ANALYZING THE CONSEQUENCES OF MIXTURE RELEASE IN THE SOUTH PARS GAS FIELD DEVELOPMENT IN IRAN- A CASE STUDY

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Abstract - In today's competitive environment, the management of hazardous facilities to ensure safe and cost effective operation is high on the corporate plan. The market demands consistent performance in presenting safe and efficient operation during complying with regulation and legislation. To analyze the dispersion of release toxic and flammable material, there are some models like PHAST, ALOHA, SLAB and DEGADIS, but according to the observations and In this article, consequences and conditions of leak of one mixture tank in Propane Treatment And Draying Unit(contain: Ethane, Propane, Isobutene, n-butane, Hydrogen sulfide) which is in service at South Pars Gas Field Development(Phase 13) is investigated using PHAST software. This paper describes the analysis and results of a PHAST study conducted on mixture tank in South Pars Gas Field (Phase 13).

Keywords- Consequence analysis, PHAST Software, Propane treatment, Leakage.

I. INTRODUCTION

All processes have a risk potential. In order to manage risks effectively, All processes must be estimated clearly. Since risk is a combination of frequency and consequence, consequence (or impact) analysis is a necessary step in the risk management process. A good manner to predict the consequences of various accidents is using comprehensive software. PHAST software is the most suitable software in the field of dispersion of toxic and flammable materials and analyzing the consequences of these accidents such as probability of death or the different kinds of fires.

This paper describes the analysis and results of a PHAST study conducted on a mix reservoirin the South Pars Gas Field Development –Phase 13petrochemical Cooperation. At first weather condition of desire location was simulated by entering weather information on the software. After that a scenario was modeled for leakage of tank with 20 mm hole diameter. Then events and consequences of this scenario are recognized with using PHAST software and then environmental effects of release of mixture gas is determined for paleography of the plant, environment and human.

II. PLANT DESCRIPTION

The South Pars / North Dome field is a natural gas condensates field located in the Persian Gulf. It is the world's largest gas field, shared between Iran and Qatar According to the International energy agency (IEA), the field holds an estimated 1,800 trillion cubic feet (51 trillion cubic meters) of in-situ natural gas and some 50 billion barrels (7.9 billion cubic Meters) of natural gas condensates.

A. Process description(PROPANE TREATMENT AND DRYING UNIT (114)))

In Unit 114 – Propane Treatment, mercaptans and water coming with the propane stream are removed. Mercaptans are removed in a first stage by an extractor column where sour propane is washed with a caustic solution as part of the Sulfrex treatment.

Finally, sweet propane is dried in molecular sieves. Water retained in the molecular sieves is further removed by means of heat supplied by one stream heated in a furnace. One unit for each phase has been foreseen sharing the layout with the Units 113/115 ("fig".1).

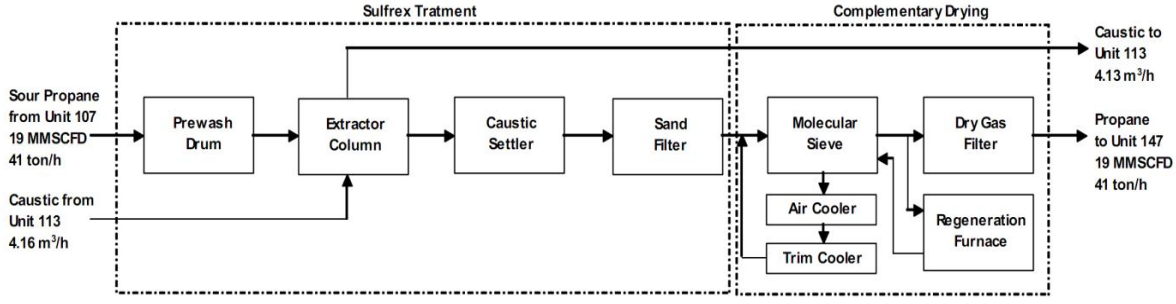


Fig1.PROPANE TREATMENT AND DRYING UNIT (114)

III. WEATHER CONDITION

The meteorological conditions envisaged for the simulations are the following:
• Ambient temperature: 10°C (the average of the minimum temperature of the 5 colder months).
• Relative humidity: 64 % (the average of the relative humidity for the 5 same months)
• Surface roughness: 0.1
• Solar radiation: 0.98 kW/m² (310 BTU/hr/ft²)
For jet fire and dispersion, the simulations are made with 2 wind speeds: 2 m/s and 5 m/s.
Considering a neutral atmosphere (Pasquill D) [4].

IV. CRITERIA

For modeling, the criteria considered are the following:

A. Fire zones

According to SP-SEC-253, "the partition into fire zones is such that the consequences of a fire, a flammable gas leak, or an explosion corresponding to the credible event likely to occur in the concerned fire zone shall not impact other fire zones to an extend where their integrity could be put at risk".

A credible event is incident not unlikely to occur within the concerned area. The incident shall not bear effect on public, but only on the facility located inside the restricted area.

The fire zone shall not overlap inside the unit. The overlap is admitted if inside the overlapped area no equipment are installed but only piping and pipe rack that shall be fire proofed.

The main principle adopted for the partition of the plant into fire zones is that it is not generally acceptable that a single credible event could result in the total loss of function of the plant.

The set of credible events taken as scenario are:
1-Gas dispersion (unionized gas/spray cloud):
-leak hole diameter
-flows remains constant for 10 minutes
-leakage flow rate limited to the maximum nominal flow rate (discharge of pump or compressor)
2-Jet fire:
Leak hole diameter: 20 mm
Sizing criteria: 9.5 kW/m² (3 000 BTU/hr/ft²) and 15kW/m² for ESDV or piping (5000BTU/hr/ft²).

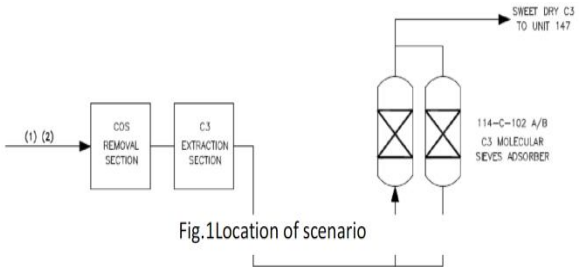


Fig.1Location of scenario

V. IMPACT AREA

The impacted area is the area that extends beyond the boundaries of the installation but which is nevertheless affected:
1- Either permanently by normal operation of the facility (radiation)
2-or exceptionally by the consequences of an emergency situation caused by a major
Failure of the facility:
The restricted area shall be always contained inside the impacted area. The set of major
failures taken as scenarios are Gas dispersion (toxic cloud)

-same as defined for restricted area
-sizing criteria: IDLH for H2S toxic dispersion:
-500 ppm for 60 s
- 400 ppm for 300 s
- 360 ppm for 600 s
- 300 ppm for 1800s

A. Scenarios considered

3 scenarios are considered:
1) LFL gas dispersion of the propane treatment and drying unit (114)
2)Horizontal jet fire of the propane treatment and drying unit (114)
3) Explosion
For the fluid composition, the stream conditions are the "summer case":
Operating pressure: 37.9 bar
Operating temperature: 62 °C
Table 1 show the Composition of mixture.

Table.1composition

COMPONENTS	% MOLE
C2H6 (Ethane)	0.06
C3H8 (Propane)	98.86
iC4H10 (Isobutene)	0.77
nC4H10(n-butane)	0.16
H2S (Hydrogen sulfide)	0.15

NOTE: Mercaptans have been added to H2S; other hydrocarbons have not been taken into account (traces)[5].

VI. GRAPHICALL RESULTS

After entering data in program, the software shows the calculations into some curves. Analyzing these

curves specify the consequences of the accident. Result of program show that the LFL is 20020 ppm. "Fig.3" shows the Scenario 1(LFL gas dispersion of the propane treatment and drying unit) in category 5/D.

This figure shows that the distance of LFL gas dispersion is 87m and its height is 3.9m when the wind speed is 5m/s. "Fig.4" shows Scenario 1(LFL gas dispersion of the propane treatment and drying unit)in category 2/D. This figure shows that the distance of LFL gas dispersion is 116mand its height is 4.1 m when the wind speed is 2m/s. By comparison between "fig.3" and "fig.4", we understand that the distance of LFL gas dispersion in category 2/D is larger than category 5/D, because the wind speed is low then accumulation is high. "Fig.5"shows Scenario2(horizontal jet fire of the propane treatment and drying unit) in Category 5/D with radiation of 15.8kw/m^2. This figure shows that the radius of radiation 15.8kw/m^2 is 43m when the wind speed is 5m/s. "Figure.6" shows Scenario2(horizontal jet fire of the propane treatment and drying unit) in Category 2/D with radiation of 15.8kw/m^2. This figure shows that the radius of radiation 15.8kw/m^2 is 49m when the wind speed is 2m/s. Compared between "fig.5" and "fig.6", indicated that radius of radiation 15.8kw/m^2 in category 2/D is larger than category 5/D, because the wind speed is low. "Fig.7" shows Scenario2 (horizontal jet fire of the propane treatment and drying unit) in Category 5/D with radiation of 9.5kw/m^2. This figure shows that the radius of radiation 9.5kw/m^2 is 46m when the wind speed is 5m/s. "Fig.8" shows Scenario2 (horizontal jet fire of the propane treatment and drying unit) in Category 2/D. This figure shows that the radius of radiation 9.5kw/m^2 is 55m when the wind speed is 2m/s. Compared between "fig.5" and "fig.6", indicated that radius of radiation 15.8kw/m^2 in category 2/D is arger than category 5/D, because the wind speed is low. In explosion category 2/D is worst case. So we Analyze this scenario in category 2/D.

"Figure.9" shows Scenario 3(explosion) in category 2/D.This figure shows that the radius of several pressure(50mbar,100mbar,170mbar and 300 mbar). The blue line for 50mbar, yellow line for 100mbar, green line for 170mbar, red line for 300mbar.

VII. RESULT

Release rate: 11.57 kg/s

"Table.2" shows results for LFL gas dispersion and jet fire in categories 5/D and 2/D.

Table.2Result for LFL Dispersion and jet fire

Wind Speed m/s	2	5
LFL (m)	116m	87m
9.5 kW/m^2	55m	46m
15.8 kW/m^2	49m	43m

Table above shows that by decreasing wind speed, LFL dispersion and radius of radiation in jet fire (in both case9.5 kW/$m^2$and 15.8 kW/m^2)will increases.

Explosion:

For the mixture tank:

Length=137m, height=4m and width=30m.

So volume is16440 m^3.

But for explosion we consider half volume full of gas so the new volume is 8220 m^3.

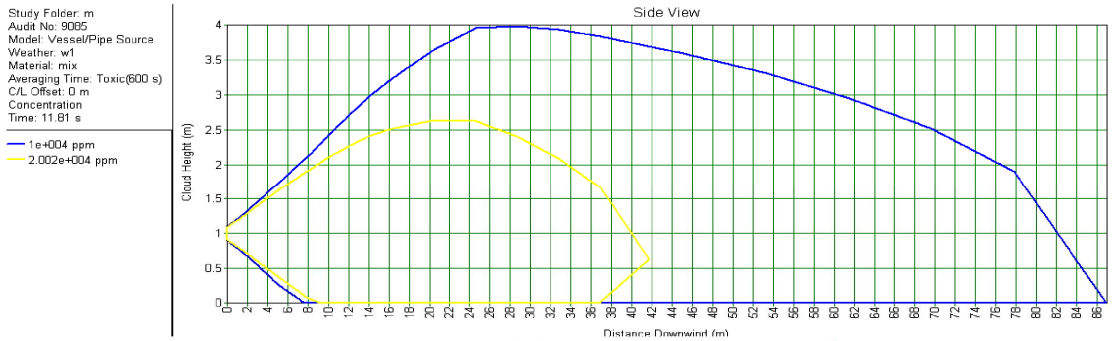


Fig.3 LFL gas dispersion, category 5/D



Fig.4 LFL gas dispersion, category 2/D

"Table.3" shows result for explosion in category 2/D.

Table3 Result for Explosion

Over pressure	Distance
50 mbar	270 m
100 mbar	167 m
170 mbar	118 m
300 mbar	80 m

In safety issues radiations of 20 kW/m^2 and 37.5 kW/$m^2$is very important because the radiation of 20 kW/m^2Causedamagetohuman, and 37.5kW/m^2

Cause damage to Equipment and cause Annie's death, from the program (in category 2/D)the radius of 20 kW/m2 is 51m and the radius of 37.5kW/m2 is 46m.also in safety issue for explosion two pressure is important. These pressure are 0.02bar and 0.2 bar. Because 0.02bar damage limited minor structural damage and damage to human and 0.2 bar cause total destruction. So we must calculated the radius for these over pressure. From the program for over pressure 0.02bar radius is 518m and for 0.2bar radius is 362m.these result are from category 2/D, because this category is worst case.

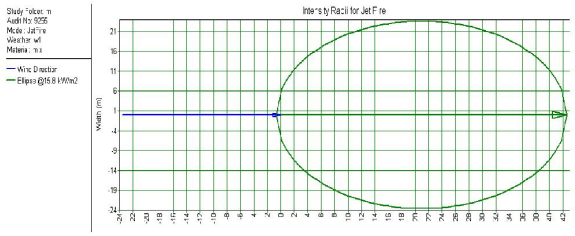


Fig.5 radius of radiation 15.8kw/m2, category 5/D

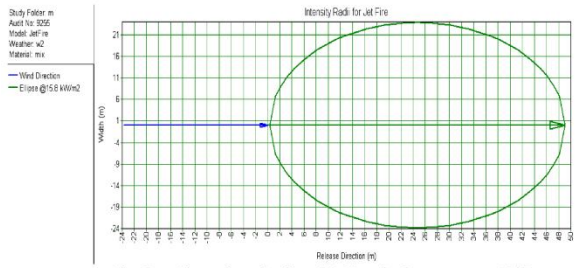


Fig.6 radius of radiation 15.8kw/m2, category 2/D

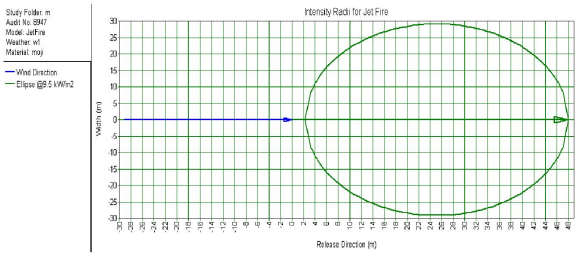


Fig.7 radius of radiation 9.5kw/m2, category 5/D



Fig.8 radius of radiation 9.5kw/m2, category2/D

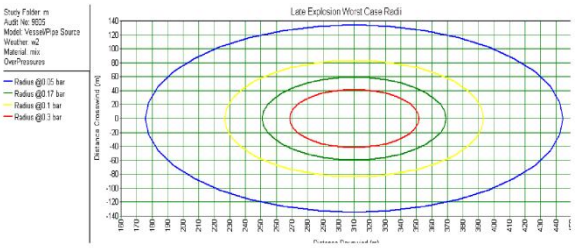


Fig.9 explosion in category 2/D

CONCLUSIONS

PHAST program is necessary for any industrial plants specially oil and gas industries,either before establishing or when it is in service, to assessment the dangers that threat the close residential areas or the surrounding environment. This program will forecast the consequences of accidents like that occurred in Bhopal of India. The software used in this study is useful for fire engineers, HSE engineers, designers and plant engineers in timely to estimate the effects of ruptures and leaks in the pressure vessels and piping used in different industry sectors. The results of PHAST in this case study shows that by decreasing wind speed, LFL dispersion and radius of radiation in jet fire (in both case9.5 kW/$m^2$and 15.8 kW/m^2) will increases. Also by decreasing wind speed, the over pressure will increases. The time of release in category 2/D (times=29.8 s) is more than category 5/D (times=11.81 s), because the wind speed is decreases. At safety point of view, the radius of 20 kW/m^2 is 51m and the radius of 37.5kW/m^2 is 46m.for over pressure 0.02bar radius is 518m and for 0.2bar radius is 362m.

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