

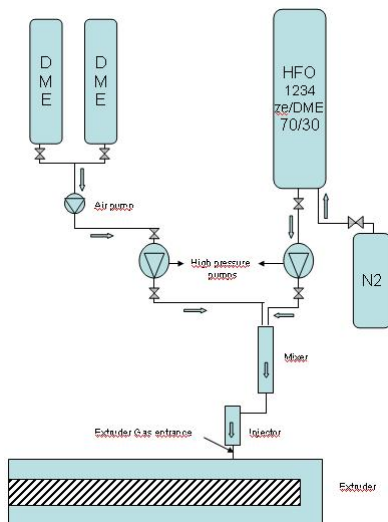


# Multilateral Fund

for the Implementation of the Montreal Protocol

## OBJECTIVE

To validate the use of HFO-1234ze as a blowing agent in the manufacture of extruded polystyrene (XPS) foam boardstock



## DEMONSTRATION OF HFO-1234ZE AS A BLOWING AGENT IN THE MANUFACTURE OF EXTRUDED POLYSTYRENE FOAM BOARDSTOCK

Project title	Validation of use of HFO-1234ze as a blowing agent in the manufacture of extruded polystyrene foam boardstock
Country	Turkey
Agency	UNDP
Sector	Foam
Subsector/application	Extruded polystyrene (XPS) foam
Enterprise/systems house	Bursa Plastic Corporation (B-Plas), Metal ve Turizm San. Ve Tic. A.S. (B-Plas)
Baseline technology	HCFC-22/HCFC-142b
Alternative technology	HFO-1234ze/DME
GWP (alternative technology)	Negligible
Potential safety issues	HFO-1234ze is non-flammable. DME is flammable
ODS phase-out (mt)	0
ODS phase-out (ODP tonnes)	0

## DESCRIPTION

The project was implemented at the facilities of Bursa Plastic Corporation (B-Plas) and additional testing was conducted at a certified laboratory. Trial products were continuous planks of 30 mm x 600 mm and 40 mm x 600 mm. For cost and processing reasons, HFO-1234ze was blended with DME by the supplier. At a later stage, DME was directly injected as a co-blowing agent. The assessment addressed the following:

- Health, safety and environmental considerations
- System processability
- Physical properties of the products obtained from trials, including thickness, density, cell size, compressive strength, lambda value, flammability, and dimensional stability
- Additional trials on compressive strength after 10 days, 20 days and 30 days, lambda values after 10 days, 20 days and 30 days, and dimensional stability (1 bundle of each sample).

- Indicative cost of conversion for introduction of the technology.

## RESULTS

Health, safety, environment: HFO-1234ze is a non ODP/insignificant GWP substance with low toxicity, non-flammable and valid for XPS applications. DME is flammable and proper precautions need to be incorporated.

System processability: HFO-1234ze needs to be shipped in pressurized containers (1,000 kPa or 10 Bar), identical to those used for CFC-11, HCFC-142a and HCFC-22. It is stable for at least one year when kept out of sunlight and at room temperature (<250 C). The solubility of HFO-1234ze in the polymer blend requires incorporation of a co-blowing agent—which reduces the insulation performance. The flammability of the HFO-1234ze/DME blend requires process safeguards.

Foam properties: HFO-1234ze-based XPS foams match HCFC-based and HFC-based foams in insulation properties and structural properties. HFO-1234ze needs 50% co-blowing with DME for acceptable processing. If this proportion can be reduced, it is expected that the insulation properties of HFO-1234ze will be superior to other HCFC alternatives and could match those of HCFC-142b/-22. The resulting foam from the assessment trials requires surface and density optimization to be commercially acceptable. The amount of co-blowing agent and the extruder could influence processing and cell structure. Further trials would be needed on different equipment to assess the impact of the extruder.

### COMPARATIVE TEST RESULTS FOR BLOWING AGENTS USED IN TURKEY BOARDSTOCK

Tests	Standard	Unit	80/20%	70/30%	50/50%	75/25%	50/50%	75/25	Standard Requirement
			HFO1234ze /DME	HFO1234ze /DME	HFO1234ze /DME	152a /DME	152a /DME	142b/22a	
			Mar-2011	Mar-2011	Dec-2011	Mar-2010	Sep-2011	Jul-2004	
Length	TS EN 822	mm	1201	1201	1201	1200.3	1200	1250	*1200
Width		mm	599	573	601	598	600	603	*600
Thickness		mm	28.6	31.7	30.6	31.6	29.8	30.7	*30
Density	TS EN 1602	kg/m <sup>3</sup>	44.2	38.6	35.0	33.8	29.8	32.0	*30– 32
Thermal conductivity 90 days	TS EN 12667	W/mK	0.034	0.029	0.030	0.035	0.032	0.028	*0,029-0,031
Aged Thermal conductivity 90 days			0.033	0.029	0.031	n/a	0.032	n/a	
Compressive strength 45 days	TS EN 826	kPa (N/m <sup>2</sup> )	380	276	298	257.4	250	248.36	*>=200
Flammability	TS EN ISO 11925-2	-	E	E	E	E	E	B1	E
Open cell ratio		%	31.69	3.41	10	-	-	-	No value

\*Depends on producer declaration

## **COST ANALYSIS**

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HFO-1234ze is non-flammable and can be used with the same equipment as HCFC-142b/HCFC-22. However, the large amount of DME as co-blowing agent will make the blend flammable. Capital conversion costs were estimated at around US\$ 200,000. A preliminary operating cost analysis indicates a substantial increase of up to 21% compared to using HFC-152a/DME 50/50. An assessment of operating costs could not be completed because of lack of data.

## **CONCLUSION**

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Based on the validation data collected so far, HFO-1234ze technology is believed to have good prospects for replacing the use of HCFCs and/or high-GWP HFCs in XPS applications while providing acceptable thermal insulation and structural properties. However, to make such a product commercially acceptable, some optimization of density and surface (pinholes) would be required.

Based on the current trials, HFO-1234ze needs 50% co-blowing with DME to be acceptable in processing. The solubility of the blowing agent could also be addressed by retrofitting the extruder. Trials with different proportions of HFO-1234ze and DME would provide the manufacturer with a choice between the best insulation (highest amount of HFO) and best cost price (highest amount of DME).

## **FINAL REPORT AND SECRETARIAT'S COMMENTS**

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<http://www.multilateralfund.org/67/English/1/6706.pdf>  
(paragraphs 69 to 75 and Annex VII in page 102)