Key Applications of smaller Diameter copper tube (5 mm)

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Spirotech Heat Exchangers founded in 1994 as a non-captive manufacturer of Fin and Tube type Heat Exchanger coils for HVAC & R applications. It started commercial manufacturing in 1996 and became the first Indian company to export coils from India in 1999.
“To be a leader in innovation, quality and growth as a Tier 1 Heat Transfer components and assemblies supplier to HVAC & R appliance and equipment industries.

To be a reliable development partner to our high quality and demanding customers for participative growth.”
1994 Founded
1996 Started Commercial Manufacturing
1999 Introduced 7mm Tube Heat Exchangers
2002 Received UL certificate for Safety
2011 Introduced Aluminum 7mm and 9.52mm
2013 Introduced 5mm Heat Exchangers
2016 Became a part of LU-VE Group
2019 4.0 Million / Annum

Sales 2018

- 5 mm 39%
- 7 mm 37%
- 9.52 mm 24%
Major Applications:

- Cloth Dryer
- Washing Machines
- Dish Dryers
- Outdoor Units
- Condensing Units
- Refrigeration Systems
## SpiroTech Manufacturing Capabilities:

<table>
<thead>
<tr>
<th>FIN PATTERN</th>
<th>MECHANICAL EXPANDER</th>
<th>FPI Range</th>
<th>Fin Gap</th>
<th>Fin Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Dimensions in mm</td>
<td>Finned Length (mm)</td>
<td>No. of Holes</td>
<td>No. of Rows</td>
<td>COPPER - ALUMINIUM</td>
</tr>
<tr>
<td>5 mm x 19.05 x 16.5</td>
<td>1600</td>
<td>40</td>
<td>10</td>
<td>8 - 21</td>
</tr>
<tr>
<td>7 mm x 21 x 12.7</td>
<td>1600</td>
<td>30</td>
<td>8</td>
<td>8-20</td>
</tr>
<tr>
<td>7 mm x 21 x 12.7</td>
<td>1100</td>
<td>40</td>
<td>8</td>
<td>8-20</td>
</tr>
<tr>
<td>7 mm x 25.4 x 22</td>
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<td>40</td>
<td>8</td>
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<td>9.52 mm x 25.4 x 22</td>
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<td>36</td>
<td>8</td>
<td>5-18</td>
</tr>
<tr>
<td>ALUMINIUM - ALUMINIUM</td>
<td></td>
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<td></td>
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<td>40</td>
<td>8</td>
<td>5-18</td>
</tr>
</tbody>
</table>
Products and Growth trend

5mm HX Trend (Y-O-Y)

<table>
<thead>
<tr>
<th>Year</th>
<th>Prod Lacs/Annum</th>
<th>% Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>0.11</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>3.32</td>
<td>20%</td>
</tr>
<tr>
<td>2016</td>
<td>3.99</td>
<td>51%</td>
</tr>
<tr>
<td>2017</td>
<td>6.01</td>
<td>105%</td>
</tr>
<tr>
<td>2018</td>
<td>12.3</td>
<td>120%</td>
</tr>
</tbody>
</table>

5 MM CONDENSER

OUTDOOR HX
Driving Factors towards smaller diameters

Historical trends towards smaller diameters

Major Driving Factors:-
✓ Saving Refrigerant cost
✓ Lower Refrigerant consumption
✓ Improved Performance
✓ Less weight & Compact in size
✓ Save the materials
✓ High Pressure Bearing Capacity
✓ Best suitable to natural refrigerants
✓ Increases the Heat transfer coefficients

Area of Changes:-
Fin design,
End Plate Design,
Tube circuits,
Tube wall thickness
Driving Factors towards smaller diameters

Historical trends towards smaller diameters

- 5/8”
- ½”
- 3/8”
- 7mm
- 5mm
- 4mm (Now)

Saving Refrigerant cost :-

- Average purchase prices of R134a, R410A and R404A, 6 times increase in last 04 years.
- HFC prices to increase further to 25 times on average by 2030.
- In this situation 5mm (Smaller Tube diameter) is good solution to get low refrigerant consumption cost & increase capacity.
- Revised #Refrigerant Flow Control regulation: Limit of Refrigerant revised to 1046 gm / Ton, can be achieved by 5mm Heat Exchangers.

#Source: European Regulation information from European Customers
Driving Factors towards smaller diameters

- Lower Refrigerant consumption
- Improved Performance

Comparison of 7mm ODU/5mm IDU Vs 9.52mm ODU/7mm IDU

The refrigerant charge of outdoor unit and indoor unit of air conditioner with 5 mm diameter tubes is decreased by 50% and 30% than those of air conditioner with large diameter tubes, respectively. The total refrigerant charge of air conditioner is reduced by 27%.

#Source: International Refrigeration and Air Conditioning Conference at Purdue, July 16-19, 2012
Driving Factors towards smaller diameters

✓ Less weight & Compact in size
✓ Save the materials

<table>
<thead>
<tr>
<th>Reduction in internal Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTIONS</td>
</tr>
<tr>
<td>COIL INTERNAL VOLUME</td>
</tr>
<tr>
<td>TUBE EXTERNAL DIAMETER</td>
</tr>
<tr>
<td>TUBE INTERNAL DIAMETER</td>
</tr>
<tr>
<td>NUMBER OF SKIPPED TUBE</td>
</tr>
</tbody>
</table>

- SUBSTANTIAL REDUCTION IN INTERNAL VOLUME FOR SAME CAPACITY
- ABOUT 30% REDUCTION IN REFRIGERANT QUANTITY RESULTING IN LOWER SYSTEM COST
- INCREASED NUMBER OF CIRCUITS GIVES 34% LESS REFRIGERANT PRESSURE DROP
Driving Factors towards smaller diameters

High Pressure Bearing Capacity: Mandatory requirement of EU Customer/UL

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>CO2 APPLICATION</th>
<th>OUT DOOR UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tube size</td>
<td>5 mm (Smooth)</td>
<td>5 mm (Inner Grooved)</td>
</tr>
<tr>
<td>Thickness</td>
<td>0.41 MM</td>
<td>0.22+0.15 MM</td>
</tr>
<tr>
<td>Fin Thickness</td>
<td>0.15 MM</td>
<td>0.12 MM</td>
</tr>
<tr>
<td>FPI</td>
<td>9</td>
<td>11.5</td>
</tr>
<tr>
<td>Strength Test (1 Min. Hold)</td>
<td>368.96 bar (Spec 289)</td>
<td>203.44 Bar (Spec 186)</td>
</tr>
<tr>
<td>Burst Test</td>
<td>374.48 Bar</td>
<td>205.58 Bar</td>
</tr>
<tr>
<td></td>
<td>(Burst from Stick out)</td>
<td>(Burst from Stick out)</td>
</tr>
</tbody>
</table>

✓ Withstands higher pressures with thinner walls (e.g. CO2)
Driving Factors towards smaller diameters

- Best suitable to natural refrigerants

- **HYDROCARBONS**
  - ISOBUTANE [R600a]
  - PROPANE [R290]
  - BUTANE [R32]

- **CARBON DIOXIDE**
  - CO₂ [R744]

- **AIR**
  - [R729]

- **WATER**
  - H₂O [R718]
Driving Factors towards smaller diameters

- Increases the Heat transfer coefficients
- High thermal conductivity
- Low wall thermal resistance
- Higher Turbulence & Heat transfer surface area
- Corrosion resistance

- 5 mm Grooved Tubes: Better Heat Transfer with correct fin configuration

<table>
<thead>
<tr>
<th>Higher Thermal Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SPECIFICATION</strong></td>
</tr>
<tr>
<td><strong>MODEL</strong></td>
</tr>
<tr>
<td><strong>CAPACITY</strong></td>
</tr>
<tr>
<td><strong>FPI</strong></td>
</tr>
<tr>
<td><strong>AIR FLOW</strong></td>
</tr>
<tr>
<td><strong>COND TEMP.</strong></td>
</tr>
<tr>
<td><strong>INLET AIR</strong></td>
</tr>
<tr>
<td><strong>FIN PITCH</strong></td>
</tr>
<tr>
<td><strong>TUBE</strong></td>
</tr>
<tr>
<td><strong>REFRIGER ANT</strong></td>
</tr>
<tr>
<td><strong>CIRCUITS</strong></td>
</tr>
</tbody>
</table>
Advantages of 5 mm HX over MCHX

5 mm HX

✓ Cost is reduced by 10% -15%
✓ 5 mm copper coils are negligible in field leaks
✓ Easy to repair in the field.
✓ Low cost and high thermal efficiency makes 5 mm coils a better alternate to both 7 mm Copper tube coils and to aluminum MCHX.
✓ High burst strength of 5 mm
✓ 5 mm is suitable for changes in circuits or sizes.

MCHX

○ MCHX are made in standard sizes only, and are used only for 1.5 TR (5.27kW) and higher capacity units.
○ MCHX are prone to corrosion and are non-repairable in the field.
○ MCHX have limited scope of customization due to manufacturing limitations.
Process flow of Heat Exchangers

STANDARD TOOLING USED TO MAKE FLARE ON VERTICAL EXPANDER M/C. WITH THIS, PROPER BELL IS MADE WITHOUT SCRATCHES ON INNER SIDE OF TUBES..

- End Plate Punching
- Fin Punching
- Hair Pin Bending
- Lacing & Expansion
- Return Bend Fixing & Brazing
- Leak Testing
- Final Inspection & Packing
Assembly Process
Challenges

✓ Availability of Copper tube in smaller diameter
  - Limited Suppliers
  - Longer Lead Time
✓ Precise tooling & Limited tool Manufacturers
✓ Skilled Brazers required because of Smaller Diameters
Applications: 5 mm Condenser Coils

Application – Condensing Unit for CO2

Application – Clothes’ Dryer
Applications: 5 mm Condenser Coils

Application – For Marine Application

Application – Window RAC
Applications: 5 mm Condenser Coils

Application – ODU of Split RAC