Annex 3: STAP Technical Review

Introduction

This technical review encompasses consideration of the issues of the reduction of energy-efficiency brought about by the replacement of CFCs in refrigerators and of the measures which are proposed in this project to remedy this situation. The scope of the project is presumed to cover both types of domestic "cold appliances" - that is, refrigerators and freezers plus the popular combination units.

Energy-Efficiency of CFC Replacement Technology

Prior to the Montreal Protocol the use of CFCs had been almost universal in domestic refrigerators. CFC 12 was the compressor gas and CFC 11 performed the important role of being the foam blowing agent and the gas in the cells of the insulating foam. In the latter function polyurethane rigid foam had almost universally replaced glass fibre.

In China, the rapidly expanding refrigerator-producing industry had been using these two compounds since the comparatively recent birth of the industry. The replacement programmes in China have involved the following:

CFC 12 is being replaced, in the main by HFC 134a. The newer alternative of iso butane, which is now widely used in Western Europe is also being used in China including by those enterprises who export to Europe. Neither is available from domestic production but iso butane of the required purity could be made available quite readily. There has been a heated debate between the proponents of the two replacement technologies as to which gives the better energy-efficiency. One point emerging is that the compressor has to be modified around the thermo-dynamic characteristics of the particular gas. That being done, the energy efficiency of the two options is similar and is then equivalent to that of CFC 12. Thus, the main measure, which is being addressed by this project, is to optimise the design of the compressor.

CFC 11 is being replaced by one of two options. The transitional technology using HCFC 14b is less costly to convert to and offers the better insulation efficiency. However, it will eventually have to be replaced since the phaseout of HCFCs is included in the Montreal Protocol. A hydrocarbon option, initially cyclopentane, is now being used by several of the larger Chinese enterprises. Despite the higher conversion costs, because of the precautions in the factory required to handle a flammable blowing agent, it is finding favour because it represents a long term solution.

Several Chinese enterprises also used "reduced CFC 11" foam formulations as an interim step in the period 1993 to 1995 before embarking on the change to either HCFC 14lb or cyclopentane from 1995 onwards. The complete changeover from CFFC 11 will take several more years for the entire industry to complete. However, all of these replacement technologies give a higher foam thermal conductivity which is translated into a higher electricity consumption. The increases in consumption are, typically 2-4% for HCFC 14lb and 4-6% for cyclopentane. The options to ameliorate this effect include increasing the thickness of the refrigerator walls as has been investigated by the US China Refrigerator

Project referred to in the project document (page 8).

This is considerable scope, when using CFC replacement technologies for both the compressor and the insulating foam, to achieve substantial savings in energy use. This has been demonstrated by the projects in China and by the actions of manufacturers in Europe, Japan and the USA. The paths they have followed are based on a combination of measures. These include the optimisation of compressor design, the improvement of door seals and increases in the foam thickness. The "green" market in Germany has resulted in several manufacturers producing models which attain the highest classification (class A) in the European Union system. In the USA there has been a "Green carrot" competition to develop energy-efficient technology. The use of vacuum insulating panels to further improve insulation efficiency has not, as yet, been widely applied by broader application is expected in the next few years as the EU (9/1999) and the USA (7/2001) introduce new, more stringent, energy standards.

Comments on the Proposed Project Activities

1) High-Efficiency Compressors

The activities listed are supported. Is there a need to license designs available elsewhere which have been optimised around the CFC replacement refrigerants?

2) Production of high-efficiency refrigerators

The activities listed are supported. The Chinese market is highly competitive - how will Haier's participation be seen by their competitors. In addition, with some knowledge of Haier's and CHEARI's technical resources - are these sufficient to role out a programme across the country?

3) Regulatory Requirements and Market-Based Incentives

The activities listed are supported. Regulatory requirements have already proven to be effective in the EU and the USA (combined with labelling). There is a lot of experience in these areas to draw upon- how will this be collected and used in China?

4) Creation of Market Conditions

These measures are supported. The labelling should have simple guide to energy consumption but also have provision for other parameter, such as noise. Consumer and retail staff education will be a critical element.

5) Monitoring and Evaluation

The measures are supported.
One element which is not covered is the provision of an efficient after sales or maintenance network to ensure that the energy-efficient refrigerators that are placed on the market continue to operate in such a manner. This may need a verification

programme for service engineer. The safety elements of servicing compressors in a market with three types of refrigerants (CFC 12, HFC 134a and iso butane) should be included in this.

SAFETY AND ENVIRONMENTAL ISSUES

The design studies should include TEWI (Total Equivalent Warming Index) analysis of new designs.

The removal from the market of the old models raises several issues. If they are to be destroyed then there should be a recycling facility in place to recover the CFC 12 from the compressor and, at lease some, of the CFC 11 from the foam to prevent these ozone depleting gases being emitted to the atmosphere. The best environmental option may be to refurbish these older units.

The safety issue relating to hydrocarbon-based compressor has been mentioned above.

The project addresses a key environmental issue. The impact of the electricity consumption of refrigerators has been well documented and is broadly recognised. In the case of China, the programme is of even higher priority because of the use of coal in power generation.

PROJECT COSTS

The project is cost effective to the GEF, especially taking into account the leveraging to be achieved through co-financing. The largest element is the Refrigerator Factory Technical Assistance. The implementation of the new energy-efficient designs in production is a key step and re-tooling costs are included in the $24 million of co-funding for this element. Is this sufficient and will this render some moneys already spent from the Montreal Protocol Multilateral Fund redundant? This represents an expenditure of the order of only 1 million per manufacturer.

The cost/benefit arguments are clearly displayed.

IMPLEMENTATION TIMEFRAME

The timeframe of five years should be achievable.

RECOMMENDATION

The project is supported.