IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Review Paper On Extent Of Hazardous Area By Using Computational Fluid Dynamics Calculation Software

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Abstract:

The current paper is an overview on previous and ongoing research carried out by the authors concerning the use of Computational Fluid Dynamics (CFD) Calculations and dispersion modelling for the accurate classification of hazardous areas generated by flammable gases, flammable liquids and their vapours. These research works containing analytic studies have led to the observation of basic principles which come to support the benefit of CFD in hazardous area classification in the areas where flammable liquids and vapours are being handled.

This review paper aims to study the work done by various researchers on use of Computational Fluid Dynamics (CFD) Calculations and modelling for hazardous area classification. It is evident from literature that the CFD modelling and calculation can help in identifying nearly accurate extent of hazardous areas and is more useful, cost effective and safe way as compared to applying general guidelines given in various standards for classification of hazardous area

Keywords:

HAC; Hazardous Area Classification, Electrical Area Classification, NFPA 497, IS: 5572 ATEX; CFD

Abbreviations:

HAC: Hazard Area Classification,

CFD : Computational Fluid Dynamics

Introduction to Hazardous Area Classification (6,7,8)

Hazardous area classification is a scientific study of determining the extent of explosive atmosphere in the areas where flammable liquids and gases are handled. Main purpose of this study to identify the areas where explosive atmosphere can be present continuously, during normal routine operations and during accidental leakages or abnormal operations and suggest to install electrical equipment rated for hazardous area. This during HAC study each area of plant is studied and classifying it to zone-0, zone-1 and zone-2 according to flammable material present in the area. The areas where flammable atmosphere is continuously present are classified as zone-0.

Hazardous Area Classification (HAC) study focus on the classification of areas around equipment handling or storing flammable liquid or gases and explosive dusts, and provides a basis for both the correct selection of fixed electrical equipment and the location of other fixed sources of ignition in those areas. An 'area' in this context is always taken to be three-dimensional.

For Classification of Hazardous Areas where Flammable Liquids, Gases, or Vapours are handled HAC is done based on following standards

NFPA 497: 2017 Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapours and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas

IEC 60079-10-1:2015, Explosive atmospheres - Part 10-1: Classification of areas - Explosive gas atmospheres

IS 5572: 2009 (reaffirmed in 2018), Classification of Hazardous Area (other than mines) having flammable gases and vapours for electrical installations.

Classification of Zone

Zone 0: Place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapor or mist is present continuously or for long periods or frequently. Examples of Zone 0 area are inside storage tank, inside process vessels and piping handling flammable liquids and gases.

Zone 1: place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapor or mist is likely to occur in normal operation occasionally. Example of Zone-1 area are sampling points, drum filling points, vent of atmospheric storage tanks handling flammable chemicals.

Zone 2: place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapor or mist is not likely to occur in normal operation, but if does occur, will persist for a short period only (means the total time for which the flammable atmosphere will exist).

Extent of the Zone: It is the distance starting from the source of the release to the point where the material is diluted below its lower explosive limit. This can be determined by using various standards stated above.

Objective of HAC (6,7,8)

The aim of hazardous area classification is to avoid ignition of those releases that may occur from time to time in the operation of facilities handling flammable liquids, flammable gases and vapours. In most practical situations where flammable materials are used it is difficult to ensure that an explosive gas atmosphere will never occur. It may also be difficult to ensure that electrical apparatus will never give rise to a source of ignition. Therefore, in situations where an explosive gas atmosphere has a high likelihood of occurring, reliance is placed on using electrical apparatus which has an extremely low likelihood of creating a source of ignition. Conversely where the likelihood of an explosive gas atmosphere occurring is reduced, electrical apparatus which has an increased likelihood of becoming a source of ignition may be used.

Use of reference figures from standards Vs use of CFD modelling

Traditionally Hazardous area classification is done based on various figures and guidance provided in various standards like IS 5572, IEC-60079-10-1, NFPA-497 etc. These figures are based on practical experience and are generic in nature. They do not consider effect of chemical properties, temperature, pressure, wind velocity etc.

The most common practice while classifying hazardous area is to use and reproduce figures given in various standards. Although these Standards express that it is necessary to consider the real conditions of the plant under study and not only the figures. There is a misunderstanding that these figures can be used independently of the plant conditions or chemical characteristics.(2)

Use of advanced dispersion modelling has proved that blind use of these references CFD modelling can lead to an error of up to -40% to +73 % when NFPA 497 is used and various pressure conditions are modelled for hexane at 14.22 PSI and 497.8 PSI(2). While considering effect of temperature on hazardous area classification using NFPA 497 and Mathematical modelling the difference can be +10% (at 30 °C) to 66.7 % (120 °C) for iso pentene (2)

Similarly, extent of hazardous area can change for each chemical at same temperature and pressure due to it's volatility, ambient conditions, weather conditions etc, release duration

Conclusion

Hazardous area classification design is required to reduce the explosion risk in process plants(5). In the era of technological development and popularity of computer software, as well as increasing computing power of computers, the introduction of CFD methodology as an effective tool, helpful also in classifying explosive hazardous areas / zones, should be considered (1). Nowadays, no one is surprised by the use of simulations based on ALOHA, PHAST, RIZEX and other programs. Properly performed simulations of smoke objects or fire development also become useful (1). This makes it all the more important to improve the knowledge base on the phenomena associated with the emission of flammable liquids/ fumes /dusts /gases for the purposes of classifying explosive hazardous areas / zones(1).

An item that contributes to a safer plant and also helps the inspection activity is the safety signalization of hazardous locations (2).

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