ECO-COOL™

BULLETIN FOR REFRIGERATION TECHNICIANS

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Editorial

A hearty welcome to our readers! We expect that during this peak business time you will not have time for Eco-Cool, but do not miss the information contained in this special issue on hydro carbons, and particularly use of the blends now available in the Indian market from Hindustan Industrial Gases & Chemicals, New Delhi.

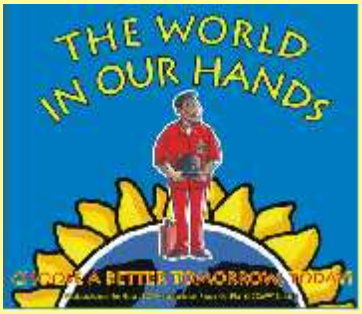
NCCoPP training programmes will be starting again in the month of August. Check the NCCoPP website or call the Regional Management Organisations for up-to-date information. Eco-Cool gives an update on the Equipment Support Scheme, the dates for the workshops in cities where the scheme is being promoted this year, and the dates scheduled for meeting our partners, the dealers of spares and refrigerants, who help us in promoting NCCoPP's objectives.

Please keep checking the NCCoPP website at www.nccopp.info for all new information or write to us at nccopp@itpi.co.in or tpm@itpi.co.in. We value your queries and feedback in every way.

Newsflashes from NCCoPP

We are delighted to announce that all NCCoPP-trained technicians (2004-2005) will shortly be receiving 50 stickers. Please use these stickers to promote your business, to advise your clients about protection of the ozone layer and publicize your skills as being trained to handle, service and retrofit appliances using alternative refrigerants.

NCCoPP is also proud to present the video "The World in Our Hands" in English and which has now been dubbed in 4 regional laguages (Bengali, Hindi, Malayalam and Oriya). This film will also be shortly circulated and will serve as a recruitment tool for technicians to sign up for the training as well as create awareness about the project.



Technicians Trained under NCCoPP (2004-05)

53	Andhra Pradesh	Madhya Pradesh	130
48	Assam	New Delhi	50
78	Bihar	Orissa	104
22	Chhattishgarh	Punjab	55
76	Haryana	Rajasthan	216
28	Himachal Pradesh	Tamil Nadu	44
59	Jammu & Kashmir	Uttar Pradesh	292
47	Karnataka	Uttranchal	29
174	Kerala	West Bengal	103

NCCoPP Contributes to the Phase-out of CFC in the RAC servicing sector by 2010 through:

- Targeting CFC-Consuming RAC servicing sector firms
- Encouraging good servicing practices for CFC-based appliances
- Training the servicing sector in handling new non-CFC technologies.

NCCoPP 2-day practical training programmes are scheduled from 2005-2009 and propose to cover:

- The CFC and ODS phase-out process
- Servicing new HFC-134a and HC-based refrigerators and other commercial appliance, including retrofitting.
- "Recovery & Recycling" (R&R) of CFC refrigerants
- Updates on technology and market changes, appropriate tools/equipment
- Best practices in servicing of Mobile Air-Conditioning (MAC)
- Retrofitting for large commercial appliances using open-type compressors, including retrofitting
- Good Servicing Practices and review of retrofit options for larger commercial applications that use Open Type Compressors;

All MSE domestic and commercial refrigeration service-sector technicians can apply for training. Specialised 1 day trainings will be held for MAC service Enterprises.

What You Say To Us

Dear Sir,

We use a two-stage rotary vacuum pump for evacuation in our workshop. But some technicians are seen using self-vacuuming in sealed unit systems. I think it is wrong to use self-vacuuming, because a capillary tube is drawn out through the condenser coil dryer outlet and this capillary tube is then left open in the atmosphere. When the system is started, high-pressure air is released from this tube which is sunk in a glass containing refrigeration oil by the technicians. If there are no bubbles, they are assured that the system has been vacuumed properly. After this, they pinch the capillary tube before stopping the system.

According to me, in this type of vacuuming, air remains in the condenser coil. This is the reason why problems like system choke-up occur in the future.

The craftsman trainees in our workshop do not want to take the vacuum pump with them when they go on fieldwork. They request us to allow them to do self vacuuming as other technicians do. But we compel them to use vacuum pumps. Please guide us on the reliability of self-vacuuming.

Yours sincerely

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Self-Vacuuming should never be done, as apart from not removing air entirely, it also does not remove moisture, which remains as free water in the system, though invisible to us. Further, self- vacuuming is also the surest way to destroy the compressor of the system as it causes lubricating oil to be pumped out, leading to reduction in oil and subsequent failure of the compressor. The process increases chances of condensation of moisture on the valve plates of the compressor and also possibly, burnout the hermetic motor due to inadequate motor cooling. The important of objectives of evacuation are to remove all non-condensible gases like nitrogen, oxygen, etc., as well as to remove moisture present as free water, which can be removed only when this water is boiled off by reducing the pressure through evacuation. Water boils at atmospheric pressure (14.7psia or 760mm or 760,000 microns of Hg) at 100°C and if it has to be boiled off and evacuated at 25°C, the pressure(or vacuum) has to drop to about 23,000 microns. For complete removal of moisture, the pressure has to drop to about 500 microns of Hg. For this a good two-stage oil sealed rotary vacuum pump is needed as also a vaccum gauge that can read in microns. Technicians just cannot escape from this process and resort to dubious techniques like self-vacuuming. Please guide your technicians accordingly.

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Dealers' Meets

Five Dealers' Meets are scheduled for this year and will commence in August 2005. These are as follows:

City: State	Date
Delhi	11 Aug. 05
Kolkata: West Bengal	13 Aug. 05
Bhopal: Madhya Pradesh	17 Sep. 05
Kanpur: Uttar Pradesh	23 Sep. 05
Udaipur: Rajasthan	15 Oct. 05

Update on Equipment Support Scheme

Under the equipment support component, NCCoPP seeks to facilitate access to service equipment for selected Refrigeration Service Enterprises. ESS is offered to eligible refrigeration servicing firms and interested RSEs have to submit Expression of Interest (EOI) with the necessary documents. The EOIs are further verified to confirm that the RSEs fulfil the criteria and based on this a consolidated list is prepared.

During the first phase of 2004-05, the Equipment Support Scheme was launched in the states of Andhra Pradesh, Karnataka, Tamil Nadu and Pondicherry. In all the three states the scheme was well-publicised through ESS workshops and through the print media. The response was overwhelming from all the three states. The total EOIs received were 468 of which 349 were complete and complying to the selection criteria. Equipment was offered to 136 RSEs and of the three packages available (A, B & C), Package A was the most sought after. ESS package details and prices are available on www.nccopp.info website.

ITPI as Principal Distributor will manage and assist UNDP in the distribution of service equipment to the RSEs. The responsibilities of the principal distributor would be to inform RSEs and collect the payment drafts of behalf of GTZ. The RSEs would receive the equipment as per the delivery schedule. Demonstration of the equipment would be given at the time of delivery and the equipment would have a guarantee of one year. RSEs from the states covered in the first phase have started depositing the drafts with the local distributor.

The second phase of ESS has begun in the states of Kerala, Maharashtra and Gujarat with ESS workshops. Six ESS workshops are underway in the second phase as per the table below and RSEs have started sending in their EOIs:

ESS Workshop Schedule

	Location: State	Cochin: Kerala	Mumbai: Maharashtra	Ahmedabad: Gujarat	Kolhapur: Maharashtra	Aurangabad: Maharashtra	Rajkot: Gujarat
1	Date	21-May-05	30-May-05	01-Jun-05	19-Jun-05	17-Jul-05	23-Jul-05
2	No. of RSEs participants	81	50	100	177		
3	State Facilitator	V. Vijayakumar	Abraham Mathew	Naranbhai Patel	Abraham Mathew	Abraham Mathew	Naranbhai Patel

Hydrocarbon Refrigerants

For decades Hydrocarbons (HC) have been used as refrigerants. Currently, these environmentally-friendly refrigerants are being re-introduced in certain applications due to their zero Ozone Depletion Potential (ODP) and negligible Global Warming Potential (GWP). Their efficiency is also slightly better, especially in the case of R-600a, than other leading alternative refrigerants. They are fully compatible with the lubricating oils conventionally used with CFC-12. Recent trends show that use of HC refrigerants is increasing globally, especially, in domestic refrigeration, small capacity commercial refrigeration appliances, and retrofitting of mobile air conditioning (MAC) inspite of their flammable characteristics.

Applications and Choice of Refrigerant

Although there are a large number of HC refrigerants which can be used for different applications the present article focuses on two commonly used refrigerants R600a(Isobutane) and a blend of R290 & R600a which are used in domestic refrigeration.

Isobutane (R-600a): Its volumetric refrigerating capacity is about 60% of that of CFC-12. The compressor used with R-600a is a new model with a higher displacement / motor combination. R-600a is generally used for domestic appliances, but sometimes also for very small commercial refrigeration appliances. It is never used for conversion/ retrofitting of existing CFC-12 or HFC-134a systems.

HC Blend (R290 & R600a): HC Blend (approx 50/50 by weight of Propane & Isobutane) has properties close to CFC-12; it gives the same capacity and operates at similar pressures. HC blend is being used by Godrej in its manufacture of domestic refrigerators, as well as in manufacturing of some commercial refrigeration appliances (e.g. ice cream freezers and water coolers). It is the refrigerant to use when converting (Retrofitting) existing CFC-12 based appliances and MAC.

Refrigerant Properties

The thermo-physical properties are provided in Table 1 below. More comprehensive data can be found in ASHRAE Handbook Fundamentals and at www.HIDECOR.com

HC refrigerants are simple compounds containing carbon and hydrogen and do not contain any halogens like chlorine, fluorine, etc. The refrigerants are non-toxic but highly flammable and completely miscible with commonly used mineral oils as well as PAG and POE. They have relatively high latent heat of vaporizations and low liquid density (about 1/3 of CFC-12), rendering them attractive in some applications.

The vapour pressure of Isobutane is much lower than that of CFC-12. However, the HC blend (R-600a/R-290) is mixed in such a proportion that it exhibits similar vapour pressures as that of CFC-12. Figures 1 and 2 show the vapour pressures of R-600a and HC blend alongwith CFC-12 and HFC-134a respectively, indicating that R-600a vapour pressures are much lower than CFC-12 and HFC-134a. The suction pressure in case of domestic refrigerators is lower than the atmospheric pressure and head pressures are also much lower than CFC-12 as well as HFC-134a. Isobutane

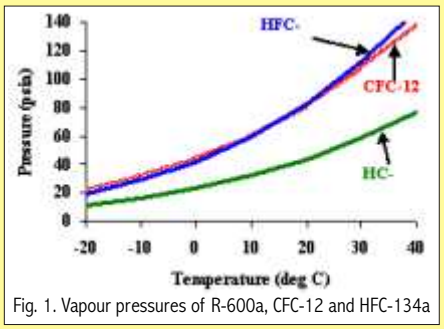

Fig. 1. Vapour pressures of R-600a, CFC-12 and HFC-134a

systems are reported to have lower noise levels by few dBs - a positive property when adopting R-

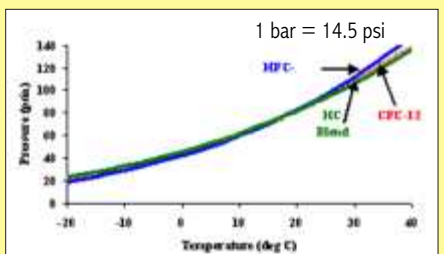

Fig. 2. Vapour pressures of HC blend (R-600a/R-290), CFC-12 and HFC-134a

600a as refrigerant for domestic refrigeration applications.

The HC blend vapour pressure is slightly higher at low temperatures than CFC-12 and HFC-134a, providing marginally higher capacity than CFC-12. Figure 2 shows that the condensing pressure is slightly lower than CFC-12 as well as HFC-134a, which is responsible for lower pressures ratio for a given application. The HC blends are well-suited as retrofit refrigerant to replace CFC-12 in existing appliances and MAC.

Blend Issues

The HC blend (R-600a/R-290) is a zeotropic mixture of two or more components, which evaporate (and condense) through a range of temperatures at a given pressure. The refrigerant is at the bubble temperature when it just starts to evaporate and is at the dew temperature when it

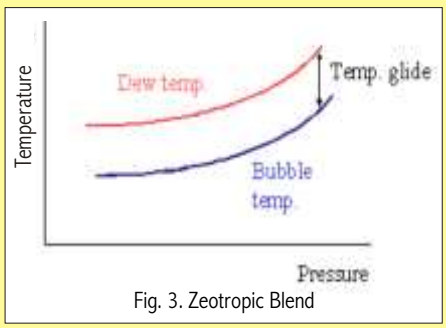

Fig. 3. Zeotropic Blend

begins to condense. The range of temperature between the dew point and the bubble point is called the temperature glide as shown in Fig. 3 for a particular blend composition.

The hydrocarbon blend has a temperature glide of approximately 8°C. As a result, uneven ice build-up may occur on the evaporator. This is not usually a problem. It is imperative that all zeotropic blends including HC blends be taken out from a cylinder as a liquid. This applies to both factory charging and servicing. If the refrigerant is taken from the cylinder in vapour (gaseous) form, the blend composition will not be accurate, as the vapour is richer in the high-pressure component of the blend. Further details can be found in the article "Refrigerant Blends" at www.HIDECOR.com.

Purity of HC Refrigerants

Refrigerants must be very pure -- they must have extremely low levels of moisture and other contaminants. The use of impure HCs will cause the following problems:

1. A high level of moisture will saturate the receiver dryer.
2. It may destroy the compressor.

In addition, the type of HC is important. HC used as a fuel, for example, is not the right composition for a refrigerant. It will not give the correct refrigeration capacity, and its use may result in higher running costs and poor reliability.

HC Refrigerant Charge

Due to the lower density of HC refrigerants, the equivalent HC charge will be approximately 40% of the CFC-12 charge

Table 1. Thermo-Physical Properties of HC Refrigerants

Refrigerant	Mol Mass (kg/kmol)	Normal boiling pt. At 1 Atm.	Critical temp. (c)	Critical pressure (bar, abs.)	Temp. glide at 25&C (K)	Latent heat at 25&C (kJ/kg)	Saturation press at 25&C (bar, abs.)
R-600a	58.1	-11.7	135.0	36.45	0	332	3.5
HC blend (R-600a/ R-290)	51.0	-31.7	105.5	34.01	7.8	353	5.2
R-290 (Pro-pane)	44.1	-42.1	96.7	42.48	0	342	9.6

weight. It must be remembered that, if specified by weight, the charge amount should be 40% of the CFC-12 weight. When the charge amount is specified in volume it should be the same as for CFC-12.

Lubricant Compatibility

HC refrigerants are fully chemically compatible with nearly all lubricating oils used in refrigeration systems. Good miscibility is maintained with most lubricants under all operating conditions. Due to the high solubility of mineral oils, in the manufacturing of new equipments with HC refrigerants a lubricant with lower solubility or increased viscosity may be needed to compensate for possible thinning of lubricant. In retrofitting a CFC-12 based appliance or MAC with HC blend, use of the same lubricant is recommended as in the original CFC-12 unit.

Lubricants containing silicon or silicate (often used as anti-foaming additives) are not compatible with HC refrigerants and should not be used. Table 2 details the various lubricants and their compatibility characteristics:

TABLE 2

Lubricant Type	Compatibility
Mineral (M)	Fully soluble with hydrocarbons, Excessive solubility at high temperature conditions. Compensate by selection of high viscosity grade oil in case of new manufacturing.
Polyolester (POE)	Generally exhibit excessive solubility with hydrocarbons. May necessitate higher viscosity grade in case of new manufacturing.
Polyalkylene Glycol (PAG)	Soluble and partially soluble with hydrocarbons depending upon the conditions. Normal grades are generally satisfactory. To be used only in Mobile AC applications

Material Compatibility

Virtually all common elastomer and plastic refrigeration materials used as 'O' rings, valve seats, seals and gaskets are compatible with HC refrigerants. These include Neoprenes, Vitons, Nitrile rubbers, HNBR, PTFE and Nylon. Materials that are not compatible with and that should not be used in HC refrigeration systems are EPDM, natural rubbers and silicon rubbers.

Desiccants

Desiccants are used within filter dryers. Most commonly used desiccants are compatible with HC refrigerants. Acceptable types are XH-5, XH-6 or their equivalents.

Safety Issues with HC Refrigerants

Hydrocarbons are flammable when mixed with air and ignited. For the vapour mixture to be flammable, the concentration of the HC vapour in air must be between the lower and upper flammable levels. If the concentration is below the lower flammability level (LFL) of approximately 2%, there is not enough HC for combustion. If the concentration is above the upper flammability level (UFL) of approximately 10% there is insufficient oxygen for combustion.

The LFL is approximately equal to 35 g/m3 of HC refrigerant in air. For safety reasons a practical limit of 8 g/m3 of HC in air should not be exceeded in a closed space. For example, in a space 3m by 3m by 2.5m high the practical limit for an HC charge is 180g. If the total charge of 180g is released into the space, it will not be enough to produce a flammable mixture. The resulting concentration will be about 20% of the lower flammability level if the refrigerant was evenly dispersed in the entire room. But this may not be the case, and therefore the practical limit should never be exceeded. Also refer to safe handling of refrigerants at www.HIDECOR.com.

HC Charge Limits

Due to safety considerations as outlined above, there are limits on charge quantity depending on type of appliance/ equipment. In case of domestic refrigerators, which are mostly installed in a relatively confined space, the refrigerant charged limit is kept as 150g which is equivalent to 375g of CFC-12 charge. In case of commercial refrigeration appliances, however, the limit of HC refrigerant charge specified is 250g, which is equivalent to 625g of CFC-12.

Retrofitting of Domestic and Commercial Appliances

The HC blend of R-600a/ R-290 is gaining a wide appreciation as retrofit refrigerant for domestic & commercial refrigeration appliances and MAC. It is mainly because the vapour pressures of HC blend are more or less similar to CFC-12, and the system refrigeration capacity too is the same as that of CFC-12. No changes are required in the refrigeration system components, which simplifies the conversion process. The only changes required are the replacement of electrical devices like OLP, relay, thermostat, and door switch and bulb holder by non-sparking sealed components to make the appliance safe.

Performance of HC based Appliances

HC refrigerants have proven to be environmentally-friendly because of zero ODP, negligible GWP, and energy efficiency. Test results indicate that even retrofitted appliances consume more or less the same energy as the original CFC-12 units. The current trend shows that manufacturers of domestic refrigerators are converting more and more to R-600a. Table 3 gives the typical operating conditions for some applications alongwith HFC-134a.

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Table 3: Typical operating conditions for some common applications with HFC-134a

Appliance (Cabinet Temperature)	Temperature°C		Pressure					
			CFC-12		HFC-134a		HC Blend	
	Evap	Cond.	Evap.	Cond.	Evap.	Cond.	Evap.	Cond.
Bottle Cooler (2 to 4°C)	-10	55	2.2 bar(abs) (17 psig)	13.6 bar (abs) (183 psig)	2 bar (abs) (14 psig)	15 bar abs. (200 psig)	2.3 bar (abs) (19 psig)	12.1 bar (abs) 161 psig)
Ice cream Freezer (-20°C)	-30	55	1 bar (abs) (-0.1 psig)	13.6 bar (abs) (183 psig)	0.84 bar abs (-2 psig)	15 bar abs. (200 psig)	1.1 bar abs (1.3 psig)	12.1 bar (abs) 161 psig)
Visi-cooler (2 to 4°C)	-10	55	2.2 bar(abs) (17 psig)	13.6 bar (abs) (183 psig)	2 bar (abs) (14 psig)	15 bar abs. (200 psig)	2.3 bar (abs) (19 psig)	12.1 bar (abs) (161 psig)
Display cabinets (2 to 4°C)	-10	55	2.2 bar(abs) (17 psig)	13.6 bar (abs) (183 psig)	3 bar (abs) (14 psig)	15 bar abs. (200 psig)	2.3 bar (abs) (19 psig)	12.1 bar (abs) (161 psig)
Refrigerators (–7 to +5°C)	-23.3	55	1.35bar(abs) (4.5 psig)	13.6 bar (abs) (183 psig)	1.15 bar (2 psig)	15 bar abs. (200 psig)	1.45 bar (abs) (6 psig)	12.1 bar (abs) (161 psig)

Retrofitting CFC Appliances With Hydrocarbons

As per the Montreal Protocol, it is imperative to phase out CFCs by 2010. Retrofitting small CFC appliances like Direct Cooled Domestic Refrigerators and other commercial appliances like Freezers etc. with Hydrocarbon (HC) blend refrigerants is a worthwhile alternative. It is hoped that the following Q&A presentation, will present HC Blend refrigerants as a good option to extend the life of the appliance in a scenario where CFCs are either not available or are too expensive.

What does "Retrofitting" mean?

Retrofitting means adapting the Refrigeration system of an existing CFC Appliance to accommodate substitute refrigerants like HFC134a or HC Blends. This could involve changes in certain components like filter dryers, compressor lubricant, capillary, etc., as well as elaborate preparatory procedures like flushing out of the old CFC compatible lubricant to ensure reliable working. In case the substitute refrigerant can be used without any change to the refrigeration system, by merely substituting the refrigerant alone, then such a substitute refrigerant is called a "Drop In".

Is HC Blend a "Drop In" refrigerant?

Yes, the HC blend (approx 50% Propane and Isobutane) is a Drop In refrigerant as no component of the existing CFC system including compressor lubricant needs to be changed. Of course, it is always a good practice to replace the filter dryer with a new one whenever a sealed refrigeration system is opened and this may be the only change required.

If HC blend is a "Drop In" why is the word "Retrofitting" used when HC blends are substituted?

Although the Refrigeration system does not need any retrofitting, the electrical sparking components in the Appliance's cabinet /door and compressor like thermostats, door switches, compressor relay and overload relay need to be replaced by non sparking or sealed components to prevent the occurrence of fire if the refrigerant were to leak into the closed cabinet or collect near the compressor. Here it is necessary to retrofit certain components outside the refrigeration system whilst the refrigerant continues to be a Drop In. The word "Retrofitting" is therefore used for HC Blends in this context and not for extensive retrofitting of the entire refrigeration system, as in the case of HFC134a refrigerant.

How does the Appliance perform when the CFC 12 refrigerant is substituted by the HC Blend of Propane (R290) & Isobutane (R600a) of about 50% by weight ?

Trials conducted in laboratories as well as in the field confirm that the performance in terms of cooling and reliability is almost as good as with R12. In fact there are less chances of a Refrigeration system breaking down due to capillary clogging and acid formation with HC refrigerants than with the CFCs and HFCs.

When should one think of retrofitting with HC Blends?

It is not necessar y to retrofit a CFC appliance if it is working properly. Retrofitting should be considered only when the refrigeration system of the CFC appliance breaks down due to leaks or any other reasons leading to the opening up of the sealed Refrigeration system. In such cases, considering the imminent phase-out of CFCs, it is worthwhile retrofitting the system with HC Blend as a "Drop In" refrigerant and replacing the sparking electrical components with sealed/non-sparking components.

What is the position regarding the availability of HC Blend refrigerants?

Currently, HC Blend refrigerants are used by Godrej in all their Refrigeration appliances and are available in the general market through outlets of Messrs Hindustan Refrigeration Brands recommended are Care 30 & HyChill HR12.

What about the availability of replacements for Sparking Components listed earlier?

We shall consider this in two parts, one for the Compressor and the other for the Refrigerator/ Appliance.

Compressors: The current relay for compressors can be replaced by PTCs (Positive Temperature Coefficient) which are electronic and do not spark. The Overload Protector (OLP) can be replaced with sealed OLPs. Both these components can be procured from the compressor manufacturers or their dealers by quoting the make and model number of the compressor and serial number also if needed.

Components in the Appliance: Sparking components like thermostats, door switches and door lights have to be replaced with sealed or encapsulated components or by enclosing the components in a sealed box conforming to IP54 which will ensure that the leaked gas will not ingress into the sealed box. It is advisable to get these components from the appliance manufacturers or their dealers quoting the model and serial number of the appliance. Joints of electrical wiring should be of the Spade and Socket type or Bullet and Socket type to prevent any sparking.

In what way is the handling of HC Blends different from that of CFC-12?

HC Blend is a blend of two gases which forms a Zeotropic mixture. There will be a temperature glide of about 8°C across the Evaporator and Condenser which results in the initial part of the Evaporator being about 8°C colder than the last section of the Evaporator. This is because the two component gases evaporate/condense at their respective saturation temperatures at the same pressure. Due to this, HC Blends have to be charged as a liquid into the system, as otherwise there are chances of the lower boiling point component entering the system in a larger proportion, resulting in improper performance. Further the density of the HC blend is much lower than CFC12 and therefore for the same volume of a refrigeration system, a charge of approximately 40% of the weight of the CFC-12 charge is adequate. Therefore charging must be done accurately by weight.

Is there any restriction in the size/capacity of the Appliances that can be retrofitted with HC blends?

Yes.

(a) It is not advisable to retrofit Frost-free Refrigerators with HC Blends.

(b) Limit retrofitting to CFC refrigerators with a charge of 375g or lower.

(c) In the case of Commercial Appliances like Freezers, Bottle Coolers, etc., retrofitting should be attempted only on those Appliances which have a charge of 625 grams of CFC-12 or lower.

Are there any other differences in the procedure for repair/servicing when using HCs?

Procedures like Leak testing with Nitrogen, Evacuation with two-stage Rotary Vacuum Pumps remain the same. Care, however, has to be taken to ensure that service/repair work is carried out at least 2m away from any ignition source, that the working area is well-ventilated to prevent any accumulation of HCs, and to always keep dry powder fire extinguishers as a precautionary measure.

Apart from Appliances, has retrofitting with HCs been done for any other refrigeration systems?

Yes, Retrofitting HC Blends on Car Air Conditioning systems has been widely done in the USA and Australia. In India, trials have been done on Car AC systems with HC Blend as Drop In and found to be satisfactory.

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Manufacturing of Hydrocarbon based appliances - Godrej Experience

"Why use unnatural synthetic chemicals, with unknown long-term effects for mankind, when nature has provided us with a range of fluids which, provided they are used in a sensible way, can satisfy all our requirements?" the late Professor Lorentzen, cited in Greenhouse Issues. No. 28 January 1997 and www.care-refrigerants.co.uk/

Refrigerators (domestic and commercial) have two critical parts: a chemical fluid/refrigerant to maintain foodstuff & perishables cold for longer duration and an insulation foam to maintain/keep things cold inside a closed container. In both of them Chlorofluorocarbons (CFC), harmful to the environment, were generously used to perform said functions.

We, at Appliance Division of Godrej & Boyce Manufacturing Co. Ltd. studied various alternatives to CFCs and believed that environmentally friendly Hydrocarbons (HC) would be the appropriate alternatives for CFCs compared to Hydrofluorocarbon (HFC), the other alternative.

HC refrigerants have the advantage of being naturally created fluids/substances as against many other alternative refrigerants including HFCs that are man-made. HCs are very efficient in reducing the power consumption of refrigeration systems. However, use of HC refrigerants calls for strict adherence to adequate safety procedures.

The Greenfreeze project launched with the support of Greenpeace International is an example of the success achieved where major European refrigerator manufacturers collectively chose energy efficient HC refrigerants as the alternatives to CFCs. For us, in India, it would have been difficult to afford a two or multi-step approach in the CFC-phase out. Therefore, we have decided to implement the use of HCs in one shot as the alternative to CFCs.

We ultimately decided to use HC blend (Isobutane-Propane) from the HC group that can also be used as drop-in refrigerant for CFC-12 and HFC-134a without changing any parts or lubricant of refrigeration system during servicing. Further, the HC blend is less expensive and its running costs are minimal. Apart from some changes in the manufacturing process, ease in appliance servicing was one of the important elements in favour of using HC refrigerant. We established that a trained and/or well-experienced technician with an average level of common sense, care, and safety could work comfortably without any problem.

From the beginning, our organization has been associated with environment protection activities in India. With this ethic in mind, we adopted HC refrigerants as an alternative to CFCs. In addition, the trials and tests that we carried out showed better coefficient of performance (COP) in case of HCs. Though, currently we are using HC blend as an alternative refrigerant in our appliances, eventually we may begin using Isobutene as a refrigerant, reducing compressor noise and deriving other benefits.

Prior to working on alternative refrigerants, we examined the options to replace CFC-11 used as the blowing agent for PU foam insulation for refrigerator cabinets and doors. Based on our trials and on advice from international agencies and factories abroad, we chose Cyclopentane and suitably altered our manufacturing process.

In searching a replacement for CFCs, we took into account the Total Equivalent Warming Impact (TEWI), an important indicator to measure the environmental friendliness of a refrigeration system. TEWI is the sum total of emissions linked with the refrigerant/fluid and the energy required to run the refrigerator. For HC appliances, the TEWI value is lower and therefore an added advantage in our decision to use HCs as alternative refrigerants.

As can be expected in any new project, we have had many good and memorable experiences along with a few lessons during the implementation of the changeover programme in manufacturing. Our first CFC free refrigerator was launched in 1996 and our CFC, HFC, HCFC free refrigerator (with HC blend), namely 'Pentacool' in frost-free refrigerator category manufactured at our Mumbai factory was launched in January 2001 .

In the first year, using Cyclopentane as a blowing agent for PUF, about 60,000 refrigerators were manufactured. In 2001, about 100,000 refrigerators were produced alongwith HC blend as refrigerant. Then the production of completely HC based appliances went up to 4.5L in 2002 and thereafter all 7.5L refrigerators produced per year became completely HC based.

Around the same time, in order to be ready to provide timely service to customers, we started imparting training on handling and servicing of HC based refrigerators to the field technicians spread across the country. In fact we have experience doing this since the early days of HIDECOR, when as members of the ECOFRIG project, we organized pilot training programmes in selected cities to share best practices with the freelancers and the RAC service technicians. Even now we have collaborated with NCCoPP for similar activities.

Though HCs are flammable by nature there were no accidents/fires in either of the factories where there was a regular consumption of HC fluids in large quantities. Similarly, since the launch of HC based refrigerators, the technicians of authorized service providers (ASP), dealers and our own service centers have managed HC blend very well without any accident. This is one of the positive effects of our service training programme where the emphasis is on good servicing practices including safety. The service complaints or problems with refrigeration system due to the change in refrigerant from CFCs to HCs have more or less remained unaffected.

With a dedicated team of managers, engineers and workmen, we at Godrej, have successfully implemented all activities as per plan. The task of CFC phase-out from our manufacturing set-up was completed at both the factories (Mumbai & Mohali in Punjab), 4 months before the target date of 1st Jan 2003. Based on our above outlined success, we have recently set up a factory at Shirwal in Maharashtra, where HC based refrigerators are being produced.

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