Greenhouse gas makes for a cooler world.

Carbon dioxide, long considered a "greenhouse gas" for its potential to contribute to global warming, now finds a possible future in replacing halogenated refrigerants in air conditioning and refrigeration systems. High-pressure CO₂ offers interesting and unique design challenges for HVAC system development, particularly in the selection of seal materials.

Temperature

The extreme temperature range involved in the transcritical CO₂ refrigeration cycle (-40° to +160°C) limits the choice of seal materials. Fluorocarbon (FKM), Hydrogenated Nitrile (HNB), and Ethylene-Propylene (EP) compounds exhibit the most suitable thermal stability.

Chemical compatibility

When evaluating the chemical compatibility between carbon dioxide, compressor oils and rubber sealing components, it is necessary to consider several important issues that can directly affect system performance. The polarity of the carbon dioxide molecule results in lower potential for swell, permeation, and explosive decompression with EP seals than with fluorocarbon or HNB materials.

Some Polyalpha olefin (PAO) compressor oils can cause swelling of EP compounds, but are generally compatible with fluorocarbon and HNB. Polyalkylene glycol (PAG) and polyol ester (POE) oils are generally compatible with all three seal materials. But because rubber compounds and commercially-available PAGs and POEs vary widely, compatibility testing with specific compressor oils and seal materials should be performed to ensure acceptable seal performance.

Pressure

Carbon dioxide refrigeration cycles must operate at significantly higher pressures than those of conventional refrigerants. Pressure-related seal failure can be caused by extrusion (gas pressure forcing the seal material into a clearance gap) permeation (pressure loss) and by explosive decompression (blisters and splits caused by expansion of gas trapped within the seal material).

Explosive Decompression can be roughly predicted, but specific compounds should be evaluated for permeation and explosive decompression in actual operating conditions whenever possible.

### COMPARISON OF REFRIGERANTS

<table>
<thead>
<tr>
<th>Refrigerant</th>
<th>UL Minimum Design Pressures</th>
<th>Critical Point Data</th>
<th>Density</th>
<th>Normal boiling point (°F)</th>
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<tbody>
<tr>
<td></td>
<td>Low side (psia)</td>
<td>High side (psia)</td>
<td>Temperature (°F)</td>
<td>Pressure (psia)</td>
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<td>205.00</td>
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</tbody>
</table>

Figures 1-3 (see reverse) document the effect of various compressor oil technologies on representative rubber compounds. Figure 4 (see reverse) demonstrates the differences in performance of compounds from within the same polymer family – the exact compound used in application is critical to success.
Unless otherwise noted, these are test values from a limited number of samples and should not be used for establishing specific limitations.

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