The Fogging and Mechanical Properties of Flexible Polyurethane Foams with Additive and Reactive Flame Retardants

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Flexible polyurethane foams have wide and prominent applications across US and global markets. This, along with the dangers and costs of vehicle and household fires, makes the incorporation of flame retardants (FRs) an unavoidable aspect of polyurethane production. However, the presence of FRs in these materials presents certain concerns, including increased emissions of volatile organic compounds (VOCs); exposure to which has been linked to the development of sick building syndrome and has been shown to have neurotoxic, organotoxic, and carcinogenic effects. This study looked to investigate how the two types of FRs, additive and reactive, differ in their effects on VOC emissions in flexible polyurethane foams, as well as the mechanical properties of the polymer. The DIN75201 fogging procedure was conducted on additive and reactive FR foams to determine the differences in VOC emissions. Additionally, both tensile and tear testing was performed on the foams to investigate how the different types of FRs affect the mechanical properties. The additive FR foams mostly showed weakened mechanical properties compared to a No FR control, in contrast to the reactive FR foams, which showed increases in strength and elongation. The additive FRs also resulted in significantly increased VOC emissions, whereas the use of reactive FRs did not result in a significant difference. These results are attributed to lack of interaction between additive FRs and the polymer chain, and the reactive FR's ability to bond to the polymer. These findings suggest that reactive FRs can be used as an alternative to additive FRs to reduce VOC emissions without sacrificing mechanical properties.