FLAME RETARDANT RIGID POLYURETHANE FOAMS FOR AUTOMOTIVE APPLICATION

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Main message: The aim of the present study was to find an appropriate flame retardant solution for a rigid polyurethane foam system used in the automotive industry. Besides the efficient FR action of the different flame retardants, their effect on the foaming characteristics, density and mechanical properties of the PUR system were also taken into account in order to be able to prepare an industrially suitable composition.

Keywords: Polyurethane foam, phosphorus-based flame retardants

Introduction

Polyurethane foams, due to their versatility and excellent insulation properties are widely used for several purposes, also in the automotive industry. However, their flammability is a major problem which has to be addressed. On the market, there are some halogen-containing flame retardants, but due to their possible toxicity, our aim was to elaborate an efficient phosphorus-based flame retardant system which ensures efficient flame retardancy and appropriate mechanical properties at the same time.

Experimental

Rigid polyurethane foams based on IsoPMDI 92140 of increasing P-content were prepared using several P-containing additive flame retardants, including red phosphorus (RP), different ammonium polyphosphates (AP422 and AP766), and phosphate esters (RDP, PNX and HF-10). The foaming characteristics were investigated, as well as the density of the obtained foams for each composition. LOI and UL-94 tests, as well as thermogravimetric analyses were carried out on each sample, while mass loss calorimetric and mechanical analyses were done on the promising samples.

Results and Discussion

The effect of the different FR additives on the foaming properties was determined: the foaming time increased in all cases, which means that the foaming process gets slower, especially in the case of the liquid FRs. The density of the foams was also increased with increasing FR content. As a general rule, liquid flame retardants, due to their lower P-content, thus higher amount required increased the density of the foams more significantly, while the hardness was slightly reduced (Figure 1).

Based on the preliminary UL-94 results, AP766 and HF-10 flame retardants were chosen for detailed analysis. In the case of HF-10 2% P-content proved to be enough to stop the horizontal burning, with a LOI value of 25 V/V%; while at 5% P-content the LOI increased to 27 V/V%. In the case of the AP766, 4% P-content was needed, which resulted in a LOI of 25 V/V% (Figure 1). Regarding the mass loss measurements, the result was opposite: AP766 was more efficient. With increasing FR content, the peak of heat release rate and the total heat released decreased systematically. Meanwhile, in the case of the HF-10, no significant decrease in the heat release was detected.

Based on the results, it can be stated, that gas-phase effect of the flame retardants is beneficial against small flames, when the aim is to prevent ignition, while intumescence is required if we are facing a fully developed fire to be able to reduce the heat release of the specimen.

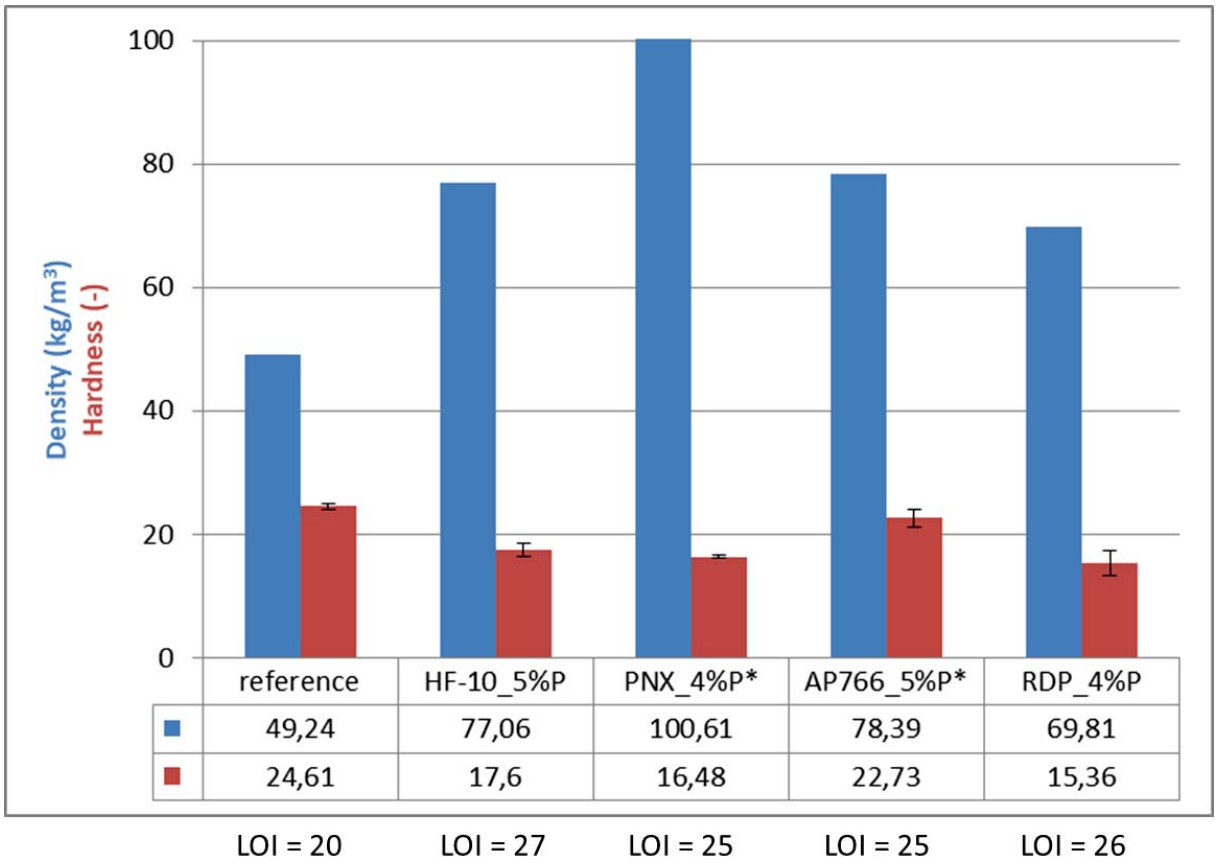

FIGURE 1. Density, hardness and LOI values of the different FR-containing compositions

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