Proposed Refrigerant Alternatives at Boise State University
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Introduction
Refrigerant usage has been under scrutiny over the past 25 years due to the Ozone Depletion Potential (ODP) of the most commonly used refrigerants. The refrigerants that can deplete the ozone layer are those that commonly include chlorine in their compound.

• When the Chlorine contained in certain refrigerants reaches the ozone layer in the stratosphere, it reacts with the ozone molecules.
• The reaction results in the chlorine atom stripping one of three oxygen molecules, resulting in a depleted ozone molecule.
• Because of the Ozone Depletion Potential and high Global Warming Potential (GWP) of refrigerant compounds, Chlorofluorocarbons (CFCs) and Hydrochlorofluorocarbons (HCFCs) are in the process of being phased out.
• With this phase-out comes the increased use of Hydrofluorocarbons (HFCs).

Terms to Know
Ozone Depletion Potential (ODP) – the potential amount of ozone layer degradation that is possible by a chemical compound. The ODP of any given substance is defined as the ratio of loss of ozone in comparison to that of CFC-11, which, as the reference point, has an ODP of 1.

Global Warming Potential (GWP) – originally developed to compare the global warming impacts of different gases. GWP is a measure of how much energy the emission of one ton of a gas will absorb over a given period of time, usually 100 years, relative to the emissions of one ton of carbon dioxide.

<table>
<thead>
<tr>
<th>Refrigerant</th>
<th>ODP</th>
<th>GWP</th>
<th>Chemical</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-11</td>
<td>1</td>
<td>4000</td>
<td>CFC</td>
</tr>
<tr>
<td>R-22</td>
<td>≤ 0.5</td>
<td>1700</td>
<td>HCFC</td>
</tr>
<tr>
<td>R-134a</td>
<td>0</td>
<td>1300</td>
<td>HFC</td>
</tr>
<tr>
<td>R-410a</td>
<td>0</td>
<td>1725</td>
<td>HFC</td>
</tr>
<tr>
<td>R-1234ze</td>
<td>0</td>
<td>&lt; 1</td>
<td>HFO</td>
</tr>
<tr>
<td>R-1234yf</td>
<td>0</td>
<td>&lt; 1</td>
<td>HFO</td>
</tr>
<tr>
<td>Ammonia</td>
<td>0</td>
<td>0</td>
<td>NH3</td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>0</td>
<td>1</td>
<td>CO2</td>
</tr>
</tbody>
</table>

Boise State University Refrigerants Alternatives
The refrigerants we recommend as alternatives are still in the R&D phase of development for large scale application. All alternative refrigerants require the alteration or replacement of current equipment. Each alternative has its own set of advantages and disadvantages when compared to the current refrigerants.

Hydrofluoroolefins (HFOs) – R-1234ze and R-1234yf have no ODP and very low GWP, but present problems with energy efficiency, toxicity, and large scale use.

Ammonia – Has no ODP or GWP and achieves higher energy efficiency than HFCs, but present problems with toxicity (toxicity can be managed with proper system maintenance). Ammonia is currently used in cold storage units.

Carbon Dioxide – Has no ODP, a GWP of 1, and is cheap and safe, but current usage is designated for smaller systems due to properties.

Currently in Use
R-11
R-22
R-134a
R-410a

To Be Phased Out
R-11
R-22

Proposed Alternatives
R-1234ze
R-1234yf
Ammonia
Carbon Dioxide