United States
Environmental Protection
Agency

Workshop on Air Emissions From Waste Management Facilities

IN LIGHT-MATERIAL SERVICE DETERMINATION FOR CONTAINERS

Self-Instructional
Problems

In Light-Material Service Determination for Containers

Definition:

The determination is based on the following definition (40 CFR Part 265.1081)

In light-material service means a container is used to manage a material for which both of the following conditions apply:

- The vapor pressure of one or more of the organic constituents in the material is greater than 0.3 kPa (2.26 mm Hg or 0.044 psi) at 20 °C.
- The total concentration of the pure organic constituents having a vapor pressure greater than 0.3 kPa at 20°C is equal to or greater than 20 percent by weight.

Basic Steps:

There are two basic steps in making an in light-material service determination for a container:

1. Determine if the **vapor pressure** of one or more of the organic constituents in the material in a container is greater than 0.3 kPa (2.26 mm Hg or 0.044 psi) at 20 °C.
2. Determine that the **total concentration** (by weight) of all pure organic constituents having a vapor pressure greater than 0.3 kPa at 20 °C is ≥20 percent by weight.

The following two examples illustrate these steps.

Example 1: A hazardous waste liquid (see Table 1) is being stored or managed in a container.

Table 1. Liquid Data

Constituents	C (mg/L)	P* (mm Hg)
Xylene	425,000	8.5
Decane	800	1.3
Toluene	455,000	30
Cumene	481	4.6
Dodecane	140	0.13

C = Concentration.
P* = Vapor pressure @ 20 °C.

The two basic steps can be used to determine if the container is in light-material service.

Step 1 -- Vapor Pressure

Determine if the **vapor pressure** of one or more of the organic constituents in the material in the container is greater than 0.3 kPa (2.26 mm Hg or 0.044 psi) at 20 °C.

$$P*_{xylene} = 8.5 mm\ Hg\ x\ \frac{1.01325\ x\ 10^2\ kPa}{760\ mm\ Hg} = 1.13\ kPa$$

Similarly,

$$P*_{decane} = 0.173\ kPa \qquad P*_{cumene} = 0.61\ kPa$$

$$P*_{toluene} = 3.9\ kPa \qquad P*_{dodecane} = 0.0173\ kPa$$

P* of xylene, toluene, and cumene is > 0.3 kPa; therefore, the condition for Step 1 has been satisfied.

Note:

- By comparing the vapor pressure of the constituents in mm Hg to the cutoff vapor pressure at 2.26 mm Hg, the same constituents are identified.
- In this example, the vapor pressures are given. If the vapor pressures are not known, they may be obtained from any of the following sources:
  - Engineering estimations (e.g., Antoine Equation, Clausius Clapeyron Equation)
  - References (e.g., Perry's Handbook, EPA CERI 90-124d Workshop--Organic air Emissions from Waste Management Facilities)

Step 2 -- Total Concentration

Determine that the **total concentration** (by weight) of all pure organic constituents having a vapor pressure greater than 0.3 kPa at 20 °C is ≥ 20 percent by weight.

A. Determine the total mass of all constituents in a unit volume of material. Because the concentration is in mg/L; determine the total mass based on 1 liter of the material.

$$M_{xylene} = 1\ liter\ x\ \frac{425{,}000\ mg}{liter} = 425{,}000\ mg$$

Similarly,

$$M_{decane} = 800\ mg \qquad M_{cumene} = 481\ mg$$

$$M_{toluene} = 455{,}000\ mg \qquad M_{dodecane} = 140\ mg$$

M = Mass of a constituent

M_{xylene}=	425,000 mg
M_{decane}=	800 mg
$M_{toluene}$=	455,000 mg
M_{cumene}=	481 mg
$M_{dodecane}$=	140 mg
M_{total} =	881,421 mg

B. Determine the weight percentage (C_T) of all pure organic constituents having a vapor pressure greater than 0.3 kPa at 20 °C.

$$C_{T_{P*>0.3\ kPa}} = \frac{Total\ Mass\ of\ all\ Constituents\ with\ P* > 0.3\ kPa}{Total\ Mass}$$

$$C_{T_{P*>0.3\ kPa}} = \frac{M_{xylene}+M_{toluene}+M_{cumene}}{M_{total}}\ x\ 100\% = \frac{(425{,}000+455{,}000+481)\ mg}{881{,}421\ mg}\ x\ 100\% = \frac{880{,}481\ mg}{881{,}421\ mg}\ x\ 100\% = 99.9\%$$

The weight percent of all constituents whose P* > 0.3 kPa is > 20%; therefore, the condition for Step 2 has been satisfied.

Note: In this example, the concentrations are given. If the concentrations are not known, they may be obtained from any of the following sources:

- Analysis of the stream using GC/MS (~$1,500 to $2,500 per sample).
- Analysis method for liquids with unknown vapor pressure -- ASTM D 2879-8.
- Engineering estimations.

Example 1 -- Summary

Because the conditions for Steps 1 and 2 were satisfied, the container used to store or manage the material is determined to be in light-material service.

Example 2: Repeat Example 1 using the concentration data given in Table 2.

Table 2. Liquid Data

Constituents	C (mg/L)	P* (mm Hg)
Xylene	800	8.5
Decane	425,000	1.3
Toluene	140	30
Cumene	481	4.6
Dodecane	455,000	0.13

C = Concentration.
P* = Vpor pressure @ 20 °C.

Step 1 -- Vapor Pressure

Determine if the **vapor pressure** of one or more organic constituents in the material in the container is greater than 0.3 kPa (2.26 mm Hg or 0.044 psi) at 20 °C.

$$P*_{xylene} = 8.5\ mm\ Hg\ x\ \frac{1.01325\ x\ 10^2\ kPa}{760\ mm\ Hg} = 1.13\ kPa$$

Similarly,

$$P*_{decane} = 0.173\ kPa \qquad P*_{cumene} = 0.61\ kPa$$

$$P*_{toluene} = 3.9\ kPa \qquad P*_{dodecane} = 0.0173\ kPa$$

P*of xylene, toluene, and cumene is > 0.3 kPa; therefore, the condition for Step 1 has been satisfied.

Note:

- By comparing the vapor pressure of the constituents in mm Hg to the cutoff vapor pressure at 2.26 mm Hg, the same constituents are identified.

- In this example, the vapor pressures are given. If the vapor pressures are not known, they may be obtained from any of the following sources:
  - Engineering estimations (e.g., Antoine Equation, Clausius Claperyron Equation)
  - References (e.g, Perry's Handbook, EPA CERI 90-124d Workshop--Organic Air Emissions from Waste Management Facilities)

Step 2 -- Total Concentration

Determine that the **total concentration** (by weight) of all pure organic constituents having a vapor pressure greater than 0.3 kPa at 20 °C is $\geq$ 20 percent by weight.

A. Determine the total mass of all constituents in a unit volume of material. Because the concentration is in mg/L; determine the total mass based on 1 liter of the material.

$$M_{xylene} = 1\ liter\ x\ \frac{800\ mg}{liter} = 800\ mg$$

Similarly

$$M_{decane} = 425{,}000\ mg \qquad M_{cumene} = 481\ mg$$

$$M_{toluene} = 140\ mg \qquad M_{dodecane} = 450{,}000\ mg$$

M = Mass of a constituent

M_{xylene}=	800 mg
M_{decane}=	425,000 mg
$M_{toluene}$=	140 mg
M_{cumene}=	481 mg
$M_{dodecane}$=	455,000 mg
M_{total} =	881,421 mg

B. Determine the weight percentage (C_T) of all pure organic constituents having a vapor pressure greater than 0.3 kPa at 20 °C.

$$C_{T_{P*>0.3\ kPa}} = \frac{Total\ Mass\ of\ all\ Constituents\ with\ P* > 0.3\ kPa}{Total\ Mass}$$

$$C_{T_{P*>0.3\ kPa}} = \frac{M_{xylene} + M_{toluene} + M_{cumene}}{M_{total}}\ x\ 100\% = \frac{(800 + 140 + 481)\ mg}{881{,}421\ mg}\ x\ 100\% = \frac{1{,}421\ mg}{881{,}421\ mg}\ x\ 100\% = 0.16\%$$

The weight percent of all constituents whose P* > 0.3kPa is **not** > 20%; therefore, the condition for Step 2 has **not** been satisfied.

Note: In this example, the concentrations are given. If the concentration are not known, they may be obtained from any of the following sources:

- Analysis of the stream using GC/MS (~$1,500 to $2,500 per sample).
- Analysis method for liquids with unknown vapor pressure -- ASTM D 2879-8.
- Engineering estimations.

Example 2 -- Summary

Because the condition for one of the two steps (Step 2) was not satisfied, the container used to store or manage the material is determined **not** to be in light-material service.