Review Fire Load Estimation and Evaluation for Thermal Power Plant

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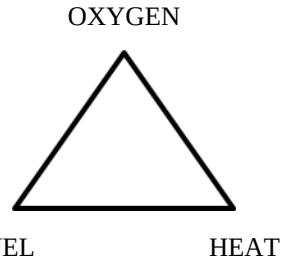
Abstract- Fire is the major hazard which may occur in the thermal power plant. There is an increase in accidents and the losses due to fires are Loss of human life Loss to the life of structure of material Loss to property The fire loads and fire densities were analyzed at thermal power plant of khaparkheda to find the requirements of firefighting equipment's in the industry. There are various methodologies to reduce the fire load in the industry which must be done to reduce the fire risk. The increasing use of engineering solutions needs to identify, characterize and quantify design fires for buildings. The characteristics of fire such as ignition, heat release, and flame temperature of design fires depend on the weight and arrangement of combustible materials. This paper includes the total fire load calculations in various thermal power plant and the locations so that fire loads can be calculated which creates hazards to the environment so that combustible materials can removed and engineered solutions can be given to reduce the fire risk.

Index Terms— Firefighting, Fire Safety, Fire load.

1. INTRODUCTION

One of the major consequence in the industrial area is fire and there are increasing cases of fire accidents which may be life threatening for the people. The fire can cause due to three main components such as Oxygen, Fuel and Heat and it is also known as Fire triangle. When oxygen supply is increased in the fire area the amount of fire burning rate increases so that heat can be generated in huge amount. To suppress the fire one of the components must be removed . The suitable fire expunger must be used to suppress the fire triangle so that fire can be easily put off.



To suppress the fire on of the components such has oxygen, Fuel and Heat must be removed so that burning rate of fire will be reduced Fire alarm system is one of the essential needs and must be installed in the building where there is combustible 2 materials present in it. In case of fire, it is very useful to journey and can be detected easily. Fire hydrants and fire eradicator must be installed where there is risk of fire. The suitable fire eradicators must be kept so that incase of fire it can be easily suppressed. Fire hydrants must be installed outside to suppress the building of fire. Fire hydrants are external fire eradicators and portable fire eradicators are internal fire eradicators.

Table 1. Classes of Fires

CLASSES OF FIRE	COMBUSTIBL E MATERIAL	EXAMPLES
Class A	solid	wood, plastic, rubber
Class B	Liquid	kerosene, petrol, liquid, gas
Class C	Gas and electrical appliances	Electrical appliances and combustible gases
Class D	Combustible metals	magnesium, potassium, titanium, and zirconium

A. Classes Of Fire

CLASS A

Class A fires consist of ordinary combustibles materials which are of solid type such as wood (all types of wood), paper, fabric, plastic and most kind of trash.

CLASS B

Class B fires consist of fire which are of liquid type namely of liquid gas, petrol and kerosene which can cause fire easily when exposed to fire.

CLASS C

Class C fires consist of gaseous state and also electrical fires. Electrical circuit and appliances can be used to suppress the fire using class C Fire extinguishers.

CLASS D

Class D fires are namely metals which are magnesium, potassium, titanium, and zirconium etc. These metals are combustible metals which comes under class D fires.

B. Types of Fire Extinguishers

1. WATER FIRE EXTINGUISHER

Water fire extinguishers are common fire extinguisher which are used to suppress the fire such as solid materials likely wood. The main use of Water fire extinguishers is the use of water as a suppression agent. This type of fire extinguisher is only used for class A type fire.

2. FOAM FIRE EXTINGUISHER

Foam fire extinguishers are water fire extinguishers. This type of fire extinguishers which can be used both for class A and B type i.e., it can suppress combustible material and also flammable liquids and gases.

3. DRY POWDER EXTINGUISHER

Dry Powder fire extinguishers are used for all types of fire extinguisher as they can be used for Class A, B and C type fires. Dry powder chemical extinguishers can be used to suppress the electrical hold appliances like electrical circuit.

4. CO2 EXTINGUISHER

CO2 fire extinguishers are mainly used for extinguishing class B and C fires. The extinguishing agent takes away heat element in the fire triangle by very cold discharge. Handling the CO2 extinguisher must be careful because the cold discharge may lead to cold burns in hands.

II. PROBLEM IDENTIFICATION

Fire hazard- Fire is one of the common hazards in the thermal power plant. It can lead to a major disaster for the plant. By doing fire safety audit we can identify the risks and control it by taking proper actions. A fire safety audit is an examination of the structures and relevant documents to ascertain how the are being managed regarding fire safety. Depending on the requirements of the occupancy, the audit can focus attention on various aspects of fire safety system such as fire and explosion prevention, protection and emergency management Fire hazard include all type of live flames causes of sparks, hot object, and chemicals that are potential for ignition, or aggravate a fire to become large and uncontrolled. Fire hazard includes all type of potential threats to fire prevention practices, firefighting, built in fire safety system and situation that restricts the escape of people from an affected building or area in the event of fire The Major Fire hazards in the industries are • LPG yard • Gas storage area • Petrol yard • Diesel yard • Paint Booth.

III. METHODOLOGY

Estimation of combustible material of a building can be determined by three methods.

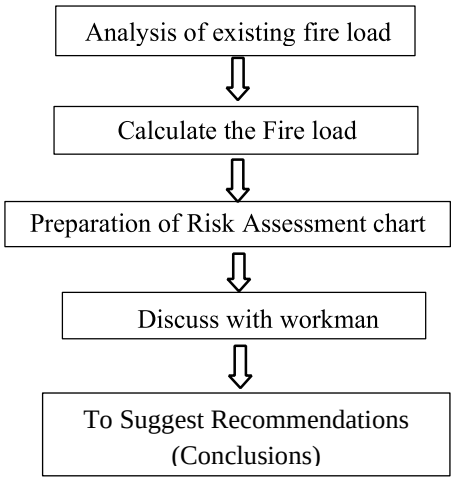
• direct measurement of mass, with conversion based on the net heat of combustion.

• direct measurement of volume (with conversion based on a combination of density and net heat of combustion).

• energy release measurement by calorimetry of an item sufficiently Fire load density is defined as the amount of heat liberated from a combustible material per square meter in floor area Fire load is to determine the severity and building up of fire. Fire load is a useful in determining the growth an severity of fires. The mass of the material is calculated in kg. The calculated mass is multiplied by its calorific value in MJ/kg to get fire load. The calculated valve is then divided by area of the floor to give fire load density. Formula where,

$$q_c = \frac{\sum m_v H_v}{A_f}$$

q_c = Fire Load density in MJ/m^2.
m_v = Total mass of vth combustible material in kg.
H_v = Calorific value of vth combustible material in M.
A_f = Area of floor in m^2.



The mass of combustible products is calculated by digital weight meter. If the mass is unknown, volume of the material is calculated in m3and the calculated volume is multiplied by density of the material in kg/m3. So the formula for calculating mass is given as,
Mass = Volume * Density

Materials	Calorific value in MJ/kg
Polythene cover	17.5
Wood	18.6
Carton box	16.9
Paper	16.3
Clothes	23
LPG	46.1
Paint & Varnishes	>2000KJ/Kg

Table 2. Calorific valves

NEED FOR SAFETY ASSESSMENT

Now-a-days safety is the challenging tasks in order to assessing the system prevent the employees from the machine. In other words, the challenge is to develop ways to better grasp in foresight what is being interpreted in hindsight or to move from a study of past failures to an Anticipation of future one. As a safety professional our main aim is to reduce the accidents in the work place. For this we have to assess safety and reduce the risk to tolerable level. That below represents the accident investigation we need to analysis the past accident/incidents. Safety assessment needs to consider future problems. To tackle this we have the risk analysis tools that include HIRA, HAZOP, FMEA, FTA, ETA, etc. Hazard Identification and Risk Assessment (HIRA) HIRA means Hazard identification and Risk Assessment. Hazard as relates to "Accident" is defined as the potential for causing harm to persons, damage to property or environmental degradation. It will particularly cause unwanted transfer of energy and can occur in random variations of normal operations or from changes in physical or human factors. An HIRA is a systematic way to identify and analyses hazard to determine their scope, impact and the vulnerability of the built environment to such hazards and its purpose is to ensure that, there is a formal process for hazard identification, risk assessment and control to effectively manage hazards that may occur within the workplaces. The challenge is to be faced by emergency planners is how to prevent, prepare, mitigate, respond and recover from a myriad of hazards. The frequent questions come from their facing this situation is:

• What are all the hazards present in my area?
• How frequently do they occur?
• How severe can their impact be on the community, infrastructure, property, and the environment? Which hazards pose the greatest threat to the community? A Hazard Identification and Risk Assessment (HIRA) give a solution for emergency planners in an swering these questions. It is a systematic risk assessment tool that can be used to identify the hazard and assess the risks. The reason for a HIRA is useful to the emergency planning:

• Prepare for the worst risks.
• Prepare for Training programs.
• Allow for the creation of exercises.

IV. CONCLUSION AND DISCUSSION

Though fire accidents are likely to occur in combustible atmosphere. Early control if fire at initial stage helps to prevent explosion and property damage. Therefore, to detect fire and alert ERT team when they are involved in work at different areas. The Fire safety audit and risk assessment method helps to preserve human life and property from fire through speedy communication. Fire load density calculation in the whole industry is done and the study gives following

conclusion. Therefore, I am going to proceed with my project in Royal Enfield plant for my phase II project.

As per loading concern this standard code of practice was first published in 1957 for the guidance of civil engineers, designers and architects associated with planning and design of buildings. It included the provisions for basic design loads (dead loads, live loads, wind loads and seismic loads) to be assumed in the design of buildings. In its first revision in 1964, the wind pressure provisions were modified on the basis of studies of wind phenomenon and its effects on structures, undertaken by the special committee in consultation with the Indian Meteorological Department. In addition to this, new clauses on wind loads for butterfly type structures were included; wind pressure coefficients for sheeted roofs both curved and sloping were modified; seismic load provisions were deleted and metric system of weights and measurements was adopted.

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REFERENCE

1. Mr. Karthick Suresh, Mr. Lokesh (2021) “fire risk assessment and fire load calculation in manufacturing industry” issn (print): 2393-8374, (online): 23940697, volume-8, issue-4, 2021.

2. Mr. Ugur Dundar a , Mr. Serdar Selamet (25 august 2022) “Fire load and fire growth characteristics in modern high-rise buildings” Fire Safety Journal 135 (2023) 103710.

3. Mr. J. LIU, W. K. CHOW(2014) “Determination of fire load and heat release rate for high-rise residential buildings” J. Liu and W.K. Chow/Procedia Engineering 84 (2014) 491 – 497.

4. Mr. Manish Nigam, Mr. Awadhesh Kumar Singh , Mr. Abhishek Dixit , (2016) “Fire Load Calculation on Hospital Buildings in India” 2016 IJEDR | Volume 4, Issue 2 | ISSN: 2321-9939.

5. Mr. N. Arunra, Mr. C. Senthil Kumar , Mr. k. Vijaya Maruthi (2015) “Estimation of Fire Load and Its Risk Assessment in Warehouse” SSRG International Journal of Industrial Engineering (SSRG – IJIE) – Volume 2 Issue 2 – May to Aug 2015.

6. Antonio M. Claret, Adriana T. Andrade, “Fire load survey of historic buildings: A case study”, Journal of fire protection Engineering, May 2007, vol 17, no.12, pp103-112.

7. Ehab Zalok, “Validation of methodologies to determine fire loads for use in structural fire protection”, Fire Protection Research Foundation, NFPA mission, May 2011.

8. Sunil Kumar, C.S.K.Rao, “Fire loads in office buildings” Journal of structural Engineering, March 1997.

9. Meacham B. et al., (2009) “Collection of Data on Fire and Collapse, Faculty of Architecture Building”, National Science Foundation, CMMI, Research and Innovation Conference

10. Majdalani, A., Torero, J. L.,(2011) “Compartment Fire Analysis for Modern Infrastructure”, Ibero Latino-Americano sobre Seguran, a contra Incendio, Brasil.

11. A.C. Bwalya, M.A. Sultan, N. B´enichou, A Pilot Survey of Fire Loads in Canadian Homes, Institute for Research in Construction, Ottawa, Canada, 2004.

12. J.A. Campbell, Confinement of Fire in Buildings, NFPA, USA, 1981.

13. S. Kumar, C.V.S. Rao, Fire load in residential buildings, Build. Environ. 30 (1995)299–305.

14. W.K. Chow, S.Y. Ngan, G.C.H. Lui, Movable fire load survey for old residential highrise buildings in Hong Kong, WIT Trans. Built Environ. 94 (2007) 215–222.

15. J. Hietaniemi, E. Mikkola, Design Fire for Fire Safety Engineering, VTT, Finland,2010.