

Advantages of ecomate® at Cryogenic Temperatures

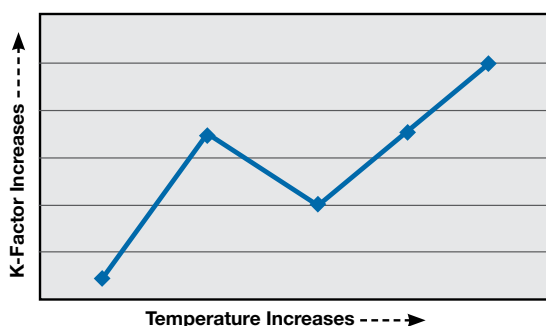
Polyurethane foams are the best insulating materials in common use today. However, not all foams perform efficiently in low-temperature applications/products e.g. cryogenic refrigeration. Certain polyurethane foams have efficiency limitations because the blowing agent can condense, or liquefy, prior to low temperature conditions, thereby diminishing the foam's insulating abilities. Once a blowing agent condenses, the thermal insulating capability of the foam decreases.

The following are reported condensation points for polyurethane foams made with some common blowing agents^{1,2,3}:

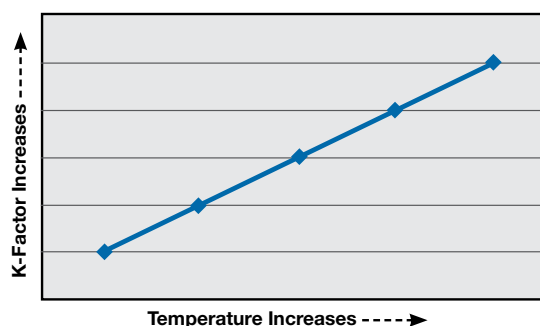
- CFC-11: ~6.3°C (43.4°F)
- Isopentane: ~22°C (71.6°F)
- HCFC-141b: ~11°C (51.8°F)
- HCFC-123: ~8°C (46.4°F)

Condensation of a blowing agent is noticeable when there is an upward inflection in the thermal conductivity as temperature is lowered. For example, a study¹ done on CFC-11 foams shows thermal conductivity results with an upward inflection at 6.3°C (43.4°F); this increase in thermal conductivity was attributed to the blowing agent changing from its gaseous form into a liquid. This phenomenon is illustrated in the graphs below:

Condensation Point



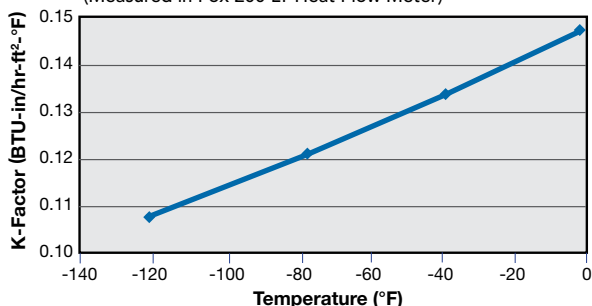
No Condensation Point



Ecomate® blowing agent and family of polyurethane foams do not have this thermal insulating limitation. Third-party testing has shown that condensation does not occur at temperatures as low as -85°C (-121°F). The graphs below show third-party and laboratory results for a typical ecomate® polyurethane foam system.

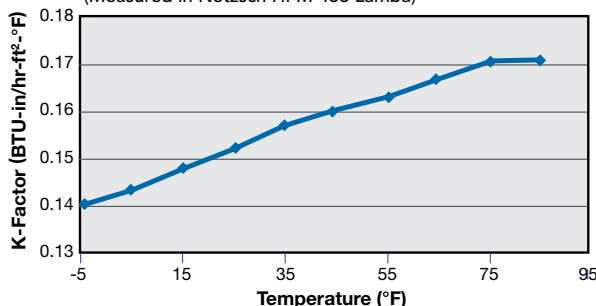
Third-Party Testing

(Measured in Fox 200 LT Heat Flow Meter)



Thermal Conductivity Profile

(Measured in Netzsch HFM 436 Lamba)



The data graphs show a linear relationship between thermal conductivity and temperature; as temperature decreases, so does the foam's thermal conductivity.

So what does this mean for ecomate®-blown foams? Knowing that ecomate® does not condense at temperatures as low as -85°C (-121°F), it is no surprise that it is the blowing agent of choice for many low temperature applications, where insulation performance is paramount. Foam Supplies' ecomate® foam products provide a solution that others cannot offer because of blowing agent condensation issues. This is yet another advantage that proves the versatility and superiority of the ecomate® technology. It should be noted that if ecomate is blended with another blowing agent, condensation may occur. Contact FSI for details on co-blowing with ecomate.

References:

- ¹Kumaran, M. K., Bomberg, M. T., and Marchand, R. G., "A Method for Evaluating the Effect of Blowing Agent Condensation on Sprayed Polyurethane Foams." *CFCs & The Polyurethane Industry 2* (n.d.): 84-90.
- ²Bogdan, Mary. "Enovate™ 3000 Blowing Agent - A Versatile and Cost Effective Blowing Agent Technology for Rigid Foam." *4th International Blowing Agents and Foaming Processes Conference*. Proc. of Blowing Agents and Foaming Processes. N.p.: Rapra Technology, 2002. 65-76. Web
- ³DuPont. *Temperature Effect on the Insulation Value of Polyurethane Foams*. N.p.: DuPont Fomacel® Foam Expansion Agent, 2011. *Technical Information ABA-14*. Web. <http://www2.dupont.com/Formacel/en_US/assets/downloads/h54876_temperature_effect_on_R_value.pdf>.