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Project Summary

Identification of CFC and HCFC Substitutes for Blowing Polyurethane Foam Insulation Products

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Substantial effort is ongoing to identify and evaluate third-generation blowing agents for polyurethane foams to replace currently used stratospheric ozone depleting ones. Work under a cooperative agreement between the Environmental Protection Agency and Syracuse Research Corporation has identified and ranked over 100 chemicals as polyurethane foam blowing agent candidates. The systematic investigation involved the analysis of vapor thermal conductivity predictive models and utilizing this methodology to identify and screen potential new foam blowing agents. Collection of physical/chemical properties of the new candidates enabled an overall evaluation. Based on the vapor thermal conductivity, boiling point, and other important properties, the chemical compounds were ranked to identify the most promising new blowing agent candidates. To efficiently evaluate new foam blowing agents, the compounds were placed and evaluated in 14 groups based on chemical structure. Compounds ranked high in this exercise included cyclopentane and cyclopentene, simple olefins consisting of hydrocarbons with four to six carbons and at least one double bond, cyclobutane analogs, and fluorinated propanes and butanes. Several novel chemical groups, such as fluoroiodoalkanes and silicon compounds, were also considered and ranked.

This Project Summary was developed by EPA's National Risk Assessment Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Overview

Chlorofluorocarbons (CFCs) are recognized as a major contributor to the depletion of stratospheric ozone in the Earth's atmosphere. Stratospheric ozone helps filter harmful ultraviolet (UV) radiation and decreases the amount that reaches the Earth's surface. Because of the potential for harm to health and the environment as a result of the increased incidence of UV radiation, the phaseout of production of CFCs was called for as of January 1, 1996, under the auspices of the Montreal Protocol and current U.S. law.

CFCs were widely used as blowing agents for rigid polyurethane foams for insulation products due to their unique combination of desirable physical/chemical properties and safety in use. Worldwide efforts to replace CFC blowing agents led to the development of the so-called second-generation blowing agents, the hydrochlorofluorocarbons (HCFCs). HCFCs have significantly lower ozone depletion potentials compared to CFCs, and many of these second-generation blowing agents could be used directly as drop-in replacements for CFCs. HCFCs, however, also face phaseout under the Montreal Protocol and subsequent agreements due to their contribution to stratospheric ozone depletion; thus, they represent only an interim replacement for CFCs.

There is a need to identify chemical compounds that are not stratospheric ozone depleters that can be used as substitutes for CFC and HCFC blowing agents in rigid polyurethane foam insulating materials. The search for these compounds

is complicated by the facts that they must possess unique physical/chemical properties and they must be compatible with foam feedstocks and production methods. Subtle differences between the third-generation blowing agents and CFCs or HCFCs may result in modification of production methods as well as differences in use and utility of the foam product.

Substantial effort has been expended by government, industrial, and private laboratories to identify and evaluate third-generation blowing agents. A cooperative agreement between the Environmental Protection Agency and Syracuse Research Corporation was designed to identify additional polyurethane foam blowing agent candidates in order to improve the chances of finding successful ones. A systematic search was conducted to identify new compounds that could replace the CFCs and HCFCs currently in use. The project involved the analysis and use of vapor thermal conductivity predictive models. The vapor thermal conductivity of the blowing agent is an important physical property for insulating materials because the blowing agent becomes incorporated into the foam and, therefore, is partially responsible for hindering the movement of heat through the foam. Given that experimental vapor thermal conductivity values are essentially limited to currently available blowing agents and refrigerants (which are mostly CFCs and HCFCs) and that experimental measurements of many compounds would be economically prohibitive, a model to rapidly screen many compounds would be advantageous in identifying new blowing agents. Current models for estimating vapor thermal conductivity were evaluated, fine-tuned to reflect the current body of knowledge in this area, and used to identify and screen potential new foam blowing agents.

The study also included the identification of potential new foam blowing chemicals and their properties and the collection of physical/chemical properties and other data on the new candidates. Based on the vapor thermal conductivity, boiling point, and other important properties of each candidate, over 100 chemical compounds identified in this study were ranked to identify the most promising new blowing agent candidates. To efficiently evaluate new foam blowing agents, the compounds were placed in 14 groups based on chemical structure. By placing compounds in chemical groups, similarities could be discussed collectively and trends that represent differences could be identified.

Compounds ranked high in this exercise included cyclopentane and cyclopentene, simple olefins consisting of hydrocarbons with four to six carbons and at least one double bond, cyclobutane analogs, and fluorinated propanes and butanes. For many other chemical groups, a high potential was noted, but gaps in available data prevented their ranking from being higher. Several novel chemical groups, such as fluoroiodoalkanes and silicon compounds, were also considered and ranked.

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The complete report, entitled "Identification of CFC and HCFC Substitutes for Blowing Polyurethane Foam Insulation Products," (Order No. PB96-113667; Cost: $27.00, subject to change) will be available only from
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