South Coast Air Quality Management District

Supplemental Instructions

for

Liquid Organic Storage Tanks

Annual Emissions Reporting Program

Revised December 2022

Table of Contents

INTRODUCTION

The purpose of this supplemental manual is to provide facilities guidance for estimating emissions from liquid organic storage tanks.

Storage tanks containing organic liquids can be found in many industries, including:

- petroleum production and refining,
- petrochemical and chemical manufacturing,
- bulk storage and transfer operations, and
- other industries consuming organic liquids.

Organic liquids in the petroleum industry, usually called petroleum products, generally are mixtures of hydrocarbons having different true vapor pressures (for example, gasoline and crude oil). Organic liquids in the chemical industry are composed of pure chemicals or mixtures of chemicals with similar true vapor pressures (for example, benzene or a mixture of isopropyl and butyl alcohol).

Typically, liquid organic storage tanks are categorized in two types: floating roof and fixed roof. There are five basic designs for organic liquid storage tanks:

- external floating roof,
- internal floating roof,
- aboveground vertical fixed roof,
- aboveground horizontal fixed roof, and
- underground storage tanks

Storage tank emissions associated with each design are briefly described here. Detailed descriptions and emission calculation procedures for each tank design are provided in Chapter 7 of EPA's Compilation of Air Pollutant Emission Factors (AP-42) with the exception of fuel dispensing. Guidance for underground storage tanks used for fuel dispensing has been developed by ARB and South Coast AQMD and presented in this document. Guidance for diesel fuel dispensing was developed from EPA AP-42, Chapter 5.2 (June 2008).

EXTERNAL FLOATING ROOF TANKS

A typical external floating roof tank consists of an open-topped cylindrical steel shell equipped with a roof that floats on the surface of the stored liquid. The floating roof consists of a deck, fittings, and rim seal system. Floating decks that are currently in use are constructed of welded steel plate and are of two general types: pontoon or double-deck. With all types of external floating roof tanks, the roof rises and falls with the liquid level in the tank. External floating decks are equipped with a rim seal system, which is attached to the deck perimeter and contacts the tank wall. The purpose of the floating roof and rim seal system is to reduce evaporative loss of the stored liquid. Some annular space remains between the seal system and the tank wall. The seal system slides against the tank wall as the roof is raised and lowered. The floating deck is also equipped with fittings that penetrate the deck and serve operational functions. The external floating roof design is such that evaporative losses from the stored liquid are limited to losses from the rim seal system and deck fittings (standing storage loss) and any exposed liquid on the tank walls (working loss).

INTERNAL FLOATING ROOF TANKS

An internal floating roof tank has both a permanent fixed roof and a floating roof inside. There are two basic types of internal floating roof tanks: tanks in which the fixed roof is supported by vertical columns within the tank, and tanks with a self-supporting fixed roof and no internal support columns. Fixed roof tanks that have been retrofitted to use a floating roof are typically of the first type. External floating roof tanks that have been converted to internal floating roof tanks typically have a self-supporting roof. Newly constructed internal floating roof tanks may be of either type. The deck in internal floating roof tanks rises and falls with the liquid level and either floats directly on the liquid surface (contact deck) or rests on pontoons several inches above the liquid surface (non-contact deck). Most aluminum internal floating roofs currently in service have non-contact decks.

FIXED ROOF TANKS

A typical vertical fixed roof tank consists of a cylindrical steel shell with a permanently affixed roof, which may vary in design from cone- or dome-shaped to flat. Losses from fixed roof tanks are caused by changes in temperature, pressure, and liquid level.

Fixed roof tanks are either freely vented or equipped with a pressure/vacuum vent. The latter allows the tanks to operate at a slight internal pressure or vacuum to prevent the release of vapors during very small changes in temperature, pressure, or liquid level. Of current tank designs, the fixed roof tank is the least expensive to construct and is generally considered the minimum acceptable equipment for storing organic liquids.

Horizontal fixed roof tanks are constructed for both aboveground and underground service and are usually constructed of steel, steel with a fiberglass overlay, or fiberglass-reinforced polyester. Horizontal tanks are generally small storage tanks with capacities of less than 40,000 gallons. Horizontal tanks are constructed such that the length of the tank is not greater than six times the diameter to ensure structural integrity.

The potential emission sources for aboveground horizontal tanks are the same as those for vertical fixed roof tanks. Emissions from underground storage tanks are associated mainly with changes in the liquid level in the tank. Losses due to changes in temperature or barometric pressure are minimal for underground tanks because the surrounding earth limits the diurnal temperature change, and changes in the barometric pressure result in only small losses.

EMISSIONS

Emissions from organic liquids storage tanks occur because of evaporative loss of the liquid during its storage and as a result of changes in the liquid level.

Emissions from fixed roof tanks are a result of evaporative losses during storage (known as breathing losses or standing storage losses) and evaporative losses during filling and emptying operations (known as working losses).

Storage loss is the expulsion of vapor from a tank through vapor expansion and contraction, which are the results of changes in temperature and barometric pressure. This loss occurs without any liquid level change in the tank.

The combined loss from filling and emptying is called working loss. Evaporation during filling operations is a result of an increase in the liquid level in the tank. As the liquid level increases, the pressure inside the tank exceeds the relief pressure and vapors are expelled from the tank. Evaporative loss during emptying occurs when air drawn into the tank during liquid removal becomes saturated with organic vapor and expands, thus exceeding the capacity of the vapor space.

For floating roof tanks, standing storage losses are a result of evaporative losses through rim seals, deck fittings, including deck seams losses, in case of internal floating roof tanks, for construction other than welded decks.

Withdrawal losses occur as the liquid levels, and thus the floating roof is lowered. Some liquid remains on the inner tank wall surface and evaporates. For an internal floating roof tank that has a column supported fixed roof, some liquid also clings to the columns and evaporates. Evaporative loss occurs until the tank is filled and the exposed surfaces are again covered.

FUEL DISPENSING

Please see the Guidelines for Fuel Dispensing Operations on the AER website.

APPENDIX: Default TAC Profile for Select Petroleum Products

Crude Oil			
Chemical Name	**CAS Number**	**Liquid Weight (%)**	**Molecular Weight**
Hexane (-n)	110543	0.40	86.17
Benzene	71432	0.60	78.11
Isooctane	26635643	0.10	114.22
Toluene	108883	1.00	92.13
Ethylbenzene	100414	0.40	106.17
Xylene (-m)	1330207	1.40	106.17
Isopropyl benzene	98828	0.10	120.20
1,2,4-Trimethylbenzene	95636	0.33	120.19
Cyclohexane	110827	0.70	84.16

Distillate Fuel Oil #2 (Diesel)			
Chemical Name	**CAS Number**	**Liquid Weight (%)**	**Molecular Weight**
Hexane (-n)	110543	0.00	86.17
Benzene	71432	0.00	78.11
Toluene	108883	0.03	92.13
Ethylbenzene	100414	0.01	106.17
Xylene (-m)	1330207	0.29	106.17
1,2,4-Trimethylbenzene	95636	1.00	120.19

Gasoline			
Chemical Name	**CAS Number**	**Liquid Weight (%)**	**Molecular Weight**
Hexane (-n)	110543	1.00	86.17
Benzene	71432	1.80	78.11
Isooctane	26635643	4.00	114.22
Toluene	108883	7.00	92.13
Ethylbenzene	100414	1.40	106.17
Xylene (-m)	1330207	7.00	106.17
Isopropyl benzene	98828	0.50	120.20
1,2,4-Trimethylbenzene	95636	2.50	120.19
Cyclohexane	110827	0.24	84.16

Gasoline (Oxygenated with MTBE)			
Chemical Name	**CAS Number**	**Liquid Weight (%)**	**Molecular Weight**
Hexane (-n)	110543	1.00	86.17
Benzene	71432	1.80	78.11
Isooctane	26635643	4.00	114.22
Toluene	108883	7.00	92.13
Ethylbenzene	100414	1.40	106.17
Xylene (-m)	1330207	7.00	106.17
Isopropyl benzene	98828	0.50	120.20
1,2,4-Trimethylbenzene	95636	2.50	120.19
Cyclohexane	110827	0.24	84.16
Methyl-tert-butyl ether (MTBE)	1634044	12.00	88.15

Gasoline (Reformulated with MTBE)			
Chemical Name	**CAS Number**	**Liquid Weight (%)**	**Molecular Weight**
Hexane (-n)	110543	1.00	86.17
Benzene	71432	1.80	78.11
Isooctane	26635643	4.00	114.22
Toluene	108883	7.00	92.13
Ethylbenzene	100414	1.40	106.17
Xylene (-m)	1330207	7.00	106.17
Isopropyl benzene	98828	0.50	120.20
Methyl-tert-butyl ether (MTBE)	1634044	8.80	88.15
1,2,4-Trimethylbenzene	95636	2.50	120.19
Cyclohexane	110827	0.24	84.16

Jet Kerosene (Jet A)			
Chemical Name	**CAS Number**	**Liquid Weight (%)**	**Molecular Weight**
Hexane (-n)	110543	0.01	86.17
Benzene	71432	0.00	78.11
Toluene	108883	0.13	92.13
Ethylbenzene	100414	0.13	106.17
Xylene (-m)	1330207	0.31	106.17

Jet Naphtha (JP-4)			
Chemical Name	**CAS Number**	**Liquid Weight (%)**	**Molecular Weight**
Hexane (-n)	110543	1.50	86.17
Benzene	71432	0.60	78.11
Toluene	108883	2.00	92.13
Ethylbenzene	100414	0.50	106.17
Xylene (-m)	1330207	2.50	106.17
Isopropyl benzene	98828	0.20	120.20
Cyclohexane	110827	1.20	84.16