Assessing smoke and heat release during combustion of electric cables using cone calorimeter

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ABSTRACT

This paper presents and discusses the data obtained on smoke and heat release measurements obtained on cables and cable materials using cone calorimeter. Power cables, communication cables, data cables and wires used for various applications in Power plant, Refineries, automobiles and other applications have been evaluated for heat release parameters.

KEYWORDS

Fire Hazards, cone calorimeter, Toxicity, Heat Release, Smoke, flammability.

INTRODUCTION

Cables are designed for transportation of electric power for long distances. Different materials like PVC, XLPE, Flame Retardant PVC, polyolefin based Low Smoke Zero Halogen (LSZH) materials, etc. are used as insulating and sheathing / jacketing materials in the construction of cables. However, the polymeric materials used in cable construction may pose a great threat and can act as a medium of fuel with liberation of heat, smoke and toxic gases in the event of fire. Though Electric cables rarely cause fire, they act as pathway in the event of fire, along which fire can travel and spread. The fire behaviour of cable depends on a number of factors, including their construction and constituent materials. In recent years, increasing attention has been given to fire risks relative to electrical cables, with the examination of their behaviour under fire conditions not only in terms of their participation in the fire and its propagation, but also in terms of the danger of fumes emitted during combustion. Apart from smoke and toxic gases, the heat release is an important parameter which characterizes the total available energy in the material in a possible fire situation. Thus the measurement of heat release rate (HRR) of burning cables is believed to be an important factor for quantifying the growth and spread of fire. Cone Calorimeter has become one of the most widely used apparatus for heat release measurement on cables and materials.

This paper presents and discusses the data obtained on smoke and heat release measurements obtained on cables and cable materials using cone calorimeter. Power cables, communication cables, data cables and wires used for various applications in Power plant, Refineries, automobiles and other applications have been evaluated for heat release measurement. The behaviour of cables have been studied at various thermal irradiances. Power cable Individual components have been evaluated at different heat fluxes in horizontal orientation. Parameters like time to ignition, mass loss rate, total heat release, heat of combustion, specific extinction area of smoke and rate of production of yields CO/CO_2 ratios are also measured and discussed.

FIRE SAFETY EVALUATION TECHNIQUES

The fire and smoke characteristics of cable materials are evaluated by several test techniques and more are being published every year. Some of the important fire tests on cables are HRR measurements using cone calorimeter ASTM 1354 [1] / ISO 5660 [2], Wire/cable bunch flame propagation IEC 60332-3 [3] /IEEE 383 [4], Smoke density of wire/cable IEC 61034 [5], ASTM E 662 [6] for Specific optical smoke density, ASTM 2843 [7] for smoke density from the burning or decomposition of plastics, Limiting oxygen index (LOI) test as per ASTM 2863 [8], IEC 60754 part 1 & 2 Evolved combustion gases of wire/cable [9], Toxicity index test as per NES 713/NCD 1409 / IEC [10] Flammability of plastics UL 94 [11], Fire survival test IEC 331 [12] / BS 6387 category C, W & Z [13] etc.

HEAT RELEASE MEASUREMENT

Heat Release Rate (HRR) measurements are used to predict the real-scale burning behavior of materials and assemblies as it quantifies fire size, rate of fire growth and consequently the release of associated smoke and toxic gases [14]. HRR is considered to be a key indicator of fire performance and is defined as the amount of energy that a material produces while burning. Heat Release Rate curve is single numbers via the initial peak Heat Release and the averages of the HRR over a set time (60, 180, 300 secs) after ignition of the specimen. MARHE, the maximum average rate of heat emission is another parameter which is used to assess the fire behavior of materials.

CONE CALORIMETER

The heat release measurements were done using Cone calorimeter shown in figure 1. The instrument is based on the principle of oxygen consumption calorimetry for measuring rate of heat release, where the net heat of combustion of any organic material is directly related to the amount of oxygen required for combustion. A laser diode is used for smoke obscuration studies : Smoke production rate, Effective heat of combustion, Specific extinction area etc. The instrument is also fitted with CO_2, CO analyzers for providing additional information like