Hydrocarbon Refrigerants used for Refrigerators & Air-conditioners and Short-Lived Climate Forcers
Organization

Established in 1897, the Godrej group has grown in India from the days of the charkha to nights at the call centers. Our founder, Ardeshir Godrej, lawyer-turned-locksmith, was a persistent inventor and a strong visionary who could see the spark in the future. His inventions, manufactured by his brother Pirojsha Godrej, were the foundation of today’s Godrej empire. One of India’s most trusted brand, Godrej enjoys the patronage and trust of around 500 million Indians every single day. Our customers mean the world to us. We are happy only when we see a delighted customer smile.

With 7 major companies with interests in real estate, FMCG, industrial engineering, appliances, furniture, security and agri care – to name a few – our turnover crosses 3.3 billion dollars (31.03.2012). 26% of our business is done overseas. With brands you can believe in, service excellence you can count on and the promise of brighter living for every customer, Godrej knows what makes India tick today.

In order for our businesses to truly become sustainable, efforts will be focused on creating carbon neutral, zero waste, water positive and energy efficient businesses. A green product / service is that which reduces energy, water or material consumption by 20%, GHG emissions by 20%, eliminates toxic materials or uses 100% recyclable, renewable and / or natural material.

Mumbai, Shirwal, Mohali
Appliance Division

1958, Godrej Appliances makes the very first refrigerator in India. Now, Eon brings cool new features to meet today’s customer needs.

With addiction to innovation, launched PUF (polyurethane foam) technology way back in the 80s. Created 100% CFC, HFC, HCFC free fridges much before green became common.

Continued moving forward - not just Refrigerators, but also Air-Conditioners, Washing Machines, Microwave Ovens, DVD Players, Televisions etc.

Was voted the Most Trusted Brand, Gold award (Reader’s Digest consumer survey) 4 years in a row by our consumers, and earned the CNBC Consumer Awaaz Award, 3 years in a row. Eon, in the Consumer World Awards, was chosen as Mera Brand of the year, 2008. The same year when Urjavaran Foundation handed over the Empower India Award, towards energy efficiency, we were at the receiving end. Next. Godrej Appliances becomes a Superbrand.
Appliance Division – Products
Refrigerators, Air-Conditioners, Washing Machines & Microwave Ovens
Select Awards - Godrej Appliances
Environmental Science

• Environment includes all conditions that surround living organisms.
• Study or interaction of humans with environment during lifetime of multidisciplinary nature.
• Examination of the interactions between the physical, chemical and biological components of the natural world, including their effects on all types of organisms and how humans impact their surroundings.
Environment

Atmosphere around Earth

- **Nitrogen** - 78%
- **Oxygen** - 20.6%
- **Other** - 1.4%
  - Argon (0.934%)
  - Water Vapor (0.4%)
  - Carbon Dioxide (0.035%)
  - Neon (0.00182%)
  - Helium (0.000524%)
  - Methane (0.00015%)
  - Krypton (0.000114%)
  - Hydrogen (0.000005%)
  - N$_2$O (0.000003%)
  - Ozone (0.0000005%)
  - CFCs (0.0000001%)
  - Known Greenhouse Gas
Ozone and Ozone Layer

- Ozone - tri-atomic form of oxygen ($O_3$) found with strong scent and blue in color in Earth’s upper and lower atmosphere.

- Ozone layer in stratosphere, 15-30 km above earth's surface.

- Ozone - protects living organisms by absorbing harmful UV-B radiation from sun.

- Ozone layer - getting destroyed by Chlorine containing substances
Previous Refrigerants

CFC-12

HCFC-22

Manmade refrigerants used in previous Refrigerators & Air-Conditioners
Environmental Effects of Refrigerants

• Depletion of the ozone layer in the stratosphere

• Global warming :
  Refrigerants directly contributing to global warming when released to the atmosphere

Indirect contribution based on the energy consumption of among others the compressors (CO₂ produced by power stations)
Impact of Previous Refrigerants
Destruction of Ozone

\[
\text{O}_2 + \text{Cl}_2 \rightarrow \text{ClO} + \text{O}_2
\]

Chlorine radical breaks bond in ozone molecule

\[
\text{ClO} \rightarrow \text{Cl} + \text{O}_2
\]

Oxygen atom in atmosphere

\[
\text{O} + \text{O}_2 \rightarrow \text{O}_3
\]

Cycle begins again

\[
\text{Cl} + \text{O}_3 \rightarrow \text{ClO} + \text{O}_2
\]

Oxygen is released into atmosphere

UV energy removes chlorine atom from CFC molecule

Produces diatomic oxygen and free chlorine radical

Breaks bond in chlorine monoxide molecule

Illustration only
Effects of Ozone Layer Depletion

- Human health
- Plants & trees
- Aquatic Ecosystems
- Materials
Effects of Ozone Layer Depletion - Human

- Skin cancer

- Premature aging (photo-aging) of skin (different from normal chronological aging)

- Cataracts and eye disorders (corneal sunburn and blindness)

- Immune system damage

- Damage to the DNA
Green House Gases

Average rise of 0.74°C on earth in last 100yrs

Illustration only
Climate Change and Global Warming

- Climate change refers to variation in global and regional climates over the time and system as a whole is shifting the average pattern.
- Select Refrigerants Contribute to Global Warming (GW) which refers to a happening wherein infrared rays are absorbed by molecules in Carbon dioxide, Methane and manmade refrigerants like CFCs, HCFCs, and HFCs.
- GW prevents heat from escaping the Earth's surface
- Climate change and global warming are co related.
Short-Lived Climate Forcer (SLCF)

• Climate forcer: any gas or particulate which can change earth’s energy balance by absorbing or reflecting radiation.

• Short-lived climate forcers (SLCFs): gases having a strong impact on climate forcing, but not long-lived in the atmosphere compared to carbon dioxide (CO₂).

• Three main SLCFs: methane, black carbon and HFCs.

*Methane: Natural emissions. Extremely potent greenhouse gas (25 times CO₂).*

*Black carbon: mainly soot. Though not GHG, it warms the atmosphere. Produced from incomplete combustion of various fuels. Important health impacts.*

*HFCs: Increase due to elevated usage as refrigerants. (Hundreds of times more potent than CO₂).*
Short-Lived Climate Forcer (SLCF)

- Atmospheric lifetimes of short-lived climate forcers in comparison to the long-lived greenhouse gas CO₂

<table>
<thead>
<tr>
<th>Substance</th>
<th>Lifetime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide</td>
<td>Decades to centuries</td>
</tr>
<tr>
<td>Methane</td>
<td>12 years</td>
</tr>
<tr>
<td>Ozone</td>
<td>4 – 18 days</td>
</tr>
<tr>
<td>Black carbon</td>
<td>3-8 days</td>
</tr>
</tbody>
</table>

Hydro fluorocarbons (HFCs) are created to replace ozone depleting substances (ODS), CFCs in refrigerators, HCFCs in air conditioners, foam blowing etc. Have zero ODPs, but considerable GWPs & longer life.
Benefits of Reducing SLCFs

• Comes out to be a great opportunity to reduce climate change and will show the way to quick climate benefits for human health, improved air and water quality and better energy efficiency.

• Additionally, may be important for protecting susceptible areas like Arctic and Himalayan glaciers.

But to happen this, there is a need to have good control on production and consumption of HFCs. Also at the same time, widespread use of alternatives to HFCs is essential.
Indian Scenario

- Mean temperature rise by end of century – mainly in north
- Rise in yearly monsoon
- More severe extremes – especially over west coast and west central parts
- Reduced crop production due to increased temperature and higher CO₂ content
- Increase in cyclones in the Bay of Bengal
- Flooding of low lying areas producing climate refugees
Greatest Threat - Sea Level Rise & Floods

- Inundation of coastal colonies
- India; out of 28 countries endangered from sea level rise
- About 5763 sq.km area and 4.6% of the coastal population would be affected
- Most vulnerable areas- Gujarat, Mumbai, South Kerala, Lakshadweep islands etc.
Alternatives to CFCs in Refrigerators

HCFC

- e.g. HCFC-22

HFC

- e.g. HFC-134a

HC

- e.g. HC-600a
Alternatives to HCFCs in Air-Conditioners

HFC

- Non flammable but High GWP
- Do not work with Mineral Oil
- Reliability/Compatibility issues with materials of system construction

E.g. HFC-410A

HC

- Negligible GWP but flammable
- Long term solution
- Work with Mineral Oil and can be used in existing & new systems

E.g. HC-290
Hydrocarbon Refrigerants

- HC refrigerants used in the late 1800’s/early 1900’s
- Naturally occurring
- Have zero ODP and negligible GWP
- Compatible with most lubricants
- ‘More’ compatible with materials normally used
- HC’s can reduce/eliminate acids forming
- Require only small quantity of original charge when replacing halocarbons refrigerant in existing appliances
- Energy saving: up to 20% due to lower molecular mass and vapor pressure

But being

- Flammable so care is utmost important
Godrej and Refrigerants

- Refrigerant selection impacts ozone layer & climate change.
- Being committed to environment protection, started Good and Green type projects.
- Determined to stop use of CFC-12 and now HCFC-22 in refrigerators and air-conditioners.
- Preferred using Hydrocarbons/natural refrigerants as they are environmentally friendly. R290+R600a blend and R290 for refrigerators and air-conditioners.
- Irrespective of refrigerant, leak tightness being priority job, started actions in manufacturing and service.
Green Appliances - Godrej
Commitment to Protect Environment

ECOFRIG
Refrigeration Training Program

• Advanced Technologies
  – Technologies to reduce charge sizes and leaks
  – Technologies that have negligible GWP refrigerants

• Advanced Practices cum Training
  – Safe use of alternatives to CFC & HCFCs
  – Retrofit Work Instructions
  – Leak Prevention & Repair
  – Good Service Practices
  – Careful Installation
Thank You For Your Time And Consideration.

S A Juvekar
16.11.2012