% vapor space)(500 gal) = 50 gal = 6.684 $ft^3$

Step 8: Calculate the number of gas moles displaced ($\Delta$n):

$$\Delta n = \left(\frac{V}{R}\right)\left(\frac{Pa_1}{T1} - \frac{Pa_2}{T2}\right)$$

R = Ideal Gas Constant = 10.73 psia $ft^3$/lb-mole °R

Step 9: Calculate the total VOC emissions (lb/yr)

$$E_{VOC} = \frac{\left(\frac{\sum (P_x)_{T1}}{14.7 - \sum (P_x)_{T1}}\right) + \left(\frac{\sum (P_x)_{T2}}{14.7 - \sum (P_x)_{T2}}\right)}{2} \times \Delta n \times MWv \times CYC$$

CYC = number of cycles per year = 6524 batches/yr total

*Raw Material & Product Loading*

$$D_L = 12.46\left[\frac{S\ P\ MW_v}{T}\right]$$ *Reference AP- 42 Chapter 5, Equation 1

$D_L$ = Displacement Loss (lb/ $10^3$ gallons transferred)

T = Temperature of transferred liquid (°R)
609.6 °R for Product
527.6 °R for Raw Material
P = True Vapor Pressure of liquid loaded (psia)
$MW_v$ = Molecular Weight of the Vapor (lb/lb-mol) (Reference AP-42 Table 7.1-2)
= 199.37 lb/lb-mol
* For a pure liquid, the Molecular of the Vapor is the normal molecular weight that is found from the periodic table.
S = Saturation Factor = 1.45 for splash loading dedicated normal service. (AP-42 Table 5.2-1)

**Calculations:**

***<u>VOC:</u>***

***Storage***: (Working and Breathing Losses)
Raw Material A: (8.25 lb from Tanks 4.0)(1 ton/2000 lb) = 0.004 tpy
Raw Material B: (776.34 lb from Tanks 4.0)(1 ton/2000 lb) = 0.39 tpy
Raw Material C: (Same as above:) 0.39 tpy
**Total** = 0.004 + 0.39 + 0.39 = **0.784 tpy**

***Loading Raw Materials into the Blend Tanks***
(12.46)[(1.45)(0.019 psi)(199.37 lb/lb-mol)/527.6 °R] **=** 0.130 lb VOC/ $10^3$ gallons transferred
(0.130 lb VOC/ $10^3$ gallons transferred)(3,262,000 gal/yr)(1 ton/2000 lb) = **0.212 tpy VOC**

***Blending & Heating***

$$\frac{\left(\frac{0.013\,\text{psi}}{14.7\,\text{psi} - 0.013\,\text{psi}}\right) + \left(\frac{0.82\,\text{psi}}{14.7\,\text{psi} - 0.82\,\text{psi}}\right)}{2} \times 0.0036\,\text{mol} \times 264.45\,\text{lb/mol} \times 6524\,\text{batches/yr}$$

= 181.04 lb VOC/yr
(181.04 lb VOC/yr)(1 ton/2000 lb) = **0.091 tpy VOC**

***Loading Product into Drums***
(12.46)[(1.45)(1 psi)(264.45 lb/lb-mol)/609.6 °R] **=** 7.84 lb VOC/ $10^3$ gallons transferred
(7.84 lb VOC/ $10^3$ gallons transferred)(3,262,000 gal/yr)(1 ton/2000 lb) = **12.79 tpy VOC**

**Total VOCs = 0.784 + 0.212 + 0.091 + 12.79 = 13.88 tpy**