A STUDY OF FIBRE REINFORCEMENT ON FIRE PERFORMANCE OF INTUMESCENT FIRE RETARDANT COATING

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Introduction

The intumescent fire-retardant coating is a vital element in the completion of structural buildings due to the safety of the occupants during fire hazards. During the fire, when the temperature rises to 500°C, structural steel loses its strength and collapses in less than an hour. The intumescent fire-retardant coating helps delay the heat transfer to the structure of the building during fire hazards. Once they catch fire, the temperature can increase to 1200°C in no time [1]. At remote locations, the rescue services are not very effective, resulting in the collapse of structure and even the whole building and the loss of many lives, similarly, in shopping complexes and houses that contain flammable stuff that catches fire quickly and cause human casualties [2].

Conventional intumescent fire-retardant coatings consist of ammonium polyphosphate (APP), Pentaerythritol (PER), expandable graphite (EG), and Melamine, which helps to produce fragile char having low strength and adhesion. This resulted in the fire penetrating the substrate easily, and the substrate temperature rises [3]. Various types of fillers, such as titanium oxide, aluminium oxide, zirconium silicate, wollastonite, halloysite nanotubes, and kaolin clay, have been incorporated into the intumescent coating to reduce waste toxicity , enhance the thermal and mechanical properties of intumescent fire-retardant coatings. Moreover, commercial fillers like zinc borate,

zirconium hydrogen phosphate, aluminium trihydrates, hydrates of magnesium, and other minerals are added to the intumescent coating formulation to produce a dense char structure [4]. However, the main focus of using these fillers was to improve the thermal performance and char morphology of intumescent fire-retardant coating; however, the mechanical resistance enhancement area was not fully discussed. Therefore, there is a need to replace the traditional intumescent coating fillers with fibrous materials to improve the char's mechanical strength and reduce the cost of intumescent coatings ingredients.

In everyday practices, glass fibre, graphite fabric, or wire mesh is attached to the substrate before applying intumescent fire-retardant coatings [5]. Mesh netting is also used as a traditional reinforcement to improve the char strength, acting as an 'anchor' [6]. For instance, the external reinforcement poses several disadvantages, such as thick coatings, complicated steps in the application, longer curing time, and lack of durability during fire [5],[7]. Researchers have used the manual method for coating application on the steel structures, which is time-consuming [8]-[9]. However, the addition of fibres into the intumescent coating has not been studied in detail.

Moreover, the application of fibres in composites has proven a breakthrough that improved the mechanical properties of the composites. Therefore, the direct introduction of hybrid reinforcing fibres into the formulation of the intumescent fire-retardant coating is expected to strengthen the resulting char of the coating, compactness of the char, thereby improving its thermal performance [10]-[11] in the event of a fire. Apart from that, the low-cost fibres make the overall intumescent coating economical.

Fibre Reinforcement

The oxidisation and detachment of the char from the substrate is a major issue during the fire incident, causing the increased temperature of the substrate. Therefore, the addition of fibres to the intumescent coating may increase the adhesion of the char to the substrate resulting in a drop in the temperature. Fibre reinforcement is a considerable advancement in ICs, which improves the thermal and mechanical properties of ICs [12]. The reinforced char has a dense porous structure with high mechanical strength, which eliminates external reinforcement, which reduces the workforce used in the application of ICs, and ultimately saves the economy. Different categories of fibres are present in the market these days concerning their function and application. The types of fibres are illustrated in Figure 1.