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Multilateral Fund
for the Implementation of the Montreal Protocol

LOW COST OPTIONS FOR HYDROCARBONS AS FOAMING AGENT IN THE MANUFACTURE OF POLYURETHANE FOAMS

Direct Injection HC Dispenser

Demonstration Projects on Alternative Technologies that Minimize Environmental Impacts

After the Montreal Protocol was adjusted in 2007 to accelerate the phase-out of HCFCs, Parties were encouraged to promote the development and the availability of alternatives to HCFCs that minimize environmental impacts, particularly for those specific applications where such alternatives are not presently available and applicable.

The decision of the Meeting of Parties to the Montreal Protocol (decision XIX/6, 2007) encourages Parties to promote the selection of alternatives to hydrochlorofluorocarbons (HCFCs) that minimize environmental impacts, in particular impacts on climate, as well as meeting other health, safety and economic considerations.

The Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol (Executive Committee) in its decision 55/43 has agreed on the importance of approving a limited number of projects in Article 5 countries to demonstrate emerging technologies in various industrial processes under local conditions.

Therefore, since 2007 the Executive Committee approved such demonstration projects in different sectors, mainly foam, refrigeration and air conditioning.

UNDP has been at the forefront of demonstration projects since 1992 and is implementing demonstration projects in all regions and all sectors. UNDP is assessing relatively new technological developments that have not or scarcely been used in developing countries. This task is conducted on behalf of and financed by the Multilateral Fund for the Implementation of the Montreal Protocol (MLF).

UNDP has been at the forefront of technology demonstration projects to replace ozone-depleting substances since 1992 and has been implementing demonstration projects in all regions and all sectors. UNDP is assessing relatively new technological developments that have not or scarcely been used in developing countries.

LOW CARBON TECHNOLOGY TRANSFER IN THE FOAM SECTOR

One of the challenges the foam producers are facing is how to convert the production technology to the one which would use the blowing agents with zero ozone depleting potential (ODP) and low global warming potential (GWP). This conversion would not only ensure that the countries are fulfilling their obligations under the Montreal Protocol but also lead to considerable reduction of greenhouse gas emissions thus mitigating the climate change

At the request of national counterparts and with financial support from the Multilateral Fund for the Implementation of the Montreal Protocol (MLF), UNDP has been implementing pilot projects in Brazil, China, Colombia, Egypt, Mexico and Turkey to assess the viability of different climate-friendlier alternatives to blowing agents used in the polyurethane (PU) and Extruded Polystyrene (XPS) production. As a result of these demonstration projects developing countries will be able to access the range of state-of-the-art and environmentally-friendly technologies tested under local conditions. For the PU foam and XPS sectors, assessments are being conducted for super-critical CO_2, methylal, optimized hydrocarbon technologies, CO_2 with methyl formate co-blowing and HFO-1234ze.

Demonstration of low cost options for hydrocarbons as foaming agent in the manufacture of PU foams

Low cost options for the use of Hydrocarbons (HC) as foaming agents in the manufacture of PU Foam were studied as part of a demonstration project in Egypt. The project was approved at 58th meeting of the Executive Committee in July 2009. The objective of this project was to develop, optimize, and disseminate low-cost systems for the use of hydrocarbons in the manufacture of PU rigid insulation and integral skin foams.

This particular pilot project has been executed in Egypt with assistance of an equipment manufacturer and a systems manufacturer.

The objectives of this project were to:

- Develop, optimize and validate low cost options for hydrocarbons as auxiliary blowing agent in polyurethane foam applications;
- Demonstrate the validated technology in a representative amount of downstream operations,
- Transfer the technology to interested system houses and other users.

As a result of these demonstration projects developing countries will be able to access the range of state-of-the-art and environmentally friendly technologies tested under local conditions

Left: Control cabinets
Right:Cyclopentane pump

Project description

This project was different from other pilot projects concerning HCFC replacements in polyurethane foams. In other projects the technology to be validated was a new one, which required development of formulations for all foam applications. In this case the technology already existed for quite a while—since around 1992—and was broadly applied in an A5 context in companies that would meet a critical size and technical proficiency. In praxis this meant that a company should use at least 50t of ODSs and have in-house engineering capabilities to be considered eligible by MLF for this technology.

The use of hydrocarbon technology has not materially changed over the last decade. It requires costly pre-blending equipment, an explosion-free area and special safety procedures. Also, in many countries the systems are unchanged while in Europe significant system optimization has taken place (additives, special polyols, co-blending). UNDP saw options for cost reductions in three areas:

- preblending at supplier level would delete the need for a preblender plus auxiliaries—but cause some increase in the system price;
- direct injection of hydrocarbons would also remove the need for a preblender but increase the equipment cost somewhat;
- the introduction of modern HC blends would allow for lower densities—along with the above-mentioned options and also lower in this way the current operating costs.

To test the feasibility of these concepts, the development and commercialization of stable pre-blends that can be safely transported and three-component production equipment was required, in addition to the introduction of modern HC blends.

Project implementation

The project was implemented through four steps.
Following concrete actions were planned:

1. System Development
2. Equipment Development
3. Trials at a Foam Plant
4. Validation which included emission/worker exposure monitoring, design of a safety system and safety procedures, validation of the outcome of the project and holding of an information dissemination inter-regional workshop.

The project's implementation was substantially completed in 2011 with complementary follow-up studies scheduled and authorized by the Executive Committee in 2012.

3-Way Mixing Head

Project results

Tests were carried out with direct injection and pre-blended polyols. The tests showed that

For pre-blended cyclo-pentane:

- Pre-blended cyclopentane systems are sufficiently stable and can be commercially used. It is recognized, however, that the shelf life will also be dependent on a specific formulation of a system, therefore needs to be checked for each individual system, and that supplier's storage recommendations need to be followed;
- As no preblender along with its auxiliary equipment (tanks, piping, etc) is needed, cost savings of around US$ 100,000 can be expected at each facility;
- Based on lower comparable (to HCFC-141b) free rise densities, incremental operational costs savings of 5.6 % (water heaters) and 7.9 % (commercial refrigeration) can be expected up and above the customary difference based on the price of cyclopentane compared to HCFC-141b. However, more research is needed to confirm this. If confirmed, the overall difference in operating costs is estimated between 6 and 8%.
- Insulation values are 5-8% better than for HCFC-141b foams but equal to conventional cyclopentane foams.

Extraction from brett mold

For pre-blended normal-pentane

- Preblended normal-pentane systems are stable for less than a month and therefore not recommended for commercial use.

For directly injected hydrocarbons

- In this case normal-pentane as well as cyclo-pentane can be used;
- However, the k-factor in case of normal-pentane is more than 11% higher than for HCFC-141b formulations, making its use in very critical formulations such as refrigeration and other appliances anyway undesirable;
- Equipment developed for this purpose shows good reproducibility and consistency as well as homogenous mixtures, despite higher polyol viscosities;
- Slightly higher k-factor and lower reactivity show that the mixer head impingement has suffered from the introduction of a third stream. While improvement could be made with an optimized catalyst package, redesign of the mixing head should be considered as well;
- Because of minimized blowing agent losses, densities are even lower than for preblended cyclopentane;
- No preblender along with auxiliary equipment (tanks, piping, etc) is needed but the need for a third dosing line might absorb most, if not all of these savings;
- Based on lower comparable densities, incremental operational costs savings of up to 10% can be expected up and above the customary difference based on the price of cyclopentane compared to HCFC-141b. The overall difference in operating costs is estimated to be up to 10%. No additional transportation costs will apply in this case. This statement still needs, as mentioned before, confirmative trials.

CONCLUSION

The substantive technology report describing these results was issued to the 66th meeting of the Executive Committee, and adopted in April 2012. Both options that are emerging from the project—preblended cyclopentane systems and direct HC injection—have been selected for ODS phase-out projects in Brazil and Egypt. The findings of the demonstration project show that further mixing head optimization will assist in enhancing the foam densities and reduce operational costs.

Complete report can be downloaded at ***http://www.undp.org/content/undp/en/home/librarypage/environment-energy/ozone_and_climate/Demoprojectsreport.html***

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