CHAPTER II

Oil Loss Characteristics

2.1 The Definition of Loss

Every liquid stock has a finite surface vapor pressure, depending on surface temperature and composition of the liquid. Through evaporation and condensation liquid is gradually in equilibrium with vapor existing above the liquid surface.

However, storage tanks are exposed to dynamic conditions that disturb this equilibrium and cause additional vaporization. This dynamic change is responsible for oil loss, especially via atmospheric emissions.

In oil industry business, the loss of oil is usually considered an inevitable matter. Of course, the company will waste a lot of money per year if it does not control the quantity of this loss. An efficient way to get the satisfactory level of loss, engineers should try to retain the lowest amount of loss.

2.2 The Classification of Loss

Oil loss can occur in every step of operation because of several causes. Oil loss is classified on the job specification into three categories as follows.

a) Manufacturing loss

b) Transportation loss or Intrasit loss

c) Plant loss

For the classification on the cause of loss, it has 16 types listed hereafter.

a) Shrinkage loss
b) Breathing loss
c) Standing loss or Storage loss
d) Filling & Emptying loss or Working loss
e) Loading loss
f) Wetting loss or Withdrawal loss
g) Temperature loss
h) Leakage loss
i) Boiling loss
j) Overflow & Spill
k) Accounting loss
l) Clingage loss
m) Calibration loss
n) Gauging loss
o) Theft
p) Tank cleaning

2.3 Plant Loss or Oil Loss in the Terminal

There are three steps of operation in each terminal and the different kinds of loss can occur in each step of operation. First step is the oil receiving unit. This operation causes two types of loss which are intrasit loss and working loss. The second operation is oil storaging in various kinds of tanks caused breathing loss, working loss, standing storage loss and withdrawal loss. The last operation is product discharging which causes loading loss.

The objective of this work is to develop a simulation program for calculating evaporation loss from oil storage step in the terminal, therefore the features of evaporation loss and storage tank design should be considered. The next two sections will explain these two topics.

2.4 Evaporation Loss Features

When liquid is evaporated and its vapor leaks out of the tank into the atmosphere, the loss of oil will occur. The more common evaporation loss of petroleum from storage tanks are breathing loss, working loss, standing storage loss and withdrawal loss.

a) Breathing Loss

Loss associated with the thermal expansion and contraction of the vapor space resulting from the daily temperature cycle is defined as breathing loss.

b) Working Loss

Working loss is loss associated with a change in liquid level in the tank. This loss may be resulted from displacement of vapor by a rising liquid surface, or from the outbreath of vapor after a rapid withdrawal and subsequent re-equilibration. (See API Bulletin 2513, Evaporation Loss in the Petroleum Industry - Causes and Control)

c) Standing Storage Loss

Standing storage loss results from causes other than breathing or change in liquid level. For floating roof tanks, the largest potential source of standing storage loss is an improper of the tank shell. The liquid surface may expose to the atmosphere in such situation. This condition exposes some liquid surface to the atmosphere. Wind affects this source of loss. Also, a small amount of vapor may permeate through flexible membrane that seals the space between the tank wall and the floating roof.

d) Wetting or Withdrawal Loss

Vaporization of liquid from a wetted tank wall, exposed when the floating roof is lowered by withdrawal of liquid, is defined as wetting loss. This source of evaporation loss is usually small.

For a complete discussion of the types of evaporation losses and their features, see API Bulletins 2513, 2517 and 2518.

2.5 Storage Tank Design Features

There are many basic tank types which are designed to serve a particular need or purpose. Each design has special requirements for accessories, maintenance and manner of operation. The following designs are most common used in the terminal operations :

-fixed roof tank

-floating roof tanks with open top (external floating roof tank)

-covered internal floating roof tank

-small horizontal and vertical cylindrical shop-fabricated tank

-LPG tank

Other types are :

-variable vapor space tank and system

-pressure tank

-underground tank (used primarily in service stations)

The most common types of storage tanks are fixed roof, floating roof atmospheric storage and pressure storage tanks. Pressure tanks generally are not subject to much leakage, whereas the atmospheric tanks do emit gases to the atmosphere. The storage of volatile product results in losses due to evaporation. It is not economically feasible to provide facilities which completely prevent these losses.

The goal of a loss control program is to estimate size of tankage equipment and accessories that, when combined with good operating procedures, reduce losses to a practical minimum. To reduce evaporation loss from storage tank, it is necessary to reduce heat transfered to the system and eliminate or control the vapor space in tank. The elimination or reduction of the vapor space to a greater extent can be carried out by tank type and dimension selection. For example, the use of floating roof tanks or internal floating covers will minimize the vapor space.

Three types of storage tanks described here are fixed roof tank, internal floating roof tank and external floating roof tank. General components, which are available in a range of commercial designs, are described in appendix A, B and C. Included in these descriptions are some comments on the potential for evaporative loss, as well as some design and operational characteristics. Other factors, such as tank maintenance and safety, are important in designing and selecting tank equipment, but are outside the scope of this work.

2.5.1 Fixed Roof Tank Features

Fixed roof tank has generally cone or dome shape roof. Fixed roof cylindrical tank are used for most products other than gasoline. These tanks are the minimal standard for storaging volatile oils when the following criteria are met :

-constructed with a vapor-tight roof

-equipped with pressure vacuum vent valves

Since it is usually the least costly to construct, it serves as the base in justifying the additional expenditure necessary to construct conservation-type tanks. The tank operates with a vapor space which varies with the liquid level in the tank. Design and construction of this type tanks are in accordance construction with API 650. These tanks are designed to operate at only slight internal pressure or vacuums. Therefore, sizable breathing and filling losses are possible.

Two types of losses taking place in fixed roof tanks are breathing losses and working losses. Breathing loss is defined as vapor expelled from a tank because of thermal expansion of existing vapors and / or expansion caused by barometric pressure changes. Working loss is defined as vapor expelled from a tank as a result of liquid pumped into the tank. The total loss from a fixed roof tank is the sum of these two losses.

2.5.2 Internal Floating Roof Tank Features

The internal floating roof consists of a simplified floating deck or pan installed in a fixed roof tank with provision for a freely ventilated area above the floating deck. There are many available internal floating roof designs which permit installation in existing fixed roof tanks. Results of tests reported in API Bulletin 2519 showed internal floating roofs reduced vapor loss from 47 to 94 % comparison with fixed roof tankage loss levels. An average loss reduction of 75 % of the total evaporation loss sustained from a fixed roof tank be used in determining the potential savings from installing an internal floating roof. Two basic types of internal floating roofs are currently available :

a) Pan roofs are constructed of steel in the form of a pan and are designed according to API Standard 650.

b) Internal floating covers are constructed of materials other than steel, such as aluminum or urethane.

Existing fixed roof tanks can be converted to internal floating roof tanks by the addition of prefabricated internal floating decks. In most cases, it is advantageous to install internal floating decks in new fixed cone roof tanks, rather than to construct an external floating roof tank (open top floating roof). The air space on top of the deck should be adequately ventilated in order to keep it out of explosive range. Vent openings (number and size depending on tank diameter) should be installed around the periphery close to the top edge of the shell.

The internal floating roof tank is subjected to a standing storage evaporation loss and a withdrawal loss. The standing storage evaporation loss is the loss from the seals and depends to some extent on the type of seal. The withdrawal loss is the loss due to evaporation of the stock from the tank walls as they are exposed during lowering of the tank level. The withdrawal loss is usually significantly smaller than the standing storage loss.

2.5.3 External Floating Roof Tank Features

The floating roof tank is constructed so that the roof floats on the liquid surface. This eliminates the vapor space and greatly reduces vapor loss. For the consideration of fire pretection and spacing, this type also has advantage over other types. The older types of floating decks in open top floaters were pan type; the newer ones are usually pontoon type except that the smaller sizes may be double deck type.

The single deck pontoon roof design provides the good stability and roof buoyancy. Pontoons are arranged around the periphery of the deck and floatation is maintained even under heavy water loads. In the double deck roof design, the entire roof becomes a series of pontoons or compartments to assure that the floatation is maintained even through there might be leaks in several compartments. The double deck construction provides assurance against boiling under the deck because of the insulating factor of the air space between decks. Since the two decks are separated by a dead air space which serves to insulate the product from the heat of the sun, products with a true vapor pressure as high as 13 psia may be stored under the double deck floating roof with no boiling problem. Types of evaporation losses that occurred in the external floating roof tanks are standing storage loss and withdrawal loss. The full information of various floating roof tank designs : pan type, single deck pontoon roof and double deck roof are described in API Bulletin 2513.

2.6 The Development of Evaporation Loss Estimation

Since 1957, a lot of loss information has been presented and developed by API. The API evaporation loss committee has studied and focused on the development of methodology to define or estimate each loss occured in each type of storage tank, especially for fixed roof tank, internal floating roof tank and external floating roof tank. To supplement the essential data for calculating loss correlation, API sponsored a program to develop additional laboratory, test tank and field tank data on evaporation losses. Besides API, oil companies, manufacturers, industry groups and regulatory agencies have tried to study and analyze this subject. Updated editions of the evaporation loss information have been published continually till now. In this work, its objectives is to develop the simulation program or calculating model for estimating evaporation losses based on API procedures that will be presented in Chapter III.