FLUORINATED ALTERNATIVES IN RESIDENTIAL AND LIGHT COMMERCIAL APPLICATIONS
GLOBAL MANUFACTURER OF FLUOROCHEMICAL REFRIGERANTS

Producing Refrigerants since:
- 1940’s in Europe
- 1950’s in U.S.
- 2000’s in Asia

General Info:
Arkema is a global producer of performance materials and specialties with 19,000 employees in 50 countries.
<table>
<thead>
<tr>
<th>Applications</th>
<th>For Today</th>
<th>For the Future</th>
</tr>
</thead>
</table>
| Air conditioning & Heat Pumps | [Image of chillers] | Forane® 427A  
  GWP = 2024  
  • Non-flammable |
| Chillers          | [Image of chillers] | Forane® 449B  
  GWP = 1296  
  • Non-flammable |

**For Today**
- Forane® 427A  
  GWP = 2024  
  • Non-flammable
- Forane® 449B  
  GWP = 1296  
  • Non-flammable

**For the Future**
- ARM-20 series
  - Forane® 457A  
    GWP = 139  
    • Mildly Flammable  
    Lower GWP Option
  - ARM-20b  
    GWP ~ 250  
    • Mildly Flammable  
    Higher Capacity Option
- Forane® 459A  
  GWP < 500  
  • Mildly Flammable  
  • 410A Replacement  
  Close Match to 410A
- ARM-42
  GWP = 131  
  • Mildly Flammable  
  • 134a Replacement  
  Close Match to 134a

Forane® is a registered trademark of Arkema
FORANE® 459A (ARM-71) – R-410A REPLACEMENT

- **Compatible with R-410A Equipment**
  - Similar Capacity and Efficiency
  - Low Glide (1.5K)
  - Limited compressor discharge temperature

- **Demonstrated more Efficient than 410A**¹
  - At Standard Conditions and High Ambient

- **Lowest Direct Carbon Footprint**¹
  - Lowest GWP of 410A Replacements in its class
  - 8% - 18% lower charge than 410A

  **Relative Carbon Footprint of R-410A Alternatives**

<table>
<thead>
<tr>
<th>Refrigerant</th>
<th>Relative Footprint</th>
</tr>
</thead>
<tbody>
<tr>
<td>FORANE® 459A</td>
<td>20%</td>
</tr>
<tr>
<td>R-32</td>
<td>27%</td>
</tr>
<tr>
<td>R-452B (DR-55)</td>
<td>30%</td>
</tr>
<tr>
<td>R-447B (L41z)</td>
<td>33%</td>
</tr>
<tr>
<td>R-410A</td>
<td>100%</td>
</tr>
</tbody>
</table>

  **80% Reduction in Carbon Footprint**

  ¹ Abdelaziz et al. (2016) ORNL/TM-2016/513, Oak Ridge National Laboratory, Oak Ridge, TN.

FORANE® 459A REFRIGERANT SUMMARY

- **Number**: R-459A
- **Class**: A2L
- **GWP**: 461
- **ODP**: 0

APPLICATIONS

- **Split Systems, Unitary AC**
- **Ducted Splits**
- **Packaged, RTU**
- **VRF systems**
- **Positive Displacement Chillers**
FORANE® 457A (ARM-20A) – R-22 REPLACEMENT FOR HVAC&R

R-22 Replacement Comparison in AC¹
- Higher Efficiency than R-22 in RTU at Standard Conditions and High Ambient
- Lower Capacity (3 - 10%)

R-404A Replacement Comparison²
- Efficiency consistently higher
- Similar Discharge Temperature
- Lower Capacity (15 – 20%)

APPLICATIONS
- Packaged, RTU
- Room A/C
- Split Systems, Unitary
- Stand-alone Refrigeration
- Supermarket Refrigeration

1. Abdelaziz et al. (2016) ORNL/TM-2016/513, Oak Ridge National Laboratory, Oak Ridge, TN.
2. Embraco Slovakia – AHRI – Low GWP AREP – test reports n°49, 50- R-457A results to be reviewed and approved by the AREP Technical Committee