Sapa asked the Danish Technological Institute to measure the heat transfer performances of three of its tubes for fin and tube heat exchangers. The heat transfer coefficient of 9.52mm precision drawn tube, Hygroove tube with straight grooves and Hygroove tube with helical grooves have been measured using a special test set-up. Based on the tube heat transfer coefficient values, Sapa calculated with a mathematical model the heat transfer coefficient of the overall heat exchanger. Data show that both Hygroove tubes give higher performance results than smooth bore tubes. In particular, compared to precision drawn tube, Hygroove helical tube shows:

1. Up to 108% higher heat transfer coefficient of the tube,
2. Up to 8% higher heat transfer performances of the overall heat exchanger.

### PERFORMANCE DATA

<table>
<thead>
<tr>
<th>Tube Type</th>
<th>Heat Transfer Coefficient (w/m²K)</th>
<th>Relative Improvement compared to PD-T (%)</th>
<th>Overall Heat Exchanger Heat Transfer Coefficient (w/m²K)</th>
<th>Relative Improvement compared to PD-T (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precision Drawn</td>
<td>5000</td>
<td></td>
<td>597</td>
<td>+4%</td>
</tr>
<tr>
<td>Hygroove Straight</td>
<td>6800</td>
<td>+36%</td>
<td>618</td>
<td>+8%</td>
</tr>
<tr>
<td>Hygroove Helical</td>
<td>10400</td>
<td>+108%</td>
<td>618</td>
<td>+8%</td>
</tr>
</tbody>
</table>

**Tube Characteristics**
- Tube: 9.52 x 0.6 x ≥2.5mm, straight
- Tube: 9.52 x 0.6 x ≥2.5mm, helical
- Tapped at one end/two ends
- Finned at one end/two ends
- Refrigerant R410A
- Evaporating temperature: 10°C
- Mass flux between 125 - 250 kg/m²s
- Inlet vapour quality of 0.1 and outlet vapour quality of 0.9
- Esters Oil: oil circulation rate (OCR) approximately 1% of mass flow

### ABOUT SAPA’S PRECISION TUBING BUSINESS AREA

Sapa Precision Tubing is the clear market leader in the field of providing aluminium solutions for heat transfer applications. Our company has 30 years of experience supplying the automotive and the HVAC&R (heating, ventilation, air-conditioning and refrigeration) industries.

Sapa’s Precision Tubing Business Area supplies aluminium extruded tubes and welded tubes for gas/ fluid, structural and solar thermal applications. In addition, we also supply niche markets (railway, heavy vehicles, geothermal and other segments) where our technological competence and innovative products can serve our customers.

Sapa Precision Tubing has about 2,000 employees at 17 plants and product and process development centers, serving local and global customers all around the world.
1. **PRICE PER METER**

   The price of aluminium raw material is one fourth the price of copper. This will definitely impact your bottom line.

2. **WEIGHT PER METER**

   Aluminium tubes are 35% lighter than copper, for equivalent burst pressure. This improves system weight significantly.

3. **CORROSION RESISTANCE**

   Corrosion can manifest itself in two ways. First, it can lead to reduced performance of the system, due to galvanic corrosion between tube and fin. In aluminium heat exchangers, due to a closer galvanic balance between fin and tube, this will occur far later than in a mixed metal - copper tubes and aluminium fins. Of course, care has to be taken in aluminium alloy selection, so that the tube will be more noble than the fin material.

   Second, corrosion can lead to tube leakages. With proper alloy selection, tube failures will not occur. However for all-aluminium heat exchangers in outside units, Sapa recommends zinc coating of the tubes as extra protection against the possible effects of aggressive environments.

4. **PERFORMANCE**

   In an all-aluminium fin and tube heat exchanger, the tubes have the same thermal expansion coefficient as aluminium fin stock. The bond between tube and fin will be constant regardless of temperature, thus ensuring better heat transfer. In addition, aluminium has less spring-back effect than copper, meaning a better bond of the tube and fin during expansion.

5. **RECYCLABILITY**

   Aluminium recycling is important for resource preservation. There is no need to separate different materials in an all-aluminium heat exchanger, thus making recycling easier.

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**THE STANDARD DROP IN SOLUTION FOR COPPER REPLACEMENT**

Precision drawn tubes are the light solution for standard heat exchangers manufactured with mechanically expanded round or oval tubes. The manufacturing process, which includes extrusion, drawing and annealing, guarantees optimum turbulence and a superior surface finish of the tube. Precision drawn tubes represent an economic alternative to copper.

**IMPROVED HEAT TRANSFER WITH INNER GROOVES**

Hygroove is an internally enhanced aluminium tube for high-fin density condensers and evaporators. The inner grooves improve heat transfer, offering higher efficiency by more compact design. Additional Zinc coating layers are available to further increase corrosion resistance, which makes this product a high performing tube. Different groove depth and geometry satisfy the specific regional requirements and refrigerants in use.

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**OUR TUBE RANGE AT A GLANCE**

<table>
<thead>
<tr>
<th>Product Design</th>
<th>Key Features</th>
<th>Availability</th>
<th>Alloy</th>
<th>Thickness [mm]</th>
<th>Burst Pressure [bars]</th>
<th>Refrigeant Load [kg/m²/h]</th>
<th>Diameter [mm]</th>
<th>Coils/Tube</th>
<th>Length Range [mm]</th>
<th>Number of Coils</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precision drawn</td>
<td>Lightweight with smooth inner surface</td>
<td>1</td>
<td>1.854</td>
<td>0.68</td>
<td>131</td>
<td>152</td>
<td>2150</td>
<td>50</td>
<td>145</td>
<td>2000</td>
</tr>
<tr>
<td>Hygroove</td>
<td>Improved heat transfer efficiency</td>
<td>5</td>
<td>1.854</td>
<td>0.70</td>
<td>130</td>
<td>147</td>
<td>1900</td>
<td>50</td>
<td>147</td>
<td>2100</td>
</tr>
</tbody>
</table>

---

**THE HIGHEST PERFORMANCE IN HEAT TRANSFER**

Hygroove and Precision drawn tubes have the same thermal expansion coefficient as aluminium fin stock. The bond between tube and fin will be constant regardless of temperature, thus ensuring better heat transfer. In addition, aluminium has less spring-back effect than copper, meaning a better bond of the tube and fin during expansion.

**WHY Sapa:ergic and effective solutions in the market.**

Choosing aluminium solutions from Sapa is more than choosing the price tag. Sapa provides more than the metal processing or the customers process and performance in the field are also part of what you get with Sapa as your supplier.

Additionally Sapa’s Research and Development department ensures you will remain at the forefront of technology and continue having the most cost effective and efficient solutions in the market.

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For heat exchangers operating in aggressive environments, Sapa strongly recommends the addition of a zinc coating to the tube. This additional layer will provide the tubes with increased corrosion protection and will improve lifetime compared to the equivalent bare tube. This zinc coating is available on smooth bore tubes, and straight inner grooved tubes.

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**WHY ALLO-LUMINUM FIN AND TUBE HEAT EXCHANGERS?**

The heating, ventilation, air conditioning and refrigeration HVAC&R industry has been using mechanically assembled copper tubes and aluminium fin solutions for years. Replacing the copper tubes with aluminium tubes provides tangible benefits.

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**WHEN CONVERTING FROM COPPER TO ALUMINIUM OR EXPANDING THE USE OF ALUMINIUM FOR ADDITIONAL APPLICATIONS, THERE ARE SEVERAL TECHNICAL CHALLENGES THAT HAVE TO BE OVERCOME.**

Sapa has 30 years of expertise supplying the automotive and the HVAC&R industries with solutions and our Applications & Development engineers will support you in every step of the project. From selecting the right dimensions and alloys for your application to providing in-depth knowledge of metallurgy, joining methods and brazing, Sapa has the experience and capability to be your partner.

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**WHY ALL-ALUMINIUM FIN AND TUBE HEAT EXCHANGERS?**

The manufacturing process, which includes extrusion, drawing and annealing, guarantees optimum turbulence and a superior surface finish of the tube. Precision drawn tubes represent an economic alternative to copper.