The History of Blowing Agents

The original blowing agents were chlorofluorocarbons (CFCs), which offered excellent thermal efficiencies. But CFCs destroy ozone molecules when they break down. This is referred to as a blowing agent’s Ozone Depletion Potential (ODP). Because of their high ODPs, CFCs have long been banned in the U.S. and nearly worldwide through the Montreal Protocol.

In the 1990s, the second generation of blowing agents were introduced: HCFCs (hydrochlorofluorocarbons). HCFCs offered lower ODP, but also provided reduced thermal values. Continuing concern over ozone depletion led to the phase out of HCFCs in most developed countries.

One of the challenges facing HVAC and refrigeration equipment manufacturers today is the continual need to increase energy efficiency. And one of the ways to do that is with better insulation, rather than more insulation (in thicker walls). That’s why more and more manufacturers are turning to polyurethane foam over legacy materials like fiberglass, rock wool and others. The R-value per inch of polyurethane is far superior to other options. (See Table 1).

However, all polyurethanes are not alike. What separates them is the foam blowing agent, which produces the foam’s cellular structure and provides the insulation value (See Table 2). During manufacturing, the blowing agent expands the liquid polyurethane chemicals, enabling them to fill cavities of any shape or size before solidifying into a rigid foam.

As with refrigerants, blowing agents have changed over the years due to their impacts on the environment. Today, the industry is undergoing dramatic changes as the world transitions away from hydrofluorocarbons (HFCs) in both refrigerants and blowing agents.
The early 2000s brought about the third generation of blowing agents, HFCs (hydrofluorocarbons), which have no ODP. However, HFCs again reduced thermal efficiency compared to earlier blowing agents. Plus, it was later found that HFCs contribute to global warming. Due to their high Global Warming Potential (GWP), HFCs (blowing agents and refrigerants) have been targeted for phase out by a long list of organizations and governments.

Eliminating HFCs

Current global agreements such as the Kigali Amendment to the Montreal Protocol (already ratified by 65 countries) and the Paris Climate Agreement call for the phase out of HFCs. In the U.S., HFC regulation has currently stalled since the 2015 EPA rule that would have eliminated HFCs was overturned in the courts.

However, while we wait for federal regulation, the U.S. states are beginning to take action against HFCs on their own. On January 1, 2019, California enacted a law which adopts the previous EPA rules for phasing out HFCs. The law sets a deadline of January 1, 2020 for the elimination of HFCs from HVAC, refrigeration and appliance foams. The law applies to all products made in – and shipped into – the state. So, manufacturers that want to sell into the nation’s most populous state have less than one year to completely transition away from HFCs.

In addition, four other states – New York, Maryland, Connecticut and Washington – have announced similar plans. These and another 13 states (and Puerto Rico) are part of the U.S. Climate Alliance, a bipartisan coalition of governors committed to reducing greenhouse gas emissions consistent with the goals of the Paris Agreement, which includes phasing out HFCs. U.S. Climate Alliance states represent 40% of the U.S. population and a $9 trillion economy.

Considering the U.S. state and international actions on HFCs, manufacturers that want to sell their products nationwide (or worldwide) will soon will have no choice but to use non-HFC blowing agents in their polyurethane foam. Fortunately, there are viable “fourth generation” options available now.

Fourth-Generation Blowing Agents

Fourth-generation blowing agents – with no ODP and greatly reduced or no GWP – now include three main options:

Hydrofluoroolefins (HFOs)

HFO blowing agents are the newest of the fourth generation blowing agents. While they offer potential, they are still unproven in “pour-in-place” applications used in HVAC/R. A widely reported issue with HFOs is in-situ acid formation, which has detrimental effects on catalysts and hence, shortens shelf-life stability. In addition, HFOs are more expensive than other blowing agents. Plus, their high molecular weights mean more blowing agent is required to achieve the same foam volume and density – further increasing costs. Finally, some HFOs have been found to produce trifluoroacetic acid (TFA), which bioaccumulates and could have a potential long-term environmental impact.
Hydrocarbons (HCs)

HCs such as cyclopentane, n-pentane and isopentane have low molecular weights and can offer lower costs than other blowing agents. But they also offer lower thermal efficiency than the other fourth generation options. In addition, they are highly flammable, requiring upfront investment in safety equipment. They are also volatile organic compounds (VOCs), meaning they produce smog.

Ecomate®

Ecomate, based on naturally occurring methyl methanoate and produced by Foam Supplies, Inc., has been in commercial use since 2002, making it a proven option. It offers excellent thermal properties (better than HFCs) and has a low molecular weight, so less quantity is required to reach needed densities – a major economic advantage. Ecomate, a liquid at room temperature, is flammable in its “neat” form, but not when blended into a polyurethane system – so no special equipment is needed. Ecomate is currently in use throughout the HVAC/R industry in FSI’s Ecofoam® insulating foam.

Conclusion

Polyurethane foams will continue to see increased usage in HVAC/R products due to their outstanding insulating properties and ability to meet increasing energy efficiency standards. Simultaneously, usage of HFC blowing agents will continue to decrease as state, federal and international regulations aimed at reducing global warming take effect.

As a result, polyurethane foams made with fourth generation blowing agents will be the only logical choices for manufacturers to meet both their thermal efficiency needs and environmental regulations. And with Ecomate-blown foams like Ecofoam, these companies can achieve their objectives without investing in new equipment or increasing their manufacturing costs.