THE STUDY ON INTERFACIAL BONDING OF EXPANDABLE GRAPHITE BASED INTUMESCENT COATING USING BENTONITE CLAY

by

JESBAINS KAUR

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ABSTRACT

The fast development of science and technology provides us with sophisticated products but concurrently increases the use of combustible materials. The usage of polymeric materials in everyday life increases the risk of fire hazards; therefore flame retardants are often incorporated into them to limit their flammability. This study characterized the interfacial bonding of expandable graphite based intumescent coating on steel substrate with respect to its physical, chemical and mechanical properties after fire test. A range of expandable graphite based intumescent coating formulations were developed with various additives. In these formulations, bentonite clay filler was incorporated to improve the adhesion of coating with substrate. Structural steel substrate was sand blasted and coated with primer coating of zinc phosphate.

For mechanical properties, the shear test was conducted according to ASTM 3163 test procedure and the maximum shear strength was 9.89Mpa for an intumescent coating formulation containing 6% of bentonite clay and 1.32Mpa for formulation without bentonite clay. X-Ray Diffraction (XRD) results showed boron phosphate, graphite and sassolite were remaining inorganic materials that acted as a thermal barrier or protecting layer at later stages of burning. Formulation containing 6% of bentonite clay had the highest residual weight which was 33.45% and formed a ceramic like protective shield at the char surface thus indicated it has good intumescent effect compared to 25.33% for coating without bentonite clay at 800°C.

The changes in microstructure of the interfacial bonding were monitored using Optical Microscope (OM) and Scanning Electron Microscope (SEM). The microstructure observation indicated a profound mechanical interlocking mechanism between the primer coating and steel substrate. An intumescent coating containing 6% of bentonite clay filler showed 10.55 times expansion and coating was attached well

to substrate with hard char that acted as a thermal barrier to reduce heat transfer to steel substrate. A control formulation without bentonite clay filler was detached from steel substrate. Therefore, bentonite clay filler played an important role in improving the adhesion of char with steel substrate due to its adhesive properties and swelling characteristics results to increase the expansion. Despite the one hour fire test performed according to ASTM E119, the substrate temperature was 170°C, thus proved a good insulator that protects the steel substrate to collapse. The separation of char with substrate was quantified after the fire test. The results showed a decrease from 1800μ m to 300μm in separation of char from substrate with increase of bentonite clay in the formulation. Thus future development of this intumescent fire retardant coating can be a potential application in the industry.