The evolution of insulation research

Bomberg, M. T.

Publisher's version / Version de l'éditeur:

Journal of Thermal Insulation and Building Envelopes, 16, Jan, pp. 227-229, 1993

The evolution of insulation research

NRCC-36026

Bomberg, M.T.

January 1993

A version of this document is published in / Une version de ce document se trouve dans:
Journal of Thermal Insulation and Building Envelopes, 16, (Jan), pp. 227-229, 1993

MARK BOMBERG, PH.D.

The evolution of insulation research

Few construction materials have undergone more changes than thermal insulation over the last two decades, and few products have been so well adapted to fit market needs. But insulation continues to be selected for its perceived field performance, rather than on the basis of accurate laboratory tests and, in many cases, scientists have yet to develop lab tests to simulate the field.

The challenge is to characterize the key factors affecting the field performance of thermal insulations — settlement of loose fills, aging of gas-filled foams, effect of air flow on glass-fibre insulations, effect of moisture on thermal performance of all insulations — and to develop lab tests that reproduce field conditions.

Older insulations were extensively tested under both field and laboratory conditions, but this has not been done with many of the newer products. And while field test results sometimes confirmed the predicted values, this was not always the case: agreement between lab and field data often depended on construction design and workmanship.

LAB AND FIELD RESULTS MAY DIFFER

One well-publicized case of disagreement occurred in the early 1980s when scientists at a Canadian university studied preformed, loose-fill glass-fibre insulation that had been pneumatically applied to attics. When observed in the field, it became apparent that convective cells caused a significant reduction in thermal performance, but since laboratory testing did not simulate the interactions between heat and air flows, it did not predict this decline in field performance.

In response to these findings, a Canadian insulation manufacturer developed a new product which was immune to convective effects, and the Canadian Standards Association modified its standard to require that loose-fill products achieve a minimum thermal resistance.

Manufacturers in the United States did not follow suit. In fact, a recent report from Oak Ridge National Laboratory noted that full-scale measurements of one loose-fill glass-fibre product showed a discrepancy of more than 30 per cent between predicted and measured full-scale performance.

Air movements can compromise the thermal performance of glass fibre in wall applications as well. Windwashing is a particularly important factor: if wall construction permits wind to enter and exit at different places in the building envelope, reduced thermal performance of the insulation may be expected. This problem can be solved by increasing density of the glass-fibre batts (dubbed 'high-performance batts') or applying loose-fill material pneumatically with a water-based adhesive in a 'blown-in blanket' system, where glass fibre is used with a density up to 24 kg/m^3.

Lab and field data may also differ in the case of foam insulations, which are made of polymeric materials (including polyurethane, polyisocyanurate, phenolic, or extruded polystyrene) that have been expanded during manufacturing by a blowing agent, making them light and rigid. They are made into boards in the factory or sprayed in place in the field.

Originally there is no air in the cells, only the blowing agent, but eventually the outside air diffuses into the foam and the blowing agent diffuses outward, changing the mixture of gases in the cells. This not only alters the thermal performance (creating what is referred to as 'thermal drift'), but also causes the foam to swell or shrink as a result of changes in the cell-gas pressure.

PERFORMANCE ASSESSMENT

The challenges for scientists studying foam insulations have been to develop laboratory techniques and perform rapid tests that accurately predict what would happen in the field many months or years later. Scientists at the National Research Council's Institute for Research in Construction have developed a methodology for assessing performance and life span using ultrathin layers of insulation material ranging in thickness from 5 to 10 mm. This technique allows researchers to simulate up to 25 years of thermal performance in six months, and is being validated by comparing predicted results with those measured on samples exposed to controlled laboratory and field conditions.

Seventeen foams from both Canadian and U.S. manufacturers are under investigation, and the Canadian foam industry believes this project will establish the baselines for developing insulation products for the 21st century.

A major impetus for the development of reliable lab tests for foam insulations has been the need to replace chlorofuorocarbons (CFCs), which until recently have been used as blowing agents for foamed plastic insulations. CFCs are non-toxic, non-flammable, non-corro-

Continued on page 36

The evolution of insulation research
Continued from page 34

sive stable gases. However, they gradually escape the cellular structure of the plastics, rise to the ozone layer and break it down, eliminating this section of the atmosphere, which protects Earth from the sun's ultraviolet radiation.

When the extent of the ozone problem became apparent, an international agreement of United Nations' countries, known as the 1987 Montreal Protocol, established a plan to cut CFC emissions in half by 1999. This meant, among other things, that the foamed plastics insulation industry had to find new blowing agents.

In co-operation with the Society of the Plastics Industry of Canada, IRC undertook several studies into CFC replacement. It soon became clear that new blowing agent 'B' would not simply replace blowing agent 'A'. The new agents reduced thermal resistance, yet increased costs: to maintain the performance and cost levels obtained with CFC agents, researchers had to look for new technology.

Tests began with sprayed polyurethane foam insulation. A generic foam — Base 88 — was developed for test purposes using the best available technology at the time (1988), and produced for investigation by three companies (BASF Canada, ICI and Demilec Inc.). Two hydrochlorofluorocarbons (HCFCs), which have much less harmful effect on the ozone layer than CFCs, were selected as the blowing agents.

So far, research has demonstrated that the sprayed polyurethanes manufactured with HCFC blowing agents have long-term thermal performance identical to that of products made with the traditional CFC-11. A second stage of the work, now underway, has begun to address the more complex issue of replacing CFCs in laminated boardstock thermal insulations.

For foam insulations, as for all insulation products, the key to current research has been to accurately predict in the laboratory what will happen in the field. The fragmented, often arbitrary lab methods of the past are proving too vague to form the basis of manufacturing or installation decisions.

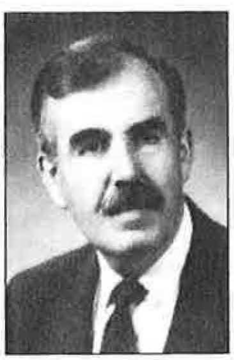
It has been essential that laboratory testing evolve to become more comprehensive and authentic, because insulation manufacturers cannot wait years for product evaluations and the market is equally impatient, especially in Canada where good thermal insulation makes the difference between an unsuitable building and a comfortable one.

Dr. Mark Bomberg is a senior scientist with the Building Performance Laboratory, IRC; co-ordinator of the SPI/IRC joint research project on the long-term performance of cellular plastics and editor-in-chief of the Journal of Thermal Insulation.

APPOINTMENTS

Acres International Limited

Oskar T. Sigvaldason



Robin G. Charlwood

Ian K. Hill

John C. W. Richie

Robert G. Witherell

John M. Gardiner, President of Acres International Limited, is pleased to announced the appointment of Dr. Oskar T. Sigvaldason as Executive Vice President, with specific responsibility for Acres Ontario operations, and as Vice President of the Company, Robin G. Charlwood, Ian K. Hill, John C. W. Ritchie and Robert G. Witherell.

Dr. Chartwood is responsible for Acres hydroelectric operations Iran; Dr. Hill is Manager of Acres operations in Halifax, Nova Scotia; Mr. Ritchie is Manager of Acres operations in Vancouver, British Columbia and Mr. Witherell is currently in Lesotho on appointment to the Lesotho Highlands Development Authority as Deputy Chief Executive, Environment and Public Affairs. The Lesotho Highlands Water Project is a multi-billion dollar waterresource development for which Acres is providing a team of senior engineering and construction management staff.

Acres International Limited is a privately owned, multi-discipline consulting engineering firm with offices across Canada and in the USA. Overseas, the Company has assignments in over 20 countries in Asia, Africa, Latin America, the Caribbean and the Middle East.