NatureWorks

RESEARCH

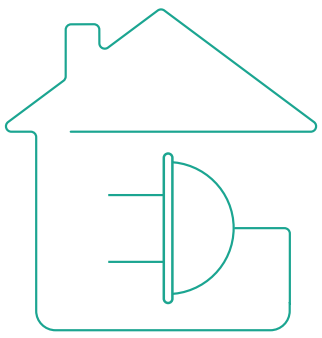
Saving Energy with Refrigerator Liners made from New Ingeo System

When it comes to appliances, industry is innovating to reduce both energy consumption and the associated carbon footprint. We've always known that our material, Ingeo™, can contribute to a lower carbon footprint, but recent research and development by NatureWorks has pushed the boundaries for how the right materials can help reduce the energy consumption of a refrigerator.

Oak Ridge National Laboratory found that by replacing HIPS with our new Ingeo system for refrigerator liners, energy consumption is reduced by 7% to 13% annually over the life of a refrigerator.

Beyond these energy and greenhouse gas savings, our Ingeo system contributes to the overall performance of a refrigerator liner.

- Improvement in energy efficiency without changing design
- No sacrificing interior capacity or long-term R&D investment
- 10x glossier than high-impact polystyrene (HIPS)
- Improved resistance to food oils and fats
- Inherent stiffness provides additional structural integrity to liners
- Ingeo system does not contain styrene or any chemicals of concern



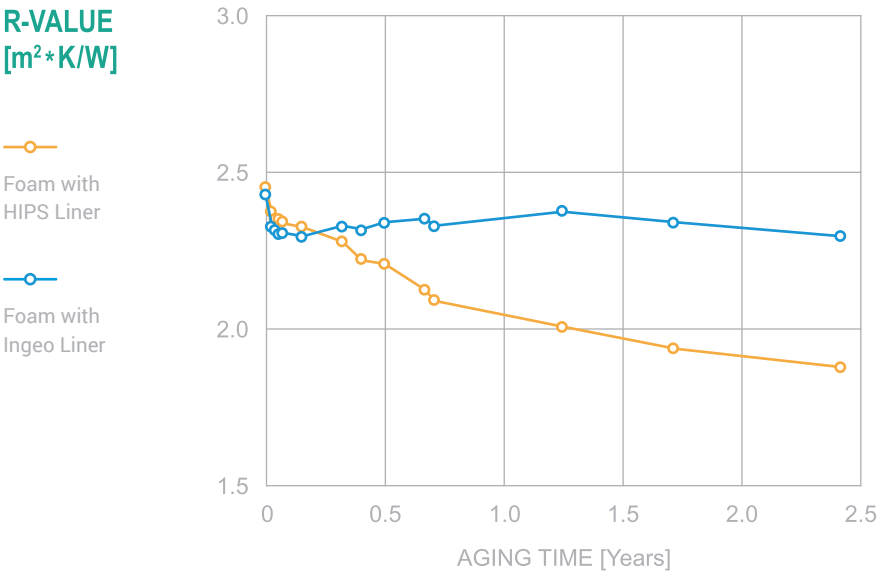
Over its lifetime, using a refrigerator with an Ingeo liner saves energy equal to running your refrigerator for 2 years.*

*Calculation based on results from Oak Ridge National Laboratory modelling under the Ingeo UC scenario for total energy use.

MEASURABLE ENERGY SAVINGS OVER THE LIFE OF ONE REFRIGERATOR

Measurements of thermal conductivity done by BASF were converted into energy use over time through modelling by the Oak Ridge National Laboratory. Results show that the new Ingeo system results in an average annual energy savings of 7.3% (Exp) to 12.5% (UC) over the HIPS incumbent.

R-VALUE [m^2*K/W]



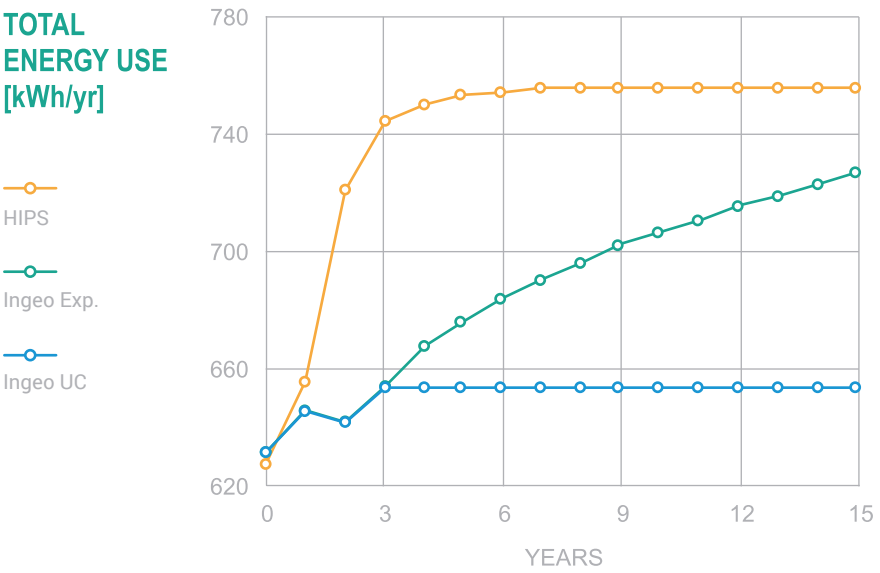
R-values were calculated from thermal conductivity measurements done by BASF.

The difference in foam insulation decay was the chief variable between the HIPS incumbent and the Ingeo system.

Sample and Test Specifications

- Size | 600 x 600mm
- 47.6 mm thick polyurethane foam with 1.2 mm thick liner on both sides of foam
- Blowing Agent | cyclopentane
- Test Method | ASTM C518 at 10°C mean temperature, using a temperature difference of 10°C
- Samples were stored at 25°C

TOTAL ENERGY USE [kWh/yr]

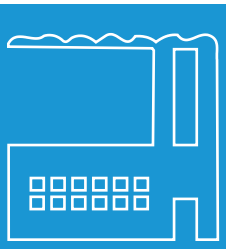


Energy consumption was modeled* under two assumptions.

Unchanged (UC)
The Ingeo liner unless punctured will retain a flat, low level of conductivity through the life of the refrigerator.

Exponential (Exp)
The Ingeo liner will eventually reach the higher level of conductivity performance associated with HIPS.

*Energy-Efficient Refrigerator Analysis (ERA) software developed by the US EPA and DOE was employed by Oak Ridge National Laboratory. ERA software is used for rule-making purposes associated with energy savings directives.

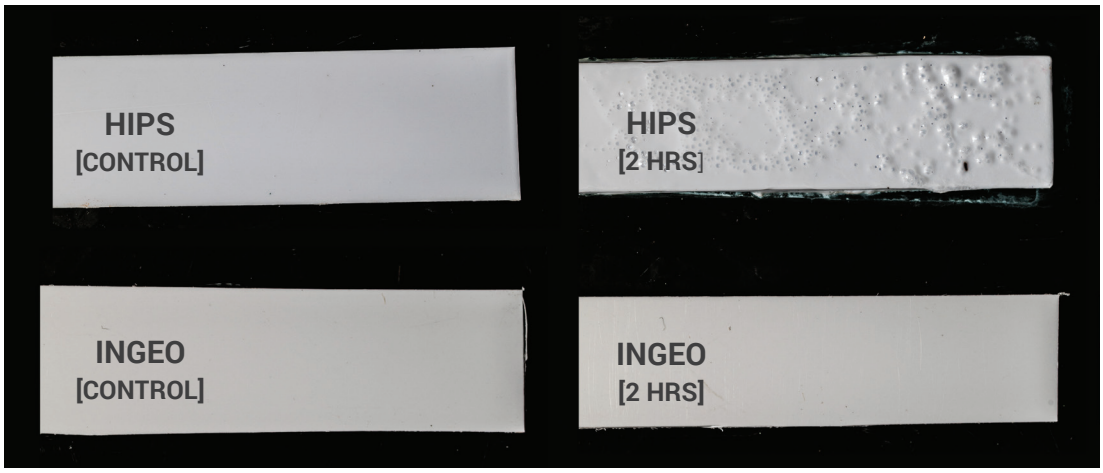


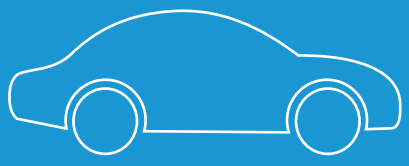
In 2018 if all new refrigerators sold in the U.S. used Ingeo liners, the lifetime energy savings are equal to running an average power plant for 3.2 years.**

**Calculation based on results from Oak Ridge National Laboratory modelling under the Ingeo UC scenario for total energy use.

Unlike HIPS, sheet made with the new Ingeo formulation for liners shows no degradation when exposed to cyclopentane. The low level of interaction between cyclopentane and Ingeo validates the UC model for total energy use.

CYCLOPENTANE EXPOSURE [25°C FOR 2 HRS]

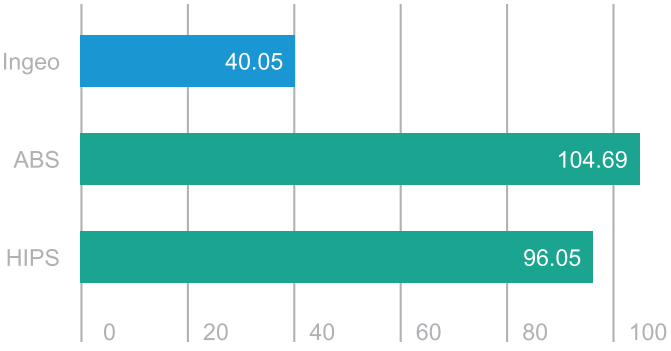




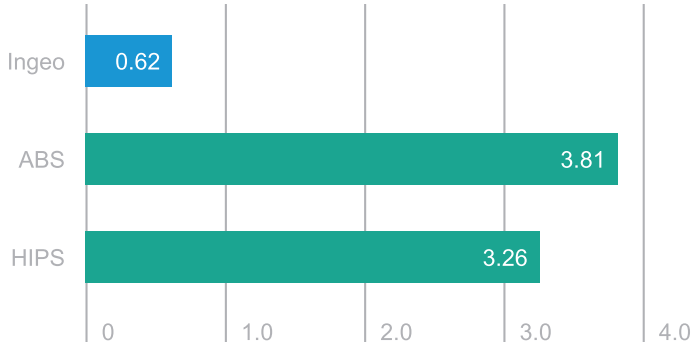
Running a refrigerator with an Ingeo liner decreases it's lifetime carbon footprint equal to driving a car 3,774 miles.**

INHERENT ENERGY SAVINGS AND LOWER CARBON FOOTPRINT FROM THE MATERIAL SUBSTITUTION

Published, peer-reviewed eco-profiles show that Ingeo's manufacture uses 60% less non-renewable energy and results in 80% fewer greenhouse gas emissions than incumbent liner materials like HIPS and ABS.



NON-RENEWABLE ENERGY USE
[MJ / kg polymer]



GREENHOUSE GAS EMISSIONS
[kg CO_2 eq. / kg polymer]

Sources: American Chemistry Council, plastics.americanchemistry.com | NatureWorks Eco-Profile, natureworksllc.com/ecoprofile

ABOUT NATUREWORKS

NatureWorks is an advanced materials company offering a broad portfolio of renewably-sourced polymers and chemicals.

Naturally advanced Ingeo™ polymers are valued for their unique functional properties and used in the packaging, fibers, and durables markets. Vercet™ lactide-based solutions help innovators realize significant, measurable performance and cost advantages in the C.A.S.E. markets.

Headquartered in Minnetonka, MN, USA, NatureWorks has a 150,000 MT/yr production facility in Blair, NE and a dedicated Ingeo Applications Development Facility in Savage, MN.

NatureWorks is jointly owned by Cargill and PTT Global Chemical.

ingeo™

HOW CAN WE HELP YOU?

To learn more about Ingeo for appliance applications, please contact a member of our Performance Polymers team.

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