

# Insulation in commercial refrigeration using water-blown PU Foam in the Islamic Republic of Iran

For most commercial refrigeration applications water-blown foams are the optimal solution having a zero ODP (ozone depletion potential) and a zero GWP (global warming potential).

## Background

The accelerated phase-out of HCFCs (hydrochloro-fluorocarbons) in Article-5-Countries according to the Montreal Protocol on Substances that Deplete the Ozone Layer reopens the chapter on the selection of a suitable blowing agent as alternative to the commonly used HCFC-141b.

In contrast to the domestic refrigeration sector, the commercial refrigeration sector mainly produces tailor-made equipment. Manufacturers of commercial refrigeration units are predominantly small- and medium-sized companies, whereas producers of household appliances are often multinationals having huge operating sites.

Both the insulating foam, as well as the overall performance of the refrigerators, are important aspects to save energy and to reduce greenhouse gas (GHG) emissions. The Islamic Republic (IR) of Iran has been a frontrunner in the phase-out of CFC and is now starting the implementation of project activities under the HCFC Phase-Out Management Plan (HPMP). The current project is part of a range of broader activities under the HPMP assisted by GIZ Proklima. GIZ is a bilateral implementing agency commissioned by the German Ministry for Economic Cooperation and Development supporting the IR Iran in implementing the provisions of the Montreal Protocol in the foam sector.

## Project Description

During the preparation of the HPMP for the commercial sector in the IR Iran, it was discovered that conversion to another blowing agent (e.g. the climate-friendly pentane) was not feasible due to the following reasons:

- The commercial appliances produced are tailored according to the needs and full production automation is impossible.
- The safe implementation when using flammable blowing agents is difficult due to the high extent of manual workmanship.
- The company's focus is mechanical workmanship and not foaming or processing technology.
- The consumption of foam is too low for the high investments needed for the safety equipment and their maintenance.

Considering the above and the need for an immediate freeze of HCFC consumption in these companies, GIZ Proklima teamed up with the chemical company BASF Polyurethanes (Lemförde-Germany), who entered the project as technology provider for verification tests of the performance of water-blown foam systems. These systems are polyurethanes, whereby the blowing effect results from the reaction of water inside the polyol component with the isocyanate component where CO<sub>2</sub> is built. It is purely chemically blown foam, without the use of any physical blowing agents (e.g. HCs, HFCs, HCFCs, etc.). These systems have been well known for quite some time and recent developments on improved physical properties gave reason to revive this technology. Water-blown foams are cost-neutral and producer-friendly compared to the available existing technologies (at the customers' sites). Water-blown foams are highly recommended for the commercial refrigeration sector due to their simple application, low capital investment costs and environmental benefits. Furthermore, when applying water-blown foam, there is no need to engage in expensive end-of-life recycling methods or processes. The Iranian company Freidooni, a producer of commercial refrigeration appliances, participated in the project and provided commercial freezer display cabinets with glass doors for the investigations and trials (see Figure 1).

The project partners manufactured a whole set of freezers with the scope of:

- Verifying the state-of-the-art (so-called business-as-usual (BAU)) appliances;
- Optimising the foaming process with HCFC to prove the potential benefit of the project;
- Introducing the water-blown foam;

The manufactured refrigerators were tested (so-called Reverse Heat Leak (RHL) tests) at the facilities of the "Institut für Technische Thermodynamik und Kältetechnik (KIT)" of the University of Karlsruhe, Germany. The institute provided an independent verification of the performance of the foam used.

In the laboratories of BASF the foam was tested with regards to the mechanical and physical properties and an expert of GIZ Proklima verified the performance of the refrigeration cooling system.

The results demonstrate that the water-blown foam is a useful alternative solution to substitute HCFC-141b. The physical and mechanical properties are in the range of the former used HCFC-141b system. The thermal conductivity values are slightly above the HCFC-141b level as expected. However, the RHL data shows no difference at all.

For designs of commercial refrigerators and freezers with doors/lids containing PU foam (no display cabinets with glass doors/lids), a measurable difference in RHL performance is expected. An energy-neutral HCFC phase-out of insulation foams in those cases is easily achievable through:

- Improved door design
- Redesigned cooling system

The conclusion of the intensive investigations is that for most commercial refrigeration applications water-blown foams are the optimal solution having a zero ODP and a zero GWP.



Figure 1:  
Selected display cabinet from Freidooni

Deutsche Gesellschaft für  
Internationale Zusammenarbeit (GIZ) GmbH

Programme Proklima

Dag-Hammarskjöld-Weg 1-5  
65760 Eschborn, Germany  
T + 49 61 96 79 - 1022  
F + 49 61 96 79 - 80 1022  
E [proklima@giz.de](mailto:proklima@giz.de)  
I [www.giz.de/proklima](http://www.giz.de/proklima)

## Project Impact

The environmental benefits of water-blown foams are huge: per appliance unit (commercial refrigerator vertical display with a gross volume of 690 litres), 885 grams HCFC-141b can be reduced. This equates to 97.4 ODP kg and 641.7 t CO<sub>2</sub>-equivalent (over the life-time of the unit; energy costs for disposal at the end of life are not included).

The use of water-blown foams has, however, a much higher impact if other application segments, such as water heaters, transport cooling, thermo ware, etc. are considered.

With the completion of these activities and verification of the results, activities will be addressed to inform the commercial sector in Iran in order to build capacity for the supply chain.

Water-blown foam technology is an excellent solution for the commercial refrigeration sector, whilst hydrocarbons have been identified as the best solution for the domestic refrigeration sector.



Figure 2: Foaming mould of the cabinet at Freidooni

Title Insulation in commercial refrigeration using water-blown PU foam in the Islamic Republic of Iran

Country Iran

Sector Foam

Objective Introducing water-blown foam

Target Group Manufacturer of commercial refrigeration appliances

Project Executing Organization BMZ (German Federal Ministry for Economic Cooperation and Development)

Implementing Partner Organization Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH; IR Iran; National Ozone Unit

Project Approval November 2010

Project Duration 12 months

Project Budget USD 50,000

Funds BASF co-funding by 20,000 €

Impact on Ozone Layer and Climate Protection

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Contact Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Programme Proklima, Dag-Hammarskjöld-Weg 1-5, 65760 Eschborn, Germany  
Email: [bernhard.siegele@giz.de](mailto:bernhard.siegele@giz.de)