A Novel Strategy Inspired by Steaming Chinese Steamed Bread for Preparation of Tannin-furanic Rigid Bio-foam

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Abstract:

Tannin-furanic rigid foam material has been receiving extensive attention due to its renewable, easy-preparation, lightweight, thermal insulation, and flame retardancy. The most fashionable approaches for tannin-furanic foam manufacturing, currently, are the self-blowing expansion by helping a blowing agent with/without extra heating and foaming *via* mechanical stirring in existing of non-environmentally friendly crosslinker. Therefore, a novel and green strategy was proposed for tannin-furanic rigid foam preparation without blowing agent and additional crosslinker by steaming driven foaming. A possible foaming mechanism was suggested. The performance of steam driven tannin-furanic based foam (SDTF) was evaluated systematically, including surface morphology, apparent density, cellular morphological characteristics, mechanical properties, thermal stability and thermal conductivity, and flame retardancy, compared with the foam obtained by standard tannin-furanic-formaldehyde foam (STF). The results indicated that a totally different surface but similar microstructure morphology of SDTF was developed by steaming driven foam, which displayed a larger cell size and thicker cell wall than STF. A much lower pulverization ratio (approximately 4.6%) was reached for SDTF with respect to STF even though its compression strength was only less than half. TGA profiles displayed that the thermal stability of SDTF was slightly higher than STF under a temperature range less than 500℃. An excellent thermal insulation performance was verified by the thermal conductivity of SDTF, only approximately 0.0286 W/m·K, which is considered ultra-low value that the STF cannot reach or seldom reach after STF modification or/and special structure design. The flame retardancy of SDTF was investigated by LOI and ignition experiment, which demonstrated a strong flame resistance and self-extinguishing nature, rendering it superior to STF. This preparation strategy provides a promising sustainable and environmentally friendly method for fabrication of green tannin-furanic foam for industry applications.