AN INFLUENCE OF CERAMIC FILLERS AND SUBSTRATE THICKNESS ON THERMAL PERFORMANCE OF INTUMESCENT FIRE-RETARDANT COATING

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Introduction

This chapter describes the preparation of titanium oxide reinforced intumescent fire retardant coating formulations. The coating formulations are tested on structural steel substrate for fire resistance test, char expansion for morphological study. The residual weight was examined using the thermogravimetric analysis technique. The char compounds by XRD and char elements were identified using EDX. Titania itself is not a flame retardant additive, but upon reaction with the decomposition product of APP forms, titanium phosphate, a thermally stable compound at a higher temperature. With the addition of Titania, fire resistance time significantly increased; thus, the substrate's back side temperature was reduced to just 119°C after conducting 60 minutes of the fire test. This was referred to as the creation of multicellular closed cell formation and titanium phosphate. Residual weight was significantly improved by adding Titania, implying that 4% Titania improved the char's anti-oxidation property, and EDS verifies this by estimating the C/O ratio. However, it is a qualitative technique, and FTIR further confirmed it.

Materials

The materials used in the study; their physical and chemical properties are described. Ammonium polyphosphate (APP > 1000) was purchased

from Clariant Malaysia Sdn. Bhd. It contains about 20% phosphorous, and it is the primary role of an acid source in the present work. It also acts as a blowing agent as its decomposition releases ammonia gas and expands the char [1]. Table 1 shows the properties of APP.

Table 1 Physical and chemical properties of APP and EG [2]

Properties	APP	EG
Appearance	White powder	Black solid particles
Molecular mass	97 g/mol	360 µm
Particle size	50 µm	>5000°C
Decomposition temperature	>275°C	Insoluble
Water solubility	<0.75 g/100 ml (25°C)	2.0 g/cm^3 (25°C)
Density	≈1.9 g/cm^3 (25°C)	Up to 99%
Polymerisation degree	>1000	350 ml/g

Expandable graphite (EG) was purchased from Kaiyu Industrial (Hong Kong) Ltd, China. This graphite was intercalated with sulphuric acid to aid in the expansion of char. It is used as a carbon source in the present work. Table 1 shows the properties of EG.

Melamine (MEL) was purchased from SABIC, KSA. It is used as a blowing agent. It decomposes to release non-flammable or non-combustible gases such as ammonia that expand the char [3]. It plays a pivotal role in the expansion process. Table 2 shows the properties of melamine.

Table 2 Physical and chemical properties of MEL and BA [2],[4]

Properties	MEL	BA
Molecular formula	$C_3H_3N_6$	H_3BO_3
Appearance	White solid	White solid (Powdered)
Molecular mass	126.12 g/mol	61.83 g/mol
Decomposition temperature	>290°C	>140°C
Water solubility	Partially soluble	Partially soluble
Density	1.57 g/cm^3	1.44 g/cm^3