CHAPTER I

INTRODUCTION

Uncontrolled fire is a danger to modern life and property. Unfortunately, this period has also seen a dramatic increase in the number of serious fires, and the number of deaths and injuries in fires remains appallingly high. Fire creates a complex toxic environment involving flame, heat, oxygen depletion, smoke, and toxic gases. Fire deaths are normally violent in nature, and smoke inhalation and not fire itself is the killer that accounts for over 80% of fire deaths. A prime cause of this fire hazard is the use of natural and synthetic flammable materials.

The last two decades have seen a major growth in the use of synthetic polymers. Nowadays plastics are considered as essential materials for construction, insulation, packaging, upholstery and transport applications. Cause of advantages over metallic and other materials, e.g. rapid, cost saving manufacture of complex mouldings and reduces assembly cost, and by consumer demands for more comfort and better design, lower weight, lower maintenance and running costs can frequently be achieved only by the increased use of plastics. Because plastics are synthetic organic-based materials with high carbon, and often high hydrogen content and will burn under the proper condition.

However, the susceptibility to fire can be reduced, and the spread of flame can be decreased by the incorporation of additives. Additives called "flame retardants" help reduce the ignition of the plastic and the rate of flame propagation. The use of flame retardants in polymers has increased dramatically in recent years, in parrallel to the growth of the plastics industry. Estimated consumption of flame retardants in Western Europe for individual plastics are shown in Table 1-1

Table 1-1 Estimated consumption of flame retardants in Western Europe for 1985 and 1992 broken down by material. (6)

Material	Consumption (in 1000 ton)	
	1985	1992
Polyolefins	10.0 - 12.0	11.0 - 13.0
Polyvinyl chloride	25.0 - 27.0	27.0 - 29.0
Polystyrene	4.0 - 4.5	4.5 - 5.0
Acrylonitrile butadiene styrene	1.0 - 1.5	1.2 - 1.8
Engineering plastics	1.5 - 1.8	1.7 - 2.0
Unsaturated polyesters	7.5 - 8.0	8.5 - 9.0
Epoxy resins	3.5 - 4.0	4.0 - 4.5
Polyurethanes	12.0 - 13.5	13.5 - 15.0
Paper and textiles	9.0 - 10.0	10.0 - 11.0
Rubber and elastomers	5.0 - 6.0	6.0 - 7.0
Others	11.5 - 11.7	12.6 - 12.7
Total	90.0 - 100.0	100.0 - 110.0

The market of fire-retardant PVC compounds is growing as these plastics compete for increasing applications in all industries. The requirements of fire-retardance are becoming more rigorous as these

markets are penetrated, as test methods become more realistic and sophisticated, and as awareness of the inherent danger in using flammable materials increases. This awareness has been accentuated by the total destruction, by fire, of buildings that were supposedly fireproof, due to combustible contents, furnishings, and decorations.

PVC is the highest consumption in the commercial commodity plastics. PVC is unique among commodity materials in that it contains chloride and, thus, produces hydrogen chloride (HCl) when it decomposes or burns. Hydrogen chloride is a relatively common toxic fire gas. Hydrogen chloride is both a potent sensory irritant and also a pulmonary irritant. It is a strong acid, being corrosive to sensitive tissue such as the eyes. Most rigid PVC formulations or PVC resin are inherently flame retardant. However, flexible formulation containing plasticizers dilute the chlorine level can burn more easily than pure PVC so that flame retardants must be incorporated for many applications to retard fire and reduce hydrogen chloride gas. Many of the existing commercial flame retardants have problems associated with their use. In particular, certain flame-retardant systems are known to cause an increase in the amount of smoke and toxic/corrosive gases generated by plastics if they burn. In addition, a number of the commercial fire retardants have been found to possess undesirable toxicological properties themselves, and there has been considerable interest in finding new, safer chemical additives for flammable materials.

The thesis "Use of Inorganic Tin Compounds as Fire Retardant in Plasticized Polyvinyl Chloride" by Mr.Surasak Oonaree. This thesis investigated the effectiveness of zinc hydroxystannate ($ZnSn(OH)_6$), zinc stannate ($ZnSnO_3$) as fire retardants in plasticized poly (vinyl chloride). It was found that zinc hydroxystannate had small effect on mechanical properties of plasticized poly (vinyl chloride) film and can be used as industrial fire retardants that show similar effectiveness as antimony trioxide in low plasticizer content poly (vinyl chloride) film and show less effectiveness than antimony trioxide in high plasticizer content poly (vinyl chloride) film and offer the advantages over antimony trioxide that they were non-toxic additives and can reduce the toxic benzene evolved from burining of the polymer.

The ultimate objective of this thesis "Fire Retarded Mechanism of Inorganic Tin Compounds in Flexible Poly (vinyl chloride)" is to study fire retarded mechanism of inorganic tin compounds zinc hydroxystannate and zinc stannate as flame retardant and smoke suppressant in plasticized PVC. This study may lead to the understanding of their mechanism in their fire retardant property and may provide some information on the development of new fire retardant.