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Effect of carbon-based nanomaterials on flexible polyurethane foaming process and foam fire behavior

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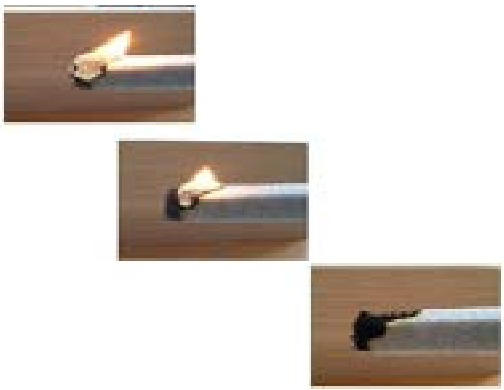
Statement of the Problem: Flexible polyurethane foams (FPUFs), due to their structure and unique properties, are widely used in several sectors such as building and construction, packaging, bedding and furniture, automotive, etc. The main disadvantage of this type of foams is their poor resistance against fire due to the oxygen entrapped in the structure, which means that FPUFs rapidly burn with a high release of toxic smokes. The most common way to solve this drawback is the addition of flame retardants into the foams formulation although the most effective additives are based on halogenated or nitrogenated compounds of considerable toxicity during handling and in case of fire where they give rise to the emission of highly toxic gases. Because of that, other ways to improve the fire behavior of FPUFs are being investigated. The purpose of this study is to analyze the fire behavior of flexible foams when different carbon based nanomaterials are incorporated into the formulation.

Methodology & Theoretical Orientation: FPUf incorporating different carbon derived nanomaterials (carbon nanofibers (CNF) and expandable graphite (ExG)) were synthesized by the one shot method allowing the material free rise in a squared box. Foaming reaction kinetic was followed by the cream and rise times. Foams obtained were chemically characterized by ATR-FTIR spectroscopy. Thermal properties were determined by TGA, and fire behavior was evaluated by internal horizontal burning test.

Findings: Chemical properties were not influenced by the carbon based nanomaterials, and the decomposition temperature was increased by 15ºC with 20 pph of ExG. Fire behavior was enhanced with both nanomaterials.

Conclusion & Significance: Improvements in the flame retardancy of FPUFs were achieved with both carbon based nanomaterials without worsening their physical-mechanical properties. Incorporation of 1% (w/w polyol) of CNF decreased the burning rate by almost 50% and 20% of ExG gave self-extinguish foam.



Recent Publications:

1. Wen-Hui Rao, Zai-Yin Hu (2017) Flame-Retardant flexible polyurethane foams with highly efficient melamine salt. Ind. Eng. Chem. Res 56 (25) pp 7712-7119
2. Xiangming Hu, Deming Wang, Shuailing Wang (2013) Synergistic effects of expandable graphite and dimethyl methyl phosphonate on the mechanical properties, fire behavior, and thermal stability of a polyisocyanurate-polyurethane foam. International Journal of Mining Science and Technology 23:13-20

3. Chao C, Gao M, Chen J (2018) Expanded graphite, Borax synergism in the flame-retardant flexible polyurethane foams. J Therm Anal Calorim 131:71
4. Zhao JJ, Chen S, Gao M (2016) Flame retardant properties of flexible polyurethane foams containing expanded graphite by Cone Calorimetry. 3th International Conference on Mechatronics and Information Technology
5. Zammarano M, Kraemer RH, Harris RH, Ohlemiller T, Shields JR, Rahatekar S, Gilman JW (2017) Effect of Carbon Nanofiber network formation on flammability of flexible polyurethane foams. National Institute of Standards and Technology.

Biography

Mª del Pilar Muñoz is a chemical engineer, she has been working in CETEM since 2013, she is in materials, adhesion and polymers department. She has experience in development & research project in different sectors such as coating, polyurethane foams or nanomaterials. She also has experience in syhtesis of prepolimers, modification chemical of nanoparticles and dispersions. She has participated in research national projects and European projects.She has built this study after years of experience in research and evaluation of test using a methodology applied modification the structure of flexible polyurethane foams using mainly nanotechnology. With the study of different properties have been investigated the behavior against the fire retardance of different carbon-base nanomaterials.

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