

# Adoption of HFC-365mfc/HFC-227ea Blowing Agent Technology

Huntsman/Yangzhou Tonglee Reefer Equipment Co. Ltd

## Abstract

Yangzhou Tonglee Reefer Equipment Co. Ltd (Tonglee) is a famous reefer container producer in China. Currently, almost all the containers produced by Tonglee are exported. Since the establishment of the company in 1994, HCFC-141b has been the sole blowing agent technology for polyurethane foam used in the company. However, some zero ODP blowing agent technologies have been tried to replace the HCFC-141b during the last two years. Now, HFC-365mfc/227ea (93%/7%) accounts for nearly 15% of the total blowing agents used in Tonglee. Compared with cyclopentane and HFC-245fa, HFC-365mfc/227ea can be used with the same foaming equipment that uses HCFC 141b without any investment in the equipment. However, since the price of HFC-365mfc/227ea is about 5-6 times higher than that of HCFC-141b, the replacement is only limited to those containers whose foaming agent is specified as HFC-365mfc/227ea by overseas end users. Additionally, the customers must be prepared to assume the extra cost themselves. In order to reduce the cost of using HFC-365mfc/227ea and help accelerate the phase out of HCFC-141b, Huntsman, in collaboration with Tonglee, developed a polyurethane system that reduces the usage of HFC-365mfc/227ea by 20% without negative impact on processing and foam properties.

## Background

Ozone depletion ranks at the top of the ten biggest global environmental issues. Producing and using ozone depleting materials threaten the environment. In 2007, Parties to the Montreal Protocol agreed to accelerate the phase-out of HCFCs both in developed and the developing countries.

As one of the first companies in China to manufacture reefer containers, Tonglee has been using HCFC-141b as the blowing agent since its foundation in 1994. The foaming machine used is a high pressure foaming machine, KM RS-155. HCFC-141b is blended with polyol in a mechanical blender.

## Development of Alternative Blowing Agent Technologies

In the reefer container industry, the requirements from overseas end users for HCFC free blowing agents are the direct drivers for HCFC-141b phase out in China at present. The short-listed options of the blowing agents and their properties are shown in the table below:

	MW	Boiling Point (°C)	Thermal Conductivity (mW/mK)
Cyclo-pentane	70.1	49.3	11 @ 10°C
HFC245fa	134	15.3	14 @ 44°C
HFC365mfc	148	40.2	10.6 @ 25°C

## Development of HFC blowing technology

Because of the explosive properties of cyclopentane, companies using cyclopentane as a blowing agent must invest heavily in the equipment. Therefore, Tonglee ruled out the cyclopentane option. Since the boiling point of HFC-245fa is only 15.3 °C, a costly static mixer must be installed. Conversely, there is no need for equipment investment for HFC-365mfc/227ea. However, the material cost of HFC-365mfc/227ea is about 6-7 times more than that of HCFC-141b; therefore, HFCs are only used when end users specifically require it.

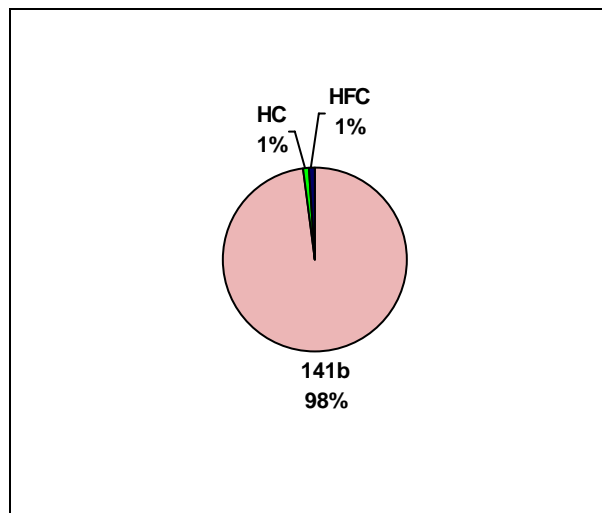
Using HFC-365mfc/227ea as a blowing agent technology is costly. As compared to HCFC-141b blowing agent technology, this novel technology means US\$721 per Forty-foot Equipment Unit (FEU) cost increase – i.e., 60% cost increase in foaming material cost. Huntsman, together with Tonglee, developed a new polyurethane system that reduces the usage of HFC-365mfc by 20%, without negative impact on

processing and foam properties. Although this means more MDI usage when less blowing agent is used, the quantity of MDI increases only 4%, and total material cost in every FEU decreases by nearly 8%.

**Blowing Agent Technologies Cost Analysis**  
(Assuming an FEU uses 550 kilograms PU material)

Blowing Agent	Boiling Point (°C)	Mixing ratio (per 100 pbw polyol)	Foam density (kg/m <sup>3</sup> )	Blowing agent price (US\$/kg)	Blowing agent cost per FEU (US\$)	MDI/Polyol, cost per FEU (US\$)	Total cost per FEU (US\$)
HCFC-141b	32	25	40-45	2.14	120	1,085	1,205
HFC-365mfc /227ea (93/7)	30	Reference system : 24	40-45	15.4	836	1,090	1,926
		Huntsman system : 19	40-45		659	1,118	1,777

Now, the replacement of HCFC-141b with HFC-365mfc/227ea is mainly required by European end users. Although HCFC-141b alternative technologies are being increasingly used over the last two years, the percentage of alternative technologies is still low compared with that of HCFC-141b. In 2007, Tonglee used 71 t of HCFC-141b and 12 t of HFC-365mfc/227ea. The pie chart below presents the 2007 usage of blowing agent technologies in reefer container industry in China.



**Impact of Switch to HFC 365mfc/227ea**

Although there are no equipment costs associated with the switch from HCFC-141b to HFC-365mfc/227ea, the high material costs are a barrier to the transition. As a polyurethane raw material supplier, Huntsman has been continuously contributing to the cost reduction in HFC-365mfc/227ea blowing technologies. However, even an optimized system blown with HFC-365mfc/227ea will be much more expensive than a HCFC-141b blown system. Most of this cost penalty will have to be borne by reefer container manufacturers or their customers. Significant reduction in the cost of using HFC-365mfc/227ea blowing technology is the key to the proliferation of this technology.

Some large reefer container manufacturers choose cyclopentane to replace HCFC-141b, as they have better economy scales and are more capital-capable to invest in the equipment required for cyclopentane. Currently, in most cases, the direct driver is the requirements from end users in the overseas market. The requirements of end users are fundamentally determined by the local regulations or their own financial capabilities.

As we can see from the case of Tonglee, the replacement of HCFC-141b requires combined efforts from all parties, including relevant government bodies, blowing agent manufacturers, polyurethane material manufacturers, reefer container manufactures and end users.

It is estimated by China's *Environmental Protection Administration* (soon to become the *Ministry of Environmental Protection* as a result of the recent National Council restructuring), that after the phase out of CFC-11 in 2007 in China, the consumption of HCFC-141b will increase at a rate of approximately 20% per year over the next few years. Therefore, it will be a big challenge for China to phase out HCFC-141b by 2030.

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**Background Information of Yangzhou Tonglee**

Yangzhou Tonglee Reefer Equipment Co., Ltd is one of the largest production bases of special containers in the world. The total investment is close to US\$25 million and the annual production capacity is 15,000 units including 10 suites of products: portcabins, cold storage, containers for Australia, containers for Japan, containers for the Army, 45'PW reefer & curtainside, bulk containers, Swapbody, Power-Gen containers, and Reefer trucks.