Engineering introduction on the drainage system of Saudi Aramco booster gas compressor station

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Abstract. Saudi Aramco engineering standard is famous for its strictness. The engineering of three kinds of drainage systems including surface water system, closed drain system and sanitary water system in the booster gas compressor station of Saudi Aramco project are introduced in this paper. The characteristics of all the facilities related to the drainage systems have also been described which can help to familiarize the engineering of Saudi Aramco booster gas compressor station.

1 Introduction

Saudi Aramco operates the world's largest single hydrocarbon network, the Master Gas System (MGS) in Saudi Arabia. The MGS is a gas gathering and processing system built in the mid-1970s, and has been the backbone of the country's industrial network since the system's completion in 1982. The MGS enables Saudi Aramco to use or market nearly all the gas associated with oil production and all non-associated gas produced from deep gas reservoirs. The purpose of constructing the MGS Expansion Project is to meet increased demand in the Central and Western Regions by providing 12.538 BSCFD (inclusive of peak summer demands) of gas by 2020 through the installation of new pipelines and booster gas compressor stations. The compressor station is designed to produce compressed hydrocarbon gas to meet the requirements of pipeline transfer from upstream sources to downstream destinations.

Saudi Aramco is famous for its strict engineering standard which is originated from American Standard but above it. Numbers of EPC contractors have been failed to make profits during the execution of Saudi Aramco project with its own standard [1, 2]. There will be lots of toxic and harmful disposals drained from the facilities of booster gas compressor station during operation [3, 4]. And it is most priority to secure the safety of people in Saudi Aramco engineering standard. Then it is very important to familiarize the principle of Saudi Aramco engineering standard for drainage system in the station which can help to save amount of cost. This paper details the drain philosophy and guidelines which is applied for the selection of a proper drainage system to ensure that all liquids can be drained safely with minimum risk of fire or injury in the booster gas compressor station.

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2 Engineering and discussions

Drains generated from the different equipment, lines & systems during normal operations, maintenance, turnaround or inspections shall be collected, segregated, transferred and properly treated [5]. There are three kinds of drainage systems involved in the booster gas compressor station which are surface water system, closed drain system and sanitary water system.

2.1 Surface water system

Surface water runoff from potentially contaminated areas will drain by oily water drainage system (OWDS). All plot areas in stations shall be equipped with an oily water drainage system for the safe removal of oily water effluent and rain water from process areas. It operates either by gravity or pumping force. The OWDS consists of catch basins, manholes, and a network of drainage piping consisting of sub-laterals, laterals, submains and mains. Figure 1 shows the process flow of collected oily water from operating equipment located in the process areas finally to the evaporation ponds after some physical treatment.

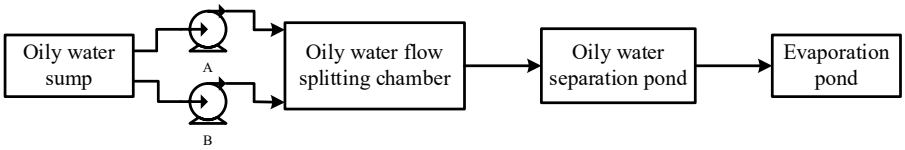

Fig. 1. Process flow of oily water drainage system.

The oily water will drain by gravity through an underground pipe network which is made of glass fiber reinforced epoxy into an oily water sump. The oily water sump is made of concrete and the size is 98.42 *FT*×78.7 *FT*×19.7 *FT*. Inlet chamber of the sump is covered with a chequered plate which is capable of allowing flexible trunking for pump suction in case of sump overpumping. The oily water sump is provided with separate pump sets to cover the normal flow and storm flow respectively. A is the lift pump and B is the deluge pump. The lift pump and deluge pump are both installed with one duty and one stand-by. And one spare lift pump is stored in the warehouse stand-by. The technical characteristics of pumps are shown in Table 1. Dual level indicators are provided for measuring the level in the sump and it will be the input of level controller to take actions. There are five set points in the level controller based on different heights of oily water in the sump which are LL, L, H1, H2 and HH from low to high. The controller continuously monitors the running pumps. If a running pump fails, the controller will start the next available stand-by pump of the same type, and send an alarm to alert the operator. As the level rises, the following actions are taken by the controller as each level set is passed:

H1: Start the duty oily water lift pump,

H2: Start the duty deluge pump. Stop the oily water lift pump,

HH: Alarm to operator.

As the level falls, the following actions are taken by the controller as it reads below each level set:

H1: Stop the deluge pump, and start the duty oily water lift pump,

L: Stop all the running pumps,

LL: The ESD system will trip all running pumps.

Raw water is supplied to the oily water lift pumps for pump priming. The start & stop level setting for normal flow pump (i.e. lift pump) shall allow for 5 min minimum runtime. Low current trip of pump motors is provided to prevent dry running conditions of pumps.

All the entrained sand will settle out in the oily water sump and water will be pumped to the oily water flow splitting chamber. The size of splitting chamber is 16 *FT*×8.2 *FT*×5.75 *FT*. Then the water will drain from the splitting chamber to two oily water separation ponds. Each of the separation ponds is equipped with two oil retention booms to collect any entrained oil that is floating on the water surface. Oil Retention booms are designed to retain floating oil for periodic removal using a portable active oil skimmer. Oil boom is flexible, fire-resistant, floating curtain type for use in protected water. Booms have sufficient freeboard to prevent oil from washing over the boom due to small waves on the pond. Flotation chambers are air-filled. Ballasted (weighted) skirts of minimum height 300 mm are provided to ensure oil retention at all pond levels, including low water levels. Booms have anchor points at both ends to permit the attachment of mooring lines. The floating oil is collected by portable skimmers and vacuum truck from third party company. Oil free water will flow over a weir to the connected evaporation pond. Each separation pond is connected with one evaporation pond. Two oily water separation ponds and two evaporation ponds lined with high density polyethylene synthetic liner are provided. The sizes of separation pond and evaporation pond are 82 *FT*×82 *FT*×13.78 *FT* and 82 *FT*×246 *FT*×13.78 *FT* respectively.

Surface water runoff from other areas where oil or other types of contamination will not occur will drain by gravity through open ditches to the percolation ponds. There are two percolation ponds and the sizes are 164 *FT*×98.4 *FT*×23 *FT* and 142.7 *FT*×131.2 *FT*×12.1 *FT* respectively.

Table 1. Technical characteristics of pumps used in drainage system.

Description	Type	Amount	Rated Capacity (GPM US)	Pressure	
				Suction (*psig*)	Discharge (*psig*)
Oily water lift pump	Centrifugal Vertical Lineshaft	1 working 1 standby and 1 warehouse standby	143.5	0.13	14.79
Deluge pump	Centrifugal Vertical Lineshaft	1 working and 1 standby	1368	0.13	36.39
Sanitary waste water lift pump	Submerged centrifugal with free flow impeller	1 working 1 standby and 1 warehouse standby	116.7	-0.29	28.5
Treated water transfer pump	Self Priming Centrifugal	1 working and 1 standby	88	-2.6	88.4

2.2 Closed drain system

A closed drain system is a piping collection above ground system connecting selected hydrocarbon drains and is provided with recovery or safe disposal of collected hazardous liquids. Any facility, process vessels or equipment handling flammable and combustible liquid hydrocarbons, toxic or high health hazard materials shall have a closed drain system (CDS) according to Saudi Aramco engineering standard. The closed drain system takes the high pressure liquid discharge from the suction and fuel gas knock-out drums on site through the piping made of carbon steel. Liquid from the knock-out drums is collected in the closed drain collection drum. There are two same horizonal placed closed drain collection drums used in the station. The technical characteristics is shown in Table 2. As the amount of liquid knock out is expected to be low, the liquid will be offloaded into trucks to be transported off site for disposal.

Table 2. Technical characteristics of closed drain collection drum.

Material of construction	Orientation	Internal Diameter (*FT*)	Weight (*t*)	Operating Pressure (*psig*)
Carbon steel and internal coated	Horizonal	14	44.05	1-50

2.3 Sanitary waste system

The process flow of sanitary waste system is shown in Figure 2. C is the sanitary waste lift pump and D is the treated water transfer pump. The sanitary sewage system includes gravity piping, sanitary waste lift station and sanitary waste water lift pumps. The sanitary sewage flows by gravity from the sewers of control rooms in the central control building through the piping made of glass fiber reinforced epoxy into the sanitary waste lift station. The size of lift station is 13.12 *FT*×13.12 *FT*×16.4 *FT*. It is then pumped via the sanitary waste water lift pumps into the sanitary waste septic tank which the size is 6.56 *FT*×19.67 *FT*×10 *FT*. The duty sanitary waste water lift pump starts automatically on high level event measured by a level indicator. The standby pump starts on high-high level event or if the duty pump has failed. Both pumps stop at a low level event. A manual switch allows the operator to select which pump is the duty pump. The ESD will stop the pumps on low-low level measured by the other level indicator. Benching is necessary to avoid the accumulation of solids in the sump corners and go anaerobic inside the septic tank. There are two vents to be taken from the bottom of top slab where the connections are used for removal of septic tank sludge by road tanker offsite. Water can also be injected into the septic tank through the vents to flush fluidizing the bottom solids and the flow of flush water is parallel along the sump walls. The liquid sanitary waste is then routed to the facultative pond. The size of facultative pond is 98.42 *FT*×39.4 *FT*×11.5 *FT*. The waste water will stay inside the facultative pond for a period of time and the facultative bacteria will have favorable external conditions and sufficient time to decompose the organic matter. Finally the treated waste water from the facultative pond will be pumped directly to the evaporation ponds through treated water transfer pumps.

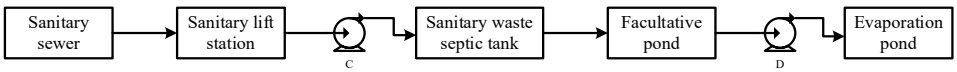

Fig. 2. Process flow of oily water drainage system.

3 Conclusions

Three kinds of drainage systems including surface water system, closed drain system and sanitary water system in the booster gas compressor station are introduced in this paper. Surface water from potentially contaminated areas of the station is collected in the oily water sump from where it is pumped to the evaporation ponds, and clean surface water from other areas will drain by gravity through open ditches to the percolation ponds. The closed drain system takes the high pressure hazardous liquids from the suction and fuel gas knock-out drums on site to the closed drain collection drums. The sanitary water waste system will pump the liquid stream into evaporation ponds after treatment whilst the sludge is trucked offsite. The characteristics of all the facilities related to the drainage systems have also been described which can help to familiarize the engineering of Saudi Aramco booster gas compressor station.

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