Fire And Explosion Risk Assessment of Crude Oil Storage Tank In Oil Refinery

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Abstract- *Fire and explosion in a crude oil storage tank is one of the devastating threats for oil storage area or terminal. This kind of hazard results in human fatality, environmental damage and causes a great economic loss for hydrocarbon industry. In this paper the scenario of fire and explosion in a tank has been simulated with the help of various methodologies like Fault tree analysis (FTA) and Structural importance degree (SID). With the help of these methodologies the most critical basic events (BEs) which may lead to accidents has been pointed out. The risk score of the specific crude oil tank has been calculated through MATLAB software. The results indicated that the final score of fire and explosion risk is in caution area. Sensitivity and importance analysis has been performed to identify the most crucial* BE_s *which will provide insights to reduce or the risk.*

Keywords- Fire and explosion, crude tank, Fault tree analysis, tank risk level, MATLAB

I. INTRODUCTION

In recent year's use of petrochemical products like petrol, diesels, kerosene, LPG are increasing with the rapid increase of population. To fulfil these requirements a number of refineries are working to refine the crude oil to produce various petrochemical products. As crude oil is used as the raw material in refinery processing unit. So large-scale crude oil storage tanks have been constructed in refinery storage site to store crude oil. As almost all the industries strictly following the safety guidelines and standards during the construction of storage tanks. But sometimes due to natural phenomena or because of human error accidents are happening in refinery storage site.So Fire and Explosion in crude oil storage tank is big issue in refinery storage site or in oil terminal. As a number of safety guidelines and procedure have been following but still there is some chances of fire occurrence. Therefore, risk assessment for oil storage tanks is very important due to different potential hazards and economic losses. Although several investigations have been performed in order to develop qualitative and quantitative methods for recognition and assessment of risks, few works have been done in a given country, equipment or its components in industries in order to determine failure rate and estimate likelihood of disaster occurrence.

The present study aimed at determination of final risk level of fire and explosion in crude oil storage tank and provision of control strategies. The study for the fault tree analysis has been done on crude oil storage tank no.2 of Indian Oil Corporation Limited, paradip storage site. All the 11 crude oil tanks of that refinery are of Floating roof tank type storage tank. In the study all the basic events (BEs) which may lead to accidents has been pointed out and structural importance degree has been evaluated.

II. METHODOLOGY

2.1 Fault tree analysis

Fault tree analysis is a top to bottom deductive failure analysis, which starts with a potential undesired event (accident) called as TOP event, and then analysing all the ways it can take place. Fault tree analysis (FTA) of crude oil tank has been done to get all the basic events associated with it. Minimal path sets method has been followed up to get all the possible way of hazard occurrenceAfter the analysis 37 BE_s has been pointed out which may lead to the fire and explosion of crude oil tank. The fault tree has been simplified by using Boolean algebra to produce the Minimal path sets (MPS), which represent the system safety. A MPS is the smallest combination of basic events whose non-occurrence, it is sure that top event does not happen.

2.2 MATLAB

MATLAB (matrix laboratory) is a multi-paradigm numerical computing environment and proprietary programming language created by Math Works. MATLAB permits matrix manipulations, implementation of algorithms, creation of user interfaces, plotting of functions and interfacing with programs written in other languages. MATLAB has been used here to evaluate the final risk score of crude oil tank no.2 by using operational parameter of tank and risk level indices.

III. RESULT

Analysis of fault tree has been done from which 13 Minimal Path Sets were produced, that means there are 13 possible paths to eliminate the oil tank accidents occurrence. The quantitative evaluation of FT represents the calculation of the structure importance degree (SID) of the BEs. The SID evaluates the BE influence on the total logical structure of the top event and exclusively depends on its location in FT. The larger SID of BE, the higher effect upon the unwanted event structure.

After the evaluation of SID for each BEs, the results were compared and arranged from highest value to lowest one. The order of BEs based on their importance degree are illustrated below:

$I_{Ø(34)} = I_{Ø(35)} > I_{Ø(36)} = I_{Ø(37)} > I_{Ø(31)} = I_{Ø(32)} = I_{Ø(33)} > I_{Ø(30)} > I_{Ø(28)} = I_{Ø(29)} > I_{Ø(1)} = I_{Ø(2)} = I_{Ø(3)} = I_{Ø(13)} = I_{Ø(14)} = I_{Ø(15)} = I_{Ø(16)} = I_{Ø(22)} = I_{Ø(23)} = I_{Ø(24)} = I_{Ø(25)} = I_{Ø(26)} = I_{Ø(27)} > I_{Ø(4)} = I_{Ø(5)} = I_{Ø(6)} = I_{Ø(17)} = I_{Ø(18)} > I_{Ø(11)} = I_{Ø(12)} > I_{Ø(7)} = I_{Ø(8)} = I_{Ø(9)} = I_{Ø(10)} = I_{Ø(19)} = I_{Ø(20)} = I_{Ø(21)}$

The results indicates that the most crucial BEs for causing the fire and explosion accident are X_{34} (formation of flammable cloud) and X_{35} (Turbulent mixing between vapour and air). The second critical one is poor ventilation initiators and followed by oil leakage contributors.

For the evaluation of final risk score of crude oil tank no.2, the operational parameter and the scores for risk assessment indices for fire and explosion in crude oil storage tanks has been taken into consideration.

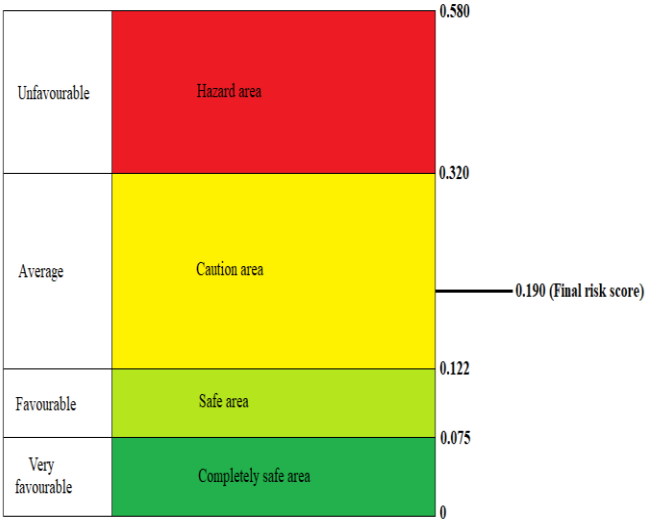
Operational parameters of crude oil storage tank:

Parameter	Amount
Design temperature	160^0C
Design pressure	1034.21 Millibar
Operational temperature	40^0C (maximum in summer)
Operational pressure	Atmospheric
Internal diameter	79m
Tank height	13.6m

The score limits for risk assessment indices for fire and explosion in crude oil storage tank no.2 is as follows:

For very safe status	0.075
For safe status	0.122
For average status	0.320
For unsafe status	0.580

By using the MATLAB software the final risk score of crude oil tank is 0.190.



IV. CONCLUSION

In this study fire and explosion risk assessment of crude oil tank no.2 has been proposed. And the final risk score of crude oil tank fire and explosion is not in safe area, it is in caution area. So there is some probability of hazard occurrence. The first two most critical basic events are belongs to the pressure relief valve, so correction measures should be taken for this valve in the storage tank. Other critical events are belongs to oil spill and oil leakage contributors, so regular inspection of the storage tank and oil level indicator or alarm should be done, by which the accidents probabilities will reduce.

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