Multilateral Fund
for the Implementation of the Montreal Protocol

OBJECTIVE

To develop, optimize, validate and disseminate low-cost systems for the use of hydrocarbons (HCs) in the manufacture of polyurethane (PU) rigid insulation and integral skin foam

DEMONSTRATION OF LOW-COST OPTIONS FOR THE USE OF HYDROCARBONS IN THE MANUFACTURING OF POLYURETHANE FOAM

Project title	Validation/Demonstration of low-cost options for the use of hydrocarbons as foaming agent in the manufacture of polyurethane foam
Country	Egypt
Agency	UNDP
Sector	Foam
Subsector/application	Polyurethane (PU) foam: rigid and integral skin foam
Enterprise/ systems house	SAIP/Pozzi-Ariozo
Baseline technology	HCFC-141b
Alternative technology	Cyclopentane, n-pentane
GWP (alternative technology)	Negligible
Potential safety issues	Flammable
ODS phase-out (mt)	0
ODS phase-out (ODP tonnes)	0

DESCRIPTION

The project identified options for cost reduction by:

1) Pre-blending at the supplier level which would avoid the need for a pre-blender plus ancillary equipment (e.g., storage tanks, piping)
2) Direct injection of HCs, which also removes the need for pre-blender systems
3) Introducing more recently developed HC blends, which would allow for lower foam densities.

The project was implemented with the assistance of SAIP/Pozzi and Dow in Italy and Egypt. The project was executed in three steps:

1) Equipment Development: A three-module high-pressure dispenser capable of processing fully formulated systems, direct injection of flammable as well as non-flammable blowing agents selected through standard procurement procedures by a qualified equipment supplier
2) System Development: Six different systems were used (three HCFC-141b-based and three HC-based) for trials at a local foam manufacturer or systems house
3) Information dissemination through inter-regional workshop.

RESULTS

The project produced the following results:

1) Physical and chemical stability of cyclopentane systems under standard conditions for up to six months was confirmed. Normal pentane systems were not stable beyond one month
2) Savings in equipment were demonstrated by using pre-blended HCs. Although direct injection did not produce the same savings in the cost of equipment as pre-blending, the compact design for direct injection could result in savings in layout and storage
3) If the lower free density can be "translated" into lower applied density, operating savings of between 6 and 8% (or 10% with direct injection) can be expected, as compared to HCFC-141b systems. However, transportation costs may increase
4) Pre-blended HC showed a k factor that was 5 to 8% higher than that of HCFC-141b foam, but equal to conventional cyclopentane foam. Direct injection of n-pentane showed a higher k factor, leading to the conclusion that this substance should not be used in critical thermal insulation applications.

EXAMPLE OF RESULTS OF OVERALL PERFORMANCE ELEMENTS TESTED IN COMMERCIAL APPLIANCE SYSTEMS

System	A	B	B	B	B
HCFC141b (pbw on top of 100pbw polyol blend)	18,7				
c-pentane (pbw on top of 100pbw polyol blend)		13	15	13	15
Type of pentane addition		PRE-BLENDED		THIRD STREAM	
Reactivity CT, GT (sec)	7; 60	5; 52	4; 56	5; 59	5; 64
Free rise density (kg/m3)	25,2	23,5	22,9	22,7	21,9
Minimum fill density MFD (kg/m3)	34,1	31,3	30,3	30,5	29,9
Applied density (kg/m3)	37,8	34,6	33,5	35	34,6
Average density distribution	0,66	0,5	0,4	0,53	0,58
Compressive strenght CS (kPa)	167	136	137	129	127
k-factor 10°C	18,4	20	20,2	20,3	20,6
Adhesion as TBS (kPa)	140	178	191	163	138
Dimensional Stability +80°C (delta vol %)	<1%	<1%	<1%	<1%	<1%
Dimensional Stability -25°C (delta vol %)	<1%	<1%	<1%	<1%	<1%
Cycle time: post expansion % at 9' DMT (on 100mm thickness)	4%	2%	1,8%	1,6%	1,2%

COST ANALYSIS

Simplified safety requirements (less exhaust, less sensors and less piping) from pre-blended HC and direct injection compared to an in situ blended system could represent savings of between US $50,000 and US $100,000. With regard to capital and operational costs required for the end-user, in general, retrofits are lower in cost when taking the direct injection approach. However, when the entire dispenser has to be replaced, pre-blending is lower in cost. For end-users with low-pressure dispensers, retrofit would be feasible but would probably not provide the intense blending required for both pre-blends and direct injection.

CONCLUSION

The key conclusions of the demonstration project are the following:

1) Pre-blended cyclopentane systems are sufficiently stable and can be commercially used
2) Pre-blended n-pentane systems are unstable and not recommended for commercial use, except when they are used through a direct-injection system
3) Direct injection with cyclopentane can achieve the same effectiveness as pre-blended systems in view of density and thermal insulation when using optimized equipment
4) Any performance differences between polyols blended in situ and those blended in a systems house is most likely related to blending and handling operations with the systems houses being more precise
5) The use of pre-blended HCs or direct injection could represent capital savings to enterprises converting from HCFC-141b
6) Both pre-blending and direct injection allow for a simplified safety system, requiring less exhaust, less sensors and less piping due to the absence of a pre-blender.

FINAL REPORT AND SECRETARIAT'S COMMENTS

http://www.multilateralfund.org/66/English/1/6617.pdf
(paragraphs 120 to 134)
http://www.multilateralfund.org/75/English/1/7520.pdf
(paragraphs 48 to 57 and Annex III in page 31)