Chapter 6
Oil and Gas Storage Tank Risk Analysis

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ABSTRACT

Storage tanks are widely used in the oil refinery and petrochemical industry in storing a multitude of different products ranging from gases, liquids, solids, and mixtures. Design and safety concerns have become a priority due to tank failures causing environment pollution as well as fires and explosions, which can result in injuries and fatalities. The chapter illustrates different types of crude oil and oil product storage tanks as well as the risks regarding the storage itself. Considering that the natural gas, in its gaseous state, is stored in underground storages like oil and gas depleted reservoirs, aquifers or salt caverns, and there are numerous publications and books covering the subject in detail, this chapter only illustrates the storage of liquefied natural gas and the risks posed by its storage.

INTRODUCTION

In oil and gas industry the movement of crude and refined oil products from the places of origin to the various markets would not be possible without the existence of economic and safe storage facilities. Storage tanks are located at the ends of feeder lines and gathering lines, along truck pipelines, at marine loading and unloading facilities and in refineries, terminals and bulk plants.

Oil produced from the early wells was stored in whisky barrels. Barrels, although unsuitable for storage use because of leaking, remained in use for a long time due to their ease of transportation and were eventually replaced by steel ones. The measurement of the oil volume is often expressed in barrels (1 bbl=0,159 m^3) precisely because of such practices. With the ever growing need for oil, the storage tank sizes increased with time. Today, crude oil is commonly stored in large aboveground atmospheric vertical cylindrical storage tanks at oil fields, terminals and refineries where storage tanks are typically installed with similar or identical vessels in a group.

At the oilfield, when the oil is brought to the surface under high pressure conditions it is passed through either a two (where the associated gas is removed and any oil and water remain together) or a three phase separator (where the associated gas is removed and the oil and water are also separated). The remaining low pressure oil is then directed to a storage vessel where it is stored for

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a period of time before being transported off-site. The remaining hydrocarbons in the oil are released from the oil as vapours in the storage vessels. At the oil fields produced crude oil is usually stored in fixed roof storage tanks while stabilised oil and oil products at terminals and refineries are stored in floating roofs tanks. Within the European Union (EU) the specification for the design of such tanks is covered by the British Standard BS EN 14015:2004 (2005) which is generally equivalent to American Petroleum Institute (API) standards, API 650 (Welded steel tanks for oil storage, 2007) and API 620 (The design and construction of large, welded, low-pressure storage tanks, 2002).

Terminals are storage facilities which generally receive crude oil and petroleum products by trunk pipeline or marine vessel. Crude oil and petroleum product terminals are designed to receive and dispatch crude oil and petroleum products to refineries, other terminals, bulk plants and consumers by pipelines, railroad tank cars and tank trucks. Tanks should ideally be located alone, but storage tanks are often grouped in tank farms. Within tank farms, individual tanks or groups of two or more tanks are usually surrounded by a catchment area in the form of a retaining wall, known as a bund or dike. Bunds would normally be constructed from earth or preferably concrete and should be largely impervious to liquid and capable of withstanding hydrostatic and hydrodynamic pressures to which they could be subjected. Whenever tanks share a common bund, intermediate walls up to half the height of the main bund walls and no more than 0,5 metres high should be provided to control small spillages from one tank affecting another. Bund floors should drain to a single location complete with sump for the regular removal of water from rainfall or firewater testing. Drains should normally be kept closed, with the drain isolation valve situated outside the bund. Bunds are normally designed to hold 110% of that of the largest tank, the excess height notionally to prevent stored liquid surging over the top of the bund in the event of a catastrophic failure of the primary containment. This allowance has proved to be inadequate as, even with storage volume excess, large quantities of liquid can still overtop bunds as discussed by Thyer and Jagger (2002) and Atherton (2005).

Natural gas can be stored in gaseous or liquefied state. The natural gas in gaseous state will be stored in underground storages (depleted oil or gas reservoirs, aquifers or salt caverns). By converting natural gas to liquefied natural gas (LNG) it can be economically transported over the oceans and great distances from the places where it is produced to those where it is in demand. Currently, the liquefied natural gas trade, accounting for the bringing to markets of some 30% of the world's natural gas (BP Statistical Review, 2013), would not be able without the development of large scale cryogenic storage units at both export and import terminals. Liquefaction of natural gas also provides the opportunity to store the fuel for use during high consumption periods close to demand centres.

BACKGROUND

The storage of crude oil and petroleum product creates the potential for leaks or accidentally releases from tanks, pipes, hoses, and pumps during loading and unloading of products. The storage and transfer of these materials also poses a risk of fire and explosion due to the flammable and combustible nature of the materials stored. Basic requirements for tank design and construction are mandated by various industrial codes and standards but the risk of an accident, although minimal, is present. There are many examples of storage tank accidents. One of the often mentioned is storage tank explosion at the Hertfordshire Oil Storage Limited part of the Buncefield (2005). The accident was caused by operational error because two level gauges were inoperable at the moment: a gauge that enabled the employees to monitor the filling operation; and an independent high-level switch which was meant to close down operations