— University of Mosul —
College of Petroleum & Mining Engineering

Petroleum Pollution

Lecture …(5)….

Petroleum and Refining Engineering Department

Waste-Management Plans

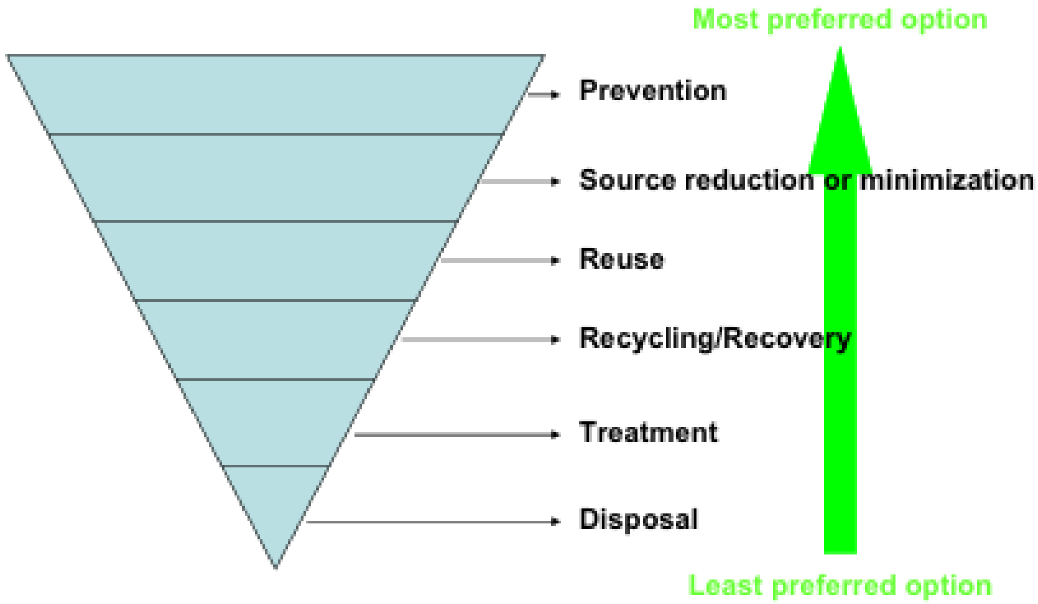

Figure 3.5 Waste-management hierarchy.

Example 2.1

At a refinery, assume there are 100 gas valves in a stream that, on average, contain 80 wt% nonmethane organic compounds, 10 wt% water vapor, 10 wt% methane, and no ethane (thus the TOC wt% would be 90). If the process operates 8000 h per year (h/year), what are the hourly and annual TOC and VOC emissions from the 100 gas valves?

Solution

The average hourly TOC emissions from the gas valves in the stream can be calculated using the applicable EF from Table 2.9 and Eq. (2.6):

$$\begin{aligned} E_{\mathrm{TOC}} &= F_{\mathrm{A}} \times \left(\frac{\mathrm{WF_{TOC}}}{\mathrm{WF_{TOC}} - \mathrm{WF_{methane}}} \right) \times \mathrm{WF_{TOC}} \times N \\ &= 0.0268 \times \left(\frac{0.9}{0.9 - 0.1} \right) \times 0.9 \times 100 = 2.71\ \mathrm{kg\ TOC/h} \end{aligned}$$

The average annual TOC emissions from the gas valves in the stream can also be calculated as follows:

$$E_{\mathrm{TOC,\ annual}} = 2.71\ \mathrm{kg\ TOC/h} \times 8000\ \mathrm{h/year} = 21680\ \mathrm{kg\ TOC/year}$$

Table 2.7 Main Air Emissions and Their Sources in Refineries (US EPA, 1995c, 2004; Speight, 2005; European Commission and Joint Research Center, 2013)—cont'd

Air Emissions	Sources and/or Processes
Sulfur oxides (SO_x)	Process furnaces and boilers, fluidized catalytic cracking regenerators, CO boilers, sulfur recovery units, flare systems, incinerators, or in processes such as crude-oil desalting, atmospheric distillation, vacuum distillation, thermal cracking/visbreaking, coking, catalytic cracking, catalytic hydrocracking, hydrotreating/hydroprocessing, alkylation, isomerization, catalytic reforming, and propane deasphalting
Volatile organic compounds (VOCs)	Storage and handling facilities, as separation units, oil/water separation systems, fugitive emissions (valves, flanges, etc.), vents, flare systems
Fugitive hydrocarbons	Crude-oil desalting, atmospheric distillation, vacuum distillation, thermal cracking/visbreaking, coking, catalytic cracking, catalytic hydrocracking, hydrotreating/hydroprocessing, alkylation, isomerization, catalytic reforming, propane deasphalting, and wastewater treatment
Catalyst dust	Catalytic hydrocracking
HCl (potentially in light ends)	Isomerization
H_2S	From caustic washing in polymerization and wastewater treatment
NH_3	Wastewater treatment
Fugitive solvents	Solvent extraction and dewaxing
Fugitive propane	Propane deasphalting

Table 3.5 Major US Federal Environmental Regulations Relevant to the Petroleum Industry (U.S. EPA, 2015c; Reis, 1996; Speight, 2005)—cont'd

Regulation	Brief Description
Endangered Species Act (ESA)	ESA regulates actions that jeopardize endangered or threatened species.
Hazard Communication Standards (HCS)	HCS informs employees of potentially dangerous substances in the workplace and trains them on how to protect themselves against potential dangers.
National Environmental Policy Act (NEPA)	NEPA regulates actions of federal government that may result in environmental impacts.
Hazardous Materials Transportation Act (HMTA)	HMTA regulates transportation of chemicals and hazardous materials through the nation's highways, railways, and waterways. The act includes a comprehensive assessment of the regulations, information systems, container safety, and training for emergency response and enforcement.
Marine Mammal Protection Act (MMPA)	MMPA regulates the use of explosives for removing offshore platforms and prohibits the taking and harassing marine mammals.
Comprehensive Wetland Conservation and Management Act (CWCMA)	CWCMA regulates activities impacting wetlands.

Table 3.6 Maximum Concentrations of Contaminants for the Toxicity Characteristic Under the RCRA (U.S. EPA, 2009)

Contaminant	Regulatory Level (mg/L)
Arsenic	0.5
Barium	100.0
Benzene	0.5
Cadmium	1.0
Carbon tetrachloride	0.5
Chlordane	0.03
Chlorobenzene	100.0
Chloroform	6.0
Chromium	5.0
o-Cresol	200.0
m-Cresol	200.0
p-Cresol	200.0

Continued

- Curtain booms (Fig. 4.3) (usually with a circular cross-section continuous subsurface skirt or flexible screen supported by an air or foam-filled flotation chamber); and
- Fence booms (Fig. 4.4) (typically with a flat cross-section held vertically in the water by integral or external buoyancy, ballast, and bracing struts).

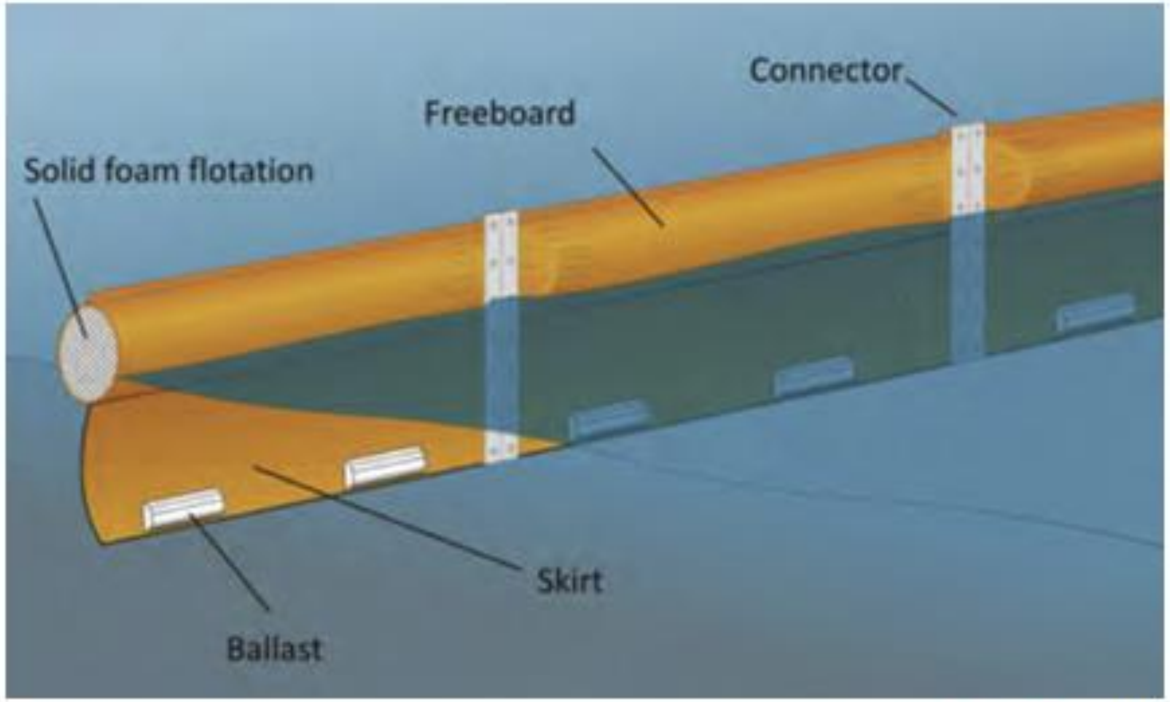

Figure 4.3 Curtain boom with external ballast and solid foam flotation (ITOPF, 2011a).

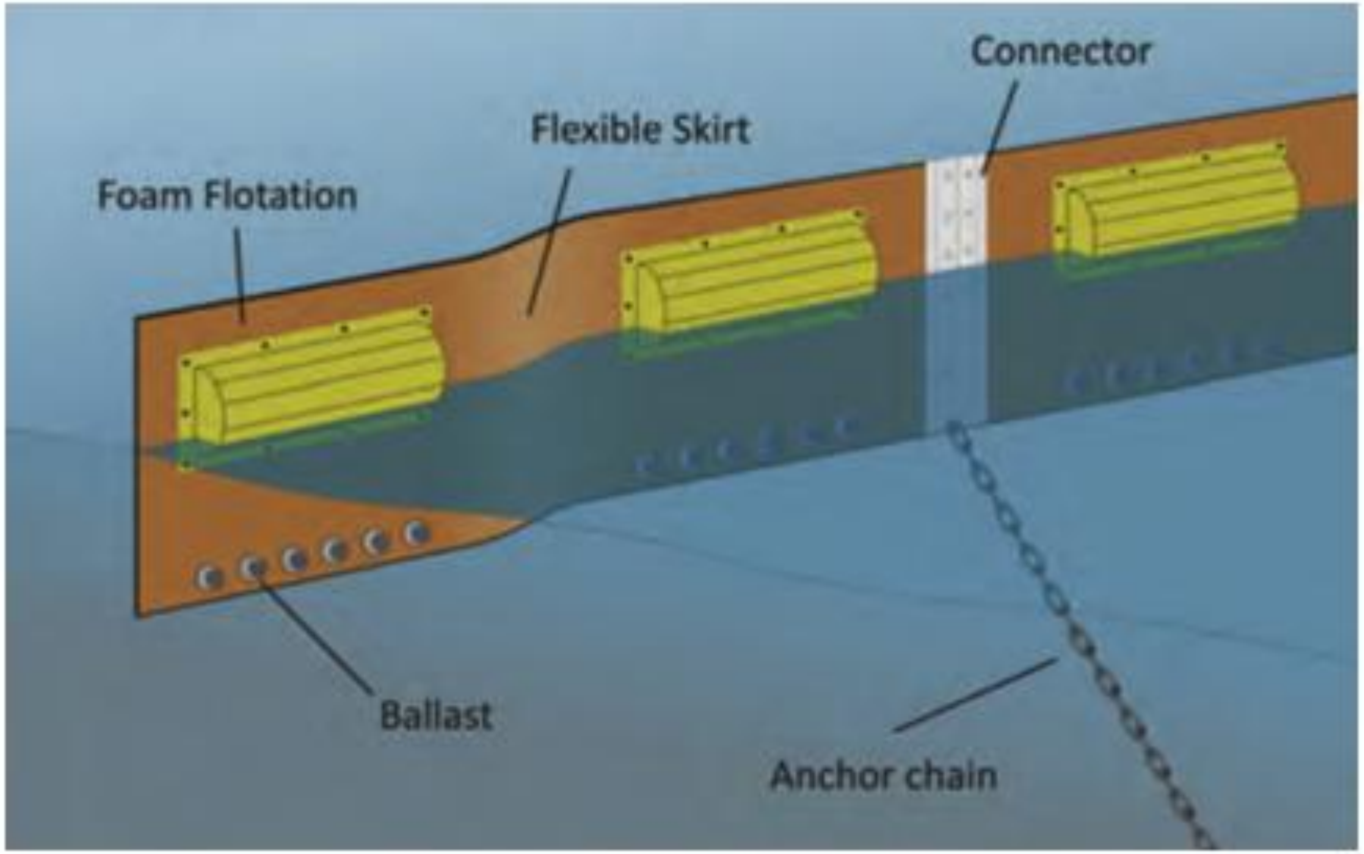

Figure 4.4 Fence boom with external foam flotation and ballast (ITOPF, 2011a).

Figure 4.2 Boom used in the Gulf of Mexico oil spill (https://commons.wikimedia.org/wiki/File:Shrimp_boats_tow_fire-resistant_oil-containment_boom_in_Gulf_of_Mexico_2010-05-03_1.jpg).

with use of foam and extreme safety procedures. Deflection or exclusion booming of sensitive areas to prevent exposure to oil, including gasoline, can be an important protection action. Environmental effects can be minimal if surface disturbance by cleanup work force traffic is controlled (API and NOAA, 1994).

There are two broad categories of boom design:

Table 2.24 Incidence of Spills <7 tons, Spills 7−700 tons, and Spills >700 tons by Operation at Time of Incident and Primary Cause of Spill During 1970−2014 (ITOPF, 2015)

Group	Item	Incidence of Spills <7 tons	Incidence of Spills 7−700 tons	Incidence of Spills >700 tons
Operations	At anchor (inland/ restricted)			4%
	At anchor (open water)			2%
	Underway (inland/ restricted)			17%
	Underway (open water)			50%
	Loading/discharging	40%	29%	9%
	Bunkering	7%	2%	<1%
	Other operations/ unknown	53%	69%	>17%
Cause	Allision/collision	2%	26%	30%
	Grounding	3%	20%	33%
	Hull failure	7%	7%	13%
	Equipment failure	21%	15%	4%
	Fire/explosion	2%	4%	11%
	Other	23%	13%	6%
	Unknown	41%	15%	3%