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Hazard Identification and Consequence Analysis in Solvent Processing Plant

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ABSTRACT : This paper analysis, is to identify the hazard in solvent processing soya industries and focus on hydrogen section of the industry .This analysis gives various reasons of hazard during operations, with the help of hazard identification techniques in hydrogen section of soya industries and consequence analysis and also gives the proper recommendation to minimize the hazards in process of hydrogen section by Checklist method.

Keywords: Checklist; consequence analysis

I. INTRODUCTION

Every year lots of minor, major or fatal accidents are occurred due to material handling In soya industries and Crusher and key hazard are associated with hydrogen section and storage of it. Hazard associated with these sections in more as compared to the other section of soya industry. Every injury has a major effect on economy due to loss of productive hour, manpower losses, compensation to the victim's .Therefore for reduction of all injuries/fatalities, corrective and preventive action should be taken .In order of this, Hazard identification can play an important role .There are many methods for hazard identification techniques which are very effective for identifying and reducing the hazard associated with soya industries. We have paid our attention towards the hazard identification techniques for identifying the actual causes of hazard which may leads to minor, major or fatal accident hence to minimize it. Therefore we have chosen the topic "hazard identification and risk assessment in solvent processing plant".

II. METHODOLOGY

For Hazard identification in Solvent processing plan mainly in hydrogen section checklist method is being used for hazard identification and consequence analysis in carried out to check the possibility of accident in the hydrogen storage section .Mainly hydrogen is stored in pressure vessel controlled by pressure gauge.

Consequence analysis is carried out to check the possibility of damage in hydrogen section it helps to determine the explosion parameter which would damage the given effective area in case of mishap.

Checklist for hydrogen section

1. Check for the pressure on pressure gauge(Y/N)

2. Check for metal fatigue cracks on piping of hydrogen on loading and unloading point(Y/N)

3. Checks for leakage across piping joints.(Y/N)

4. Check the hydrant line across hydrogen section for leakages(Y/N)

A. The equivalent TNT mass (Kg)

$$M_{TNT} = \frac{f_E \, \Delta H_c M_G}{\Delta H_{TNT}}$$

where M_G (kg) - mass of the hydrogen gas that takes part in the explosion (10.8Kg), ΔH_C - heat of combustion of the hydrogen gas (120000kJ/kg), ΔH_{TNT} - heat of combustion of TNT (4,760 kJ/kg), and coefficient, f_E arbitrarily taken as 0

B. Energy of explosion

The energy, E (MJ) released by the explosion

$$E = V[\Delta H_c * \rho * \frac{1}{3})]$$

Where, ΔH_C- the heat of combustion of hydrogen (120MJ/kg), V -the volume of the cloud(360m^3), - the density of hydrogen (0.0899kg/m^3) stoichiometry of the reaction (ratio of hydrogen : air = 1:3). The energy, E released by the explosion is found to be 1300 MJ

C. The scaled distance

The Sachs-scaled distance, r'

$$(r' = x\left(\frac{E}{P_a}\right)^{-1/3}$$

Where, x-distance from the centre of explosion (25m),

E -Energy released during the explosion (1300MJ), and

P_a -ambient pressure (0.1 MPa). The Sachs-scaled distance, r' is found to be 1.06.

D. Explosion overpressure

The blast over pressure, P_s (MPa)

$$P'_s \quad P_a \quad P_r \quad t_1$$
$$P_s \quad P'_s \quad P_a = P_r * \quad t_1$$

Where, P'_s - the Sachs-scaled over pressure (dimensionless) from the curve consist of scaled over pressure as a function of scaled distance is found to be

0.4 and P_a- ambient pressure (0.1 MPa). The blast over pressure at a distance of 25 m from the centre of explosion is found to be 0.4 bars.

E. Time duration of positive phase

The time duration of the positive phase, t_p (s)

$$t_p = \frac{t'_P}{C_S}\left(\frac{E}{P_a}\right)^{1/3}$$

Where, t'_p-Sachs-scaled positive phase duration (dimensionless) from the curve consists of positive Phase duration as function of scaled distance is found to be 0.4 [18], C_S - the velocity of sound (340 m/s), E - Energy released (1300MJ), -ambient pressure (0.1 MPa).The time duration of the positive phase, is found to be 0.0172 s.

III. DAMAGE ESTIMATE FOR COMMON STRUCTURES BASED ON OVERPRESSURE

The overpressure values obtained by the Multi-Energy Method are higher than those obtained by the Equivalent TNT method and Baker-Strehlow method. Also values produced by the Multi-Energy Method are nearer to the actual values observed based upon the damages that occurred from the explosions. So Multi-Energy Method is considered for vulnerability calculations.

Exposure level bar	Damage
.0103	Pressure for glass rapture
.0276	Structural damage building steel frame damage
0.09	Building damage
.276	Total destruction of building
0.689	

TNT Method			TNO Method			Baker-strehlow Method
x	Z	P_s	r'	P_s	t_p	P_s
(m)	(m/Kg$^{1/3}$)	(bar)	bar	(bar)	(ms)	(bar)
5	1.66	3.16	0.212	-	-	-
10	3.33	0.64	0.420	3.20	12.4	2.5
15	5.00	0.26	0.638	1.20	13.3	0.7
20	6.66	0.17	0.850	0.70	15.2	0.4
25	8.33	0.13	1.060	0.40	17.2	0.3
50	16.6	0.05	2.120	0.18	24.2	0.17
75	25.0	0.03	3.190	0.09	27.6	0.10
100	33.33	0.02	4.250	0.05	31.6	0.09

IV. CONCLUSIONS

Since from the data calculation it can be seen that the explosion of hydrogen vessel will cause a diverting damage in first 50m explosion may rapture the hydrant lines around the tanks may cause fatality in this range also .If the projectile explosion occurs it may get to first 300m and may leads to projection of hydrogen tanks also.

The recommendations of preventive measures are

1. Purging of hydrogen line should be performed with an inert gas such as nitrogen to avoid the formation of flammable mixtures.
2. Suitable flash back arrester/flame arrester should be provided in hydrogen line to shuts off gas flow in the event of flash back.
3. Gas and flame detectors should be installed in the vicinity of hydrogen holder. Because of hydrogen flame is invisible special detectors are required.
4. Adequate ventilation should be provided in all hydrogen systems to eliminate/minimize the potential hazards and formation of combustible mixtures.
5. Venting of hydrogen should be done according to standard and regulations.
6. Use an air monitor equipped to detect hydrogen on regular basis.
7. Barriers or safeguards should be provided to minimize risks and control failure.
8. Hazard placards are posted on hydrogen storage facilities.

NOMENCLATURE

E :Total energy released by the explosion, MJ

f: Fraction of energy

M_G : Mass of the flammable gas, kg

P_a : Ambient pressure, MPa

P_S : Blast verpressure, MPa

P'_s : Sachs-Scaled overpressure,

Pr: Probit value

r' : Sachs-Scaled distance

R : Radius of cloud, m

t_p : Positive phase duration of explosion in seconds

t'_p : Sachs-scaled positive phase duration

V : Volume of vapour cloud, m^3

X : Distance from the centre of the explosion, m

Z : Scaled distance, $m/kg^{1/3}$

ΔH_C : Heat of combustion of the flammable gas,

LFL : Lower flammability limits M_{TNT}: Equivalent TNT mass, Kg

TNT : Tri nitrotoluene

TNO: The Netherlands Organization

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