Table of Contents

Section 1: Principle of Operation ................................................................. 2
  Model FC 125 ....................................................................................... 3
  Model FC 150 ....................................................................................... 4
  Model FC 200 ....................................................................................... 5
  Model FC 300 ....................................................................................... 6
  Model FC 400 ....................................................................................... 7
  Model FC 600 ....................................................................................... 8
Section 3: Options ................................................................................... 9
  Port Orientation ................................................................................... 9
  Drain Port ........................................................................................... 9
Section 4: Performance: GAS-to-GAS ...................................................... 10
Section 5: Performance: Water-to-GAS .................................................... 11
Section 6: Setup: Water-to-GAS .............................................................. 11

Nafion® is a registered trademark of DuPont.
FC™ is a trademark of Perma Pure LLC.
Section 1: Principle of Operation

FC™-Series Humidifiers are shell and tube moisture exchangers that allow transfer of water vapor. Humidifiers can be setup Gas-to-Gas or Water-to-Gas. Water molecules are absorbed into walls of the Nafion® tube and transferred to dry gas stream. This transfer is driven by the difference in partial pressures of water vapor on opposing sides.
### Section 2: Specifications

#### Model FC125

<table>
<thead>
<tr>
<th>Model Number</th>
<th>A (inch)</th>
<th>B (Nom.)</th>
<th>C (inch)</th>
<th>D (inch)</th>
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<tr>
<td>FC125-240-5MP</td>
<td>7.9</td>
<td>5</td>
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<td>10</td>
<td>9.6</td>
<td>7.9</td>
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</table>

**Materials of construction:**
- Housing – Shell – Polypropylene, End caps – GE Noryl
- Seals – EPDM (peroxide cured)
- Tube bundle headers – Thermoset polyurethane
- Membrane tubing – Nafion®

**Operating fluid pressure range:** 0 to 172 kPa (0 to 25 psig) @ 80°C (176°F)

**Operating fluid temperature range:** 1 to 80°C (33 to 176°F)

**Pressure differential on tubing:** 35 kPa (0 to 5 psid) @ 80°C (176°F)
  - Negative pressure differential will collapse tubing and must be avoided

**Storage temperature range:** -30 to 60°C (-22 to 140°F)

**Fittings:** Due to differing rates of expansion, metal fittings are not recommended. ABS or Nylon fittings are preferred.
Model FC150

<table>
<thead>
<tr>
<th>Model Number</th>
<th>A</th>
<th>B (Nom.)</th>
<th>C</th>
<th>D</th>
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<tr>
<td></td>
<td>inch</td>
<td>mm.</td>
<td>inch</td>
<td>mm.</td>
</tr>
<tr>
<td>FC150-480-7PP</td>
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<td>292.1</td>
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<td>177.8</td>
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<td>FC150-480-10PP</td>
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<td>FC150-480-15PP</td>
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</table>

Materials of construction:
- Housing – Polypropylene
- Seals – EPDM (peroxide cured)
- Tube bundle headers – Thermoset polyurethane
- Membrane tubing – Nafion®

Operating fluid pressure range: 0 to 172 kPa (0 to 25 psig) @ 80°C (176°F)

Operating fluid temperature range: 1 to 80°C (33 to 176°F)

Pressure differential on tubing: 35 kPa (0 to 5 psid) @ 80°C (176°F)
   Negative pressure differential will collapse tubing and must be avoided

Storage temperature range: -30 to 60°C (-22 to 140°F)

Fittings: Due to differing rates of expansion, metal fittings are not recommended. ABS or Nylon fittings are preferred.
Model FC 200

Shell diameter: 2.48 inches (63mm)

Materials of construction:
- Housing – Shell – Polypropylene, End caps - GE Noryl
- Seals – EPDM (peroxide cured)
- Tube bundle headers – Thermoset polyurethane
- Membrane tubing – Nafion®

Maximum operating pressure: 3 Bar Absolute

Operating fluid temperature range: 1 to 80°C (33 to 176°F)

Pressure differential on tubing: 35 kPa (0 to 5 psid) @ 80°C (176°F)
  Negative pressure differential will collapse tubing and must be avoided

Storage temperature range: -30 to 60°C (-22 to 140°F)

Fittings: Due to differing rates of expansion, metal fittings are not recommended. ABS or Nylon fittings are preferred.

<table>
<thead>
<tr>
<th>Model Number</th>
<th>A (inch)</th>
<th>A (mm)</th>
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<th>B (mm)</th>
<th>C (inch)</th>
<th>C (mm)</th>
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<tbody>
<tr>
<td>FC200-780-7MP</td>
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**Model FC 300**

<table>
<thead>
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<td>FC300-1660-7LP</td>
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<td>FC300-1660-10LP/HP</td>
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<td>510.5</td>
<td>15</td>
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</tbody>
</table>

Shell diameter 3.4 inches (86.4mm)

**Materials of construction:**
- Housing – GE Noryl
- Seals – EPDM (peroxide cured)
- Tube bundle headers – Thermoset polyurethane
- Membrane tubing – Nafion®

**Maximum operating pressure**: LP models to 10 psig; HP models to 45 psig

**Operating fluid temperature range**: 1 to 90°C (33 to 212°F)

**Pressure differential on tubing**: 35 kPa (0 to 5 psid) @ 80°C (176°F)
  - Negative pressure differential will collapse tubing and must be avoided

**Storage temperature range**: -30 to 60°C (-22 to 140°F)

**Fittings**: Due to differing rates of expansion, metal fittings are not recommended. ABS or Nylon fittings are preferred.
**Model FC 400**

- **E**: 7.20 inches (182.9 mm)
- **F**: 6.11 inches (155.2 mm)

Shell diameter 4.5 inches (114.3 mm)
Optional 3/8” NPT drain port available

### Materials of construction:

- Housing – GE Noryl
- Seals – EPDM (peroxide cured)
- Tube bundle headers – Thermoset polyurethane
- Membrane tubing – Nafion®

### Maximum operating pressure:

- LP models to 10 psig; HP models to 45 psig

### Operating fluid temperature range:

1 to 90°C (33 to 212°F)

### Pressure differential on tubing:

35 kPa (0 to 5 psid) @ 80°C (176°F)

- Negative pressure differential will collapse tubing and must be avoided

### Storage temperature range:

-30 to 60°C (-22 to 140°F)

### Fittings:

Due to differing rates of expansion, metal fittings are not recommended. ABS or Nylon fittings are preferred.

---

**Model Number**

<table>
<thead>
<tr>
<th>Model Number</th>
<th>A</th>
<th>B (Nom.)</th>
<th>C</th>
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<tr>
<td></td>
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<td>inch</td>
<td>mm.</td>
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<tr>
<td>FC400-2500-7LP/HP</td>
<td>12.8</td>
<td>325.1</td>
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<td>401.3</td>
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Model FC 600

<table>
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<th>A (inch)</th>
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<tbody>
<tr>
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<td>FC600-7000-15PP</td>
<td>22.75</td>
<td>577.9</td>
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</tbody>
</table>

Materials of construction:
- Housing - Polypropylene
- Seals – EPDM (peroxide cured)
- Tube bundle headers – Thermoset polyurethane
- Membrane tubing – Nafion®

Operating fluid pressure range: 0 to 35 kPa (0 to 5 psig) @ 80°C (176°F)

Operating fluid temperature range: 1 to 80°C (33 to 176°F)

Negative pressure differential will collapse tubing and must be avoided

Storage temperature range: -30 to 80°C (-22 to 176°F)

Fittings: Due to differing rates of expansion, metal fittings are not recommended. ABS or Nylon fittings are preferred.
Section 3: Options

Port Orientation

When ordering, please specify the orientation of the end caps.

Drain Port

Due to differing rates of expansion, metal fittings are not recommended. ABS or Nylon fittings are preferred.
Section 4: Performance: GAS-to-GAS

Units are expressed as flow rate of air (alpm) in relation to approach dew point temperature. Approach temperature is defined as difference between wet gas entering humidifier and humidified stream outlet. For example, for FC125-240-10MP at 25 lpm, wet gas enters humidifier at 70°C at Approach Temperature of 4°C humidified stream outlet would be 66°C.

\[
\text{Approach dew point} = \text{dp}1 - \text{dp}2 \\
\text{Approach Temp} = \text{T}1 - \text{T}2
\]

Example: 70°C cathode exhaust  
Approach dew point = 4°C  
Approach Temp = 2.5°C

Humidifier outlet  
66°C dew point  
67.5°C Temp  
93% RH
Section 5: Performance: Water-to-GAS

Performance can be controlled by increasing heat or by decreasing sample flow. Chart below shows performance of various models.

<table>
<thead>
<tr>
<th>Model</th>
<th>Flow Rate (Actual Liters per minute)</th>
<th>Flow Rate (Actual Liters per minute)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FC-600-8&quot;</td>
<td>1,667</td>
<td>3,333</td>
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<td>FC-400-10&quot;</td>
<td>744</td>
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<td>FC-300-10&quot;</td>
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<td>FC-200-7&quot;</td>
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<td>FC-125-5&quot;</td>
<td>36</td>
<td>71</td>
</tr>
</tbody>
</table>

Section 6: Setup: Water-to-GAS

In Water-to-Gas setup, heated water needs to be continuously circulated. Flow with greater pressure needs to be flowing inside tubes to prevent tubing collapse. DI water should be circulated at 4 LPM for 100 LPM of dry gas flow.

Due to differing rates of expansion, metal fittings are not recommended. ABS or Nylon fittings are preferred.