

SYNTHESIS OF POLYURETHANE FOAMS WITH CO₂ AS PHYSICAL BLOWING AGENT

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Introduction:

In the field of thermosetting polyurethane foams (PUFs) obtained by the curing reaction between polyol and isocyanate, the selection and the amount of the blowing agents is very important to the final cellular structure and properties of the foam.

In particular, to address the recent interest in combining the CO₂ (physical) foaming with the classical (chemical) polyurethane foaming, a novel instrumented pressure vessel was designed for investigating: i) sorption under high gas pressure on the two, separate, components of the polyurethane foams, ii) synthesis under high gas pressure after the two components mixing, and iii) foaming upon release of the pressure.

Materials and Methods:

A formulated polyol and a polymeric methylene diphenyl di-isocyanate (PMDI) were supplied by DOW Italia S.r.l. (Correggio, RE, Italy) and used "as received". High purity grade CO₂ was supplied by SOL (Naples, Italy).

Foaming tests were carried out at 35°C and 40 bar of CO₂ pressure, by changing CO₂ amount, in a pressure vessel that makes use of a sample holder with a flexible impeller that allows to keep polyol and PMDI separated during the sorption stage until saturation and to mix the two reactants to start the PUF curing reaction, at any stage of it physical foaming occurs due to pressure release. Furthermore, pressure vessel makes use of a sapphire window for FT-NIR spectroscopy monitoring of CO₂ sorption in both reactants and curing reaction, by using Frontier™ NIR spectrometer equipped with a fiber optic reflectance probe.

Results:

PUFs obtained, at 35°C and 40 bar of CO₂ pressure, by increasing CO₂ amount show the final morphology to change from an inhomogeneous to more homogeneous one until to become a pulverized product for higher CO₂ amounts.

From NIR spectra collected during CO₂ sorption in polyol and PMDI, it is possible to detect the CO₂ combination bands, while, during PUF formation, it is possible to follow the isocyanate band decrease and the urethane band formation and increase.

Discussion:

The synthesis of PUFs in presence of CO₂ was investigated in terms of final morphology and NIR spectroscopy investigation.