Scientific Journal of Impact Factor (SJIF): 5.71

E-ISSN (O): 2348-4470
P-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 9,Issue 7,July 2022

FIRE WATER DEMAND CALCULATION FOR STORAGE TANK

Vignesh [1]

[1]*Technical Safety Engineer*

Abstract —*Abstract is intended for the Calculation of Fire Water & Foam Demand for Large Atmospheric Crude Storage Tanks. The fire water and foam solution systems to be designed to control burning and provide exposure protection to the fire zone with the largest demand. The demand will include the supply to tank cooling systems, foam pourers, foam and fire water monitors. The fire water demand is calculated according to guidance from RPI, NFPA, EN & EI.*

Keywords-*Fire Water, Foam, Storage Tanks, Cooling Etc.*

I. INTRODUCTION

Fire is one of the major threats to people, asset and environment. Fire constitutes a relatively significant threat to life and property in industrial plant. The main purpose of this document is to determine the maximum firewater demand and foam demand for various credible scenarios of fire on crude storage tank (External floating roof).
The objectives of demand document are to finalize the capacity of firewater pump & foam system.

The Fire mitigation measures are continuously improving to the threat of fire in industry in many ways, including education on fire hazards, plant safety layouts, process safety studies such as Fire & Explosion Risk Assessments and new & advanced type of fire fighting equipment.

II. BASIS FOR FIRE WATER DEMAND CALCULATION

The following assumptions are taken into consideration for the calculation of the maximum firewater demand (depending upon various fire scenarios):
The maximum firewater demand for the facility shall be based on the worst case fire scenario as defined below:

- *Rim seal fire/ Full surface fire*
- *Adjacent tank cooling etc. (tank of same dia & height assumed)*

Firewater demand for each fire zone has been calculated for single worst-case fire scenario as defined by simultaneous operation of largest fixed fire/foam water system together with the operation of adjacent fire systems for exposure protection. Foam solution demand is calculated based on 1% foam concentrate + 99 % water.

III. APPLICATION RATES

Below are the Application rates from various standards for the various fire scenarios;

Fire Scenario	Device	Rate	References
Rim Seal	**Foam Pourers**	12.2 lpm/m^2 of 1% foam solution	• NFPA 11, Table 5.3.5.3.1 for 12.2lpm/m^2, 20 min application and 24.4 m separation between each foam pourer.
Full Surface Fire	**Foam Pourers**	6 lpm/m^2 of 1% foam solution supplied for 90 minutes.	• EN-13565-2 (6 lpm/m^2) • NFPA 11, Table 5.3.5.3.1 for 24.4 m separation between each foam pourer.
	Foam Monitors	10.1 lpm/m^2 of 1% foam solution supplied for 90 minutes.	• EN-13565-2 (6 lpm/m^2) • RPI Position Paper (App 3-8 {90 mins})
	Foam Monitors	10 lpm/m^2 of 1% foam solution supplied for 45 minutes.	

Fire Scenario	Device	Rate	References
Tank Cooling	**Water Spray**	2 lpm/m^2 of fire water for 120 minutes over one quadrant of tank surface (side)	• EI-19, D5(ii) - [2 lpm/m^2] As per Section 7.1.8 of NFPA 15, maximum horizontal separation distance between each spray nozzle shall not exceed 3m.

IV. SURFACE AREAS

Surface areas for each type of fire protection is calculated as below;

Table 4.1 Surface Area Calculations

Fire Scenario	Type of Protection	Calculations	
Rim Seal Fire Scenario	Rim Seal Fire Foam Dam Area	Dia. of Tank – D1	100 m
		Tank Height (m)	23.9 m
		Foam Dam width	0.6 m
		Dia. of roof up to foam dam [D2 = D1 – 2 x 0.6 m foam dam area]	100 – (2 x 0.6) = 98.8 m
		Foam Dam Area [π/4 x ($D1^2$-$D2^2$)]	π / 4 x (100^2 - 98.8^2) = **187** m^2
Full Surface Fire Scenario	Tank Top Foam monitor Area	Dia from centre of Tank – D3	40 m (note-1)
		Area of roof for monitor coverage from centre on tank [π / 4 x $D3^2$]	π / 4 x 40^2 = **1256** m^2
	Full Surface Foam Application Area	Area for Full surface foam [π / 4 x $D1^2$ - π / 4 x $D3^2$]	(π /4 x 100^2) – 1256= **6594** m^2
Adjacent Tank Cooling	Water Spray	Elevation considered for cooling of tank shell up to top wind girder (E1)	22.8 m
		Surface area of tank shell for one quadrant (A1) = (π x D1 x E1) / 4	1791 m^2

Note-1: To cover full surface roof, 40 m dia to be considered for tank top monitor coverage which is beyond the quick-fill of full surface foam pourers (30m). The remaining tank roof surface area shall be covered by full surface foam pourers.

V. FIRE WATER & FOAM DEMAND

For each fire scenario, the foam solution and fire water demand is calculated and presented in below tables.

Rim seal Fire Scenario:

Device	Description	Unit	Rim Seal
Foam Pourers	Application Rate	lpm/m^2	12.2
	Area to cover	m^2	187
	Foam Solution rate	lpm	2282

Device	Description	Unit	Rim Seal
	Foam Solution rate	m^3/hr	**137**
	Water Flow rate	m^3/hr	**135.63**

Full Surface Fire Scenario:

Device	Description	Unit	Full Surface
Foam Pourers	Application Rate	lpm/m^2	6
	Area to cover	m^2	6594
	Foam Solution rate	lpm	39564
	Foam Solution rate	m^3/hr	**2374**
	Water Flow rate	m^3/hr	**2351**
Foam Monitor	Application Rate	lpm/m^2	10.1
	Area to cover	m^2	1257
	Foam Solution rate	lpm	12696
	Foam Solution rate	m^3/hr	**762**
	Water Flow Rate	m^3/hr	**754**
Total	Theoretical Foam Solution Flow	m^3/hr	**3136**
	Theoretical Water Flow demand	m^3/hr	**3105**

Adjacent Tank Cooling:

Device	Description	Unit	Tank Cooling
Water Spray	Application Rate (lpm/m^2)	lpm/m^2	2
	Surface area of tank shell for two quadrants (A2) = A1 x 2 quadrants	m^2	1791 x 2 = 3582 m^2
	Water flow through two quadrants = A1 x 2 lpm/m^2	lpm	1791 x 2 x 2 = 7164
	Total theoretical flow for two quadrants	m^3/hr	7164 x 0.06 = **430**

VI. CONCLUSION

In case of rim seal fire scenario, the theoretical fire water demand is 136 m^3/hr. & Foam Concentrate required for rim seal fire scenario is 0.45 m3 (for application of 20min @ 137 m3/hr).

In case of full surface fire scenario, the theoretical fire water demand is 3,105 m^3/hr. Foam Concentrate required for full surface fire scenario on any tank is 47 m3 ((for application of 90 min @ 3136 m3/hr).

The worst case fire water demand is considering the full surface fire + Water spray for adjacent tank cooling. i.e 3105 + 430 = 3535 m3/hr.

4 Nos. of Fire Water Pumps (4 X 1135 m3/hr.- 3 Main + 1 Reserve) and foam Capacity of Approx. 2 x 50m3 (1 Main + 1 Reserve) are required to cater this demand.

REFERENCES

[1] NFPA 20: Standard for the Installation of Stationary Pumps for Fire Protection
[2] NFPA 11: Standard for Low, Medium and High Expansion Foam
[3] IP-19: Fire Precautions at Petroleum Refineries and Bulk Storage Installations
[4] EN-13565-2: Fixed firefighting systems - Foam systems - Part 2: Design, construction and maintenance
[5] NFPA 15: Standard for Water Spray Fixed Systems for Fire Protection

