Impact Factor (SJIF): 3.632

International Journal of Advance Research in Engineering, Science & Technology

e-ISSN: 2393-9877, p-ISSN: 2394-2444

Volume 3, Issue 4, April-2016

Improvement of Rim Seal Fire Protection System

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***Abstract*:- Rim seal fires are those that occur in the edge of the rim seal region of the floating roof tank. These are the most common cause of the fire in the floating roof tanks. Ream seal fire is caused by following reasons: 1) Lightning Strikes.2) Sparks produced by static electricity. The automatic rim seal fire detection and extinguishing system immediately detects and suppresses a rim seal fire till such time the foam pourer system is activated. The company is facing the problem in deciding the number of nozzles, distance between the nozzles and finding the orifice diameter of nozzles resulting into uncertainty in discharge time. The number of nozzles is based on the diameter of the tank. The main objective of this project is to identify the problems of the Fire Protection System Used in the Rim Seal and work on diameter of nozzle orifice, deciding the distance between the nozzles and capacity of pressure vessels (Module). The aim of this project is to flood the rim seal area which is of 300mm with AFFF foam so that the fire doesn't comes in contact with air resulting in extinguishing of fire.**

Keywords-Rim seal, Nozzles, Floating roof tank.

I. INTRODUCTION

Vimal Fire Control PVT LTD is the Indian Fire & Safety Equipment and Systems manufacturing company which manufactures the fire protection system for fire safety equipments. One of the systems they are manufacturing is Rim Seal Fire Protection system. This Rim Seal Fire Protection System is used by oils and petroleum industries, etc. In this system, the company faces the problem of deciding the Orifice Diameter for discharging the tank module in selected amount of time. In this semester we are going to mainly work on deciding and calculating the various parameters which are directly related to orifice diameter such as Quantity of the foam required in the foam module tank, manifold segment diameter, circumference length of manifold length, number of modules, foam module capacity, number of nozzles per segment, number of nozzle per tank, distance between the nozzles.

1.1 RIM SEAL FIRES:

Ream seal fires are those that occur in the edge of the rim seal region of a floating roof tank. These are the most common causes of the fire in floating roof tanks. Once the rim seal has been penetrated or the seal is damaged, vapours will be released from the tank. Following ignition, the fire will soon spread to involve the entire rim seal region, causing a threat to the tank contents as well as surrounding tanks.

Fig.1 Rim seal fire protection system

The system is mainly categorized in the following sub systems.

1.1.1 The linear heat detection system : The highly sensitive metallic heat detection system detector panel/ box consist of a micro processor based electronic circuit. The panel also contains a highly sensitive pressure sensor and positive displacement micro pump (use for de-bugging of the detection tube). The detection tube of desired length, which is laid along the periphery of the rim seal, one end terminates in the detector panel and the other end is blind. While initially setting up/ commissioning the system, the blind is opened to allow air to enter in the tube to set the reference pressure and once again sealed. Air at an atmospheric pressure is there within the sensor tube.

1.1.2 Foam based extinguishing system : The extinguishing system is designed to be a primary device, which deploys UL Listed 3% low expansion foam onto the fire within the first few second of it detected. The aim being to contain and extinguishing a fire before it develops into a fully evolved fire. Based on the tank Diameter, the number of modules/segments various accordingly. Each foam discharging unit complete with their deployment facilities consist of auto actuation foam discharging valve, solenoid valve, manual installation ball valve, pressure switch, pressure gauge and safety valve, etc. Each unit (module) is coupled to form distribution manifold piping. Each module is provided with filling, flushing and draining facilities for operation, maintenance and sampling purpose.

1.2 Aim And Objective Of The Project: The aim of the project is to work on the improvement of the rim seal fire protection system. With the help of OISD (Oil Industry Safety Directorate) 116 and 117 we are going to derive the formulas to calculate: **Size of pressure module, Number of modules used per tank, Number of nozzles per segment, Number of nozzle per tank, Distance between nozzles.**

The objective of the project is to find the orifice diameter and to achieve the discharge time as per company's requirements which will be calculated if all the above parameters will be known. So in this semester we are going to formulate and calculate all the above parameter to finally calculate the diameter of the orifice.

II. METHODOLOGY

Flame height is an important parameter that evaluates the flame danger level. It influences the heat exchange of flame radiation to the external environment and combustion rate and the development process of combustion of the oil products can be predicted according to the flame height. Generally, the larger oil supply rate is, the higher the height of the flame is but dimensionless height H/D (the ratio of average flame height and tank diameter) of the flame becomes small with then increase of oil tank diameter. The experimental correlations of dimensionless flame height and tank diameter can be expressed as following H/ D = 2.89 x D **-0.258** Where H is flame height and D is pool fire diameter. In this paper, pool fire tank diameter D, that is to say the tank diameter, is 68 m. The height of pool fire flame is 66 m according to formula (1). A floating roof tank consists of a circular open top tank with a hollow pontoon roof that sits on the fuel surface and floats up and down as the level changes. To prevent evaporation around the edges of the roof, a seal, usually made of rubber, is used to fill the gap between the tank shell wall and the roof. The reseals come in many different types and designs, but all are subjected to the day-to-day forces of movements that result in wear and tear. It is in this seal area that fires most commonly start.

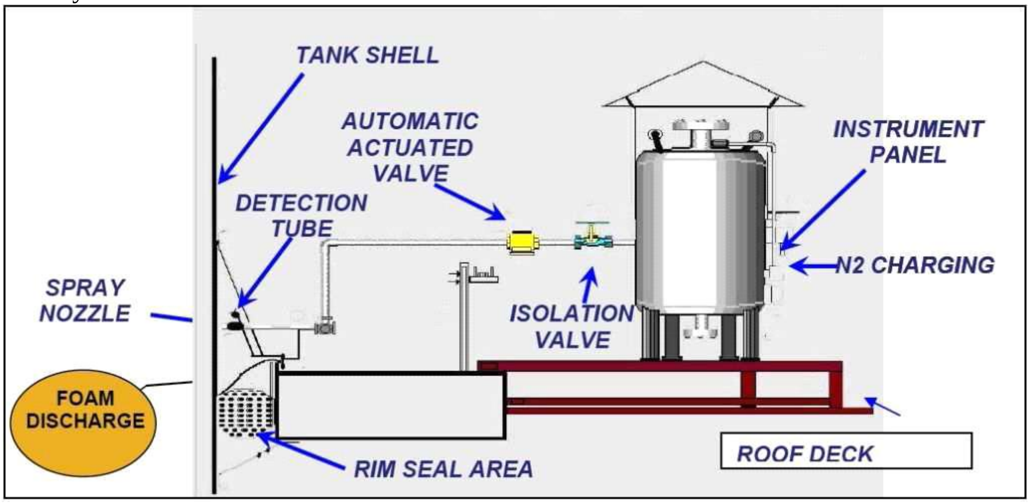

Fig.2 Working of fire extinguishing system

III. IMPLEMENTATION STRATEGY AND CALCULATIONS

Implementation : The main purpose of this project is to implement the calculation value and data which is used by the company by regenerating the new calculation data in our own way. The company is facing the problem in deciding the number of nozzles, distance between the nozzles, finding the orifice diameter of nozzles, resulting in to the uncertainty in the discharge time.

3.1. Proposed methodology-1 :

Design criteria:

- Length of seal area(l) : 0.3 m
- **π** : 3.142
- discharge time(t) : 40 sec (as per company requirements)
- rate of application of foam as per OISD(r) : 18 mm per minute
- standard distance between nozzles(L2) : 1500 MM
- Diameters: : 26m for small tank
  40m for medium tank
  79m for large tank

3.2. Proposed methodology-2 :

1) find major head losses:

$hl = F_d*(l/d)*(v^2/2g)$

Where, L= total length of pipe 37m

D= hydraulic diameter of the pipe 0.034m

v= average flow velocity 0.93m/s

g= local acceleration due to gravity 9.81m/s^2

F_d= dimensionless coefficient Darcy friction factor= 0.2

2) Minor head losses:

$hl = k(v^2/2g)$

Where, k=loss coefficient

IV. RESULTS

For tank diameter: 26m (small)

Area of rim seal (A)	24.5076 m^2
Quantity of foam required (q)	294.0912 L
Manifold segment diameter (D1)	25.4 m
Circumference length of manifold length(L1)	79.8068 m
Number of segment or number of module (n)	2 Nos.
Foam solution per module considering safety margin of 5% to 3%	154.39788 L
Foam module capacity	200 L
Number of nozzles per segment	26 Nos.
Number of nozzle per tank	54 Nos.
Distance between nozzle	1478 mm

For tank diameter: 40 m (medium)

Area of rim seal (A)	37.704 m^2
Quantity of foam required (q)	452.448 L
Manifold segment diameter (D1)	39.4 m
Circumference length of manifold length(L1)	123.7948 m
Number of segment or number of module (n)	3 Nos.
Foam solution per module considering safety margin of 5% to 3%	158.3568 L
Foam module capacity	200 L
Number of nozzles per segment	42 Nos.
Number of nozzle per tank	126 Nos.
Distance between nozzle	982 mm

For tank diameter: 79 m (large)

Area of rim seal (A)	74.4654 m^2
Quantity of foam required (q)	893.5848 L
Manifold segment diameter (D1)	78.4 m
Circumference length of manifold length(L1)	246.3328 m
Number of segment or number of module (n)	6 Nos.
Foam solution per module considering safety margin of 5% to 3%	156.37734 L
Foam module capacity	200 L
Number of nozzles per segment	28 Nos.
Number of nozzle per tank	168 Nos.
Distance between nozzle	1466 mm

V. CONCLUSION

- Although rim seal fire of large floating roof tank is of high risk and low probability, it will cause great loss for national properties and harmful effect on environment once it occurs. This system should comprise of highly sensitive fire extinguishing system couples with number of pre-mixed foam storage discharge modules of adequate capacity.

- Each module should be dedicated for protection of an equal portion of the Rim Seal Area. The operational philosophy should ideally work and Foam discharge instantly into the rim seal area. Also there must be equal number of nozzles used the system on each side of module tank and it should maintain the pressure drop in the manifold pipe as pressure drop increases discharge decreases.

- On the basis of final calculation & result we are getting optimal solution. We are define the discharge value in decided time period to select orifice diameter. As per customer required time period the decide orifice diameter on this method of calculation. And we are define one criteria of 40second time period.

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