CHAPTER I

INTRODUCTION

1.1 The flammability problem

Today, polyurethanes are used all over the world in all manner of applications, for example, furniture manufacture, automotive engineering, building construction, the production of surface coatings and thermoplastic materials. Although polyurethanes take many different forms, their chemical structure varies only slightly, and they are still produced by the polyisocyanate polyaddition process originally discovered by *Otto Bayer*. Polyurethanes are high-molecular products which can be made for a specific application-solid or expanded, flexible, semi-rigid or rigid, moulded articles and film or fibres (1).

The utility and versatility of polyurethane foams have resulted in their introduction in to a wide variety of markets, and their widespread acceptance has made them significant materials in many applications in which fire hazard is an important consideration. Because polyurethane foams, like most organic materials, tend to be combustible unless care is taken to render them flame-retardant, the flammability of polyurethane foams has long been a factor limiting their greater use (2).

The fire hazard associated with cellulose in the form of wood, textiles and paper has caused concern the earliest times and attempts have been made for hundreds of years to minimized it by the use of fire retardant additivity. During the past 30 years polymers, in the form of rubbers, plastics and fibres, have gradually replaced conventional materials until, at present, very larged amounts are used in the construction and furnishing of homes, offices and public buildings. These commercial polymers are almost exclusively organic compounds which are frequently even more flammable than the conventional cellulosic materials and are thus associated with a much increased fire hazard.

The flammability of polymers and the associated destruction of property is not the only problem, however. Fatalities in fire incidents are not normally the result of burning. Instead, victims are suffocated by smoke or poisoned by noxious gases. A secondary effect of smoke is to limit visibility thereby making escape more difficult which in turn leads to panic. Unfortunately, compared with conventional materials, the smoke from plastics is often more dense and the fumes more poisonous. In addition, the normal methods of reducing flammability usually increase the density of the smoke and fumes. The burning characteristics of synthetics polymeric materials are so varied and the smoke may contain such a variety of dangerously of toxic materials (3).

The demand for very efficient additives to lower the combustibility of flame-retardant urethane foams has strongly increased in recent years because of stricter fire regulations and the general overall need for safety. Natural and synthetic polymers are generally made flame-retardant by incorporation of compounds containing one or more of the following elements: phosphorus, nitrogen, antimony, chlorine, bromine, boron, titanium or zirconium. Although a number of flame retardants are commercially available, many person suffer from their use. In particular, certain additives are known to cause an increase in smoke and toxic gas emission during combustion of the associated substrate and there is concern that some flame retardants are themselves environmentally undesirable. In addition, there is concern in some countries over its possible carcinogenicity. Hence, the gennerally accepted non-toxicity of inorganic tin chemicals has played a major part in contributing to their increased industrial consumption in recent years. It is seen as a potentially very important one for zinc stannates, and hence a major part of the research into tin chemmicals as fire retardants has involved their incorporation into halogenated plastics and elastomers.

1.2 Novel fire retardant additives

Two inorganic tin compounds (4), zinc hydroxy stannate (ZHS) and zinc stannate (ZS), have recently been introduced as novel fire-retardant additives for halogen-containing polymer formulations. Previous work at International Tin Research Institute (I.T.R.I.) has shown that these essentially non-toxic compounds are effective flame retardants and smoke suppressants in halogenated polyester resins, rigid and flexible PVC, chlorinated elastomers, and in alkid resin-based paint systems.

Since flame retarder additives generally reduce physical properties of plastics and cost more than base resins, it is desirable to minimize the amount used. An additive system must be selected for the fabrication method as well as to meet the flammability and physical requirements of the intended end used.

The choice of ZHS and ZS as fire retardants in polyurethane foams appear to offer a range of advantages over certain alternative flame retardants :

- Non-toxic, safe and easy to handle.
- Combine flame retardancy with smoke suppression.
- High performance at low addition levels.
- Benificial effects with halogens and fillers.
- Unlimited pigment compatibility.
- Wide range of application.

The objectives of this work are the application of ZHS and ZS as fire-retardants for polyurethane foams and to observe the effects of ZHS and ZS on the flammability, smoke density and physical properties of flexible polyurethane foams. It is thought that the information gained from this investigation will be used to modify the fire-retardant property of polyurethane foams.