Discussion of Automotive Air Conditioning Molecular Sieve Specifications
**Material Specification**

**AD-1® Molecular Sieve Material**

AD-1® Molecular Sieve 8x12 Beads

Designed for use in Automotive Air Conditioning Systems

<table>
<thead>
<tr>
<th>Properties</th>
<th>US Units Specification</th>
<th>Metric Specification</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Capacity @ 4.6 torr, 25°C (wt%) (minimum)</td>
<td>16.0%</td>
<td>16.0%</td>
<td>ADT-1</td>
</tr>
<tr>
<td>Loss on Ignition (LOI) @ 960° (wt%) (maximum)</td>
<td>1.0%</td>
<td>1.0%</td>
<td>ADT-2</td>
</tr>
<tr>
<td>Density (minimum)</td>
<td>53.0 lbs/ft³</td>
<td>0.848 gm/ml</td>
<td>ADT-3</td>
</tr>
<tr>
<td>Crush, average 25 beads (minimum)</td>
<td>14.0 lbf</td>
<td>62.0 N</td>
<td>ADT-4</td>
</tr>
<tr>
<td>Hydrated Attrition (wt%) (maximum)</td>
<td>2.0%</td>
<td>2.0%</td>
<td>ADT-6</td>
</tr>
<tr>
<td>Bead Size Distribution (wt%)*</td>
<td>100.0% min</td>
<td>100.0% min</td>
<td>ADT-7</td>
</tr>
<tr>
<td>Through 6 mesh</td>
<td>90.0% min</td>
<td>90.0% min</td>
<td></td>
</tr>
<tr>
<td>Through 8 mesh</td>
<td>10.0% max</td>
<td>10.0% max</td>
<td></td>
</tr>
<tr>
<td>Through 12 mesh</td>
<td>0.01% max</td>
<td>0.01% max</td>
<td></td>
</tr>
<tr>
<td>Through 20 mesh</td>
<td></td>
<td></td>
<td></td>
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<td>12.0 lbf</td>
<td>14.0 lbf</td>
<td>ADT-4</td>
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| Sealed Tube Chemical Compatibility              | Pass                    | Pass                   | ASHRAE 97   |

Although specifications are the same, AD-1® molecular sieve typical values exhibit increased density which allows for more desiccant to be packed into a smaller area in the Accumulator, R-D, or Integrated Condenser.

AD-1® molecular sieve exhibits increased durability with higher crush strength.

AD-1® molecular sieve has demonstrated equal to, or better, attrition test results when compared to UOP XH-7™ molecular sieve.

XH-7 is a trademark of UOP
**AD-1® Molecular Sieve Adsorbent**

Flow Dry® Technology AD-1® molecular sieve adsorbent was created in response to a strong market need for a high quality, high performing, yet economical desiccant for drying HFC-134a, 1234yf and other refrigerants.

For years, one supplier’s product line set a standard for quality and performance in refrigerant drying applications that other suppliers could not meet. An equivalent product is now available. AD-1® molecular sieve was specifically developed as the economic desiccant alternative to meeting those high standards for:

- High water capacity
- Strong resistance to attrition (wet and dry)
- High bead crush strength
- Density
- Chemical compatibility

The desiccant’s purpose is to remove moisture from the refrigerant. AD-1® molecular sieve delivers the same drying performance that users have come to expect.

System vibration has always been an issue in refrigerant systems. Vibration can cause molecular sieve beads to move or rub against each other. This can cause dust to form from bead attrition, which can then cause premature system failure due to plugging, or excessive component wear. AD-1® molecular sieve meets and exceeds the industry standards for attrition resistance. It is important to have excellent attrition resistance when the beads are dry – early in the system life, and when wet – as the system ages and the desiccant has adsorbed more moisture.

High bead crush strength signifies a durable product that can withstand the rigors of the dryer assembly process and the end use application. AD-1® desiccant exceeds industry expectations with superior bead crush strength.

Most dryers have a defined, but limited volume available for the desiccant. AD-1® desiccants density utilizes the right amount of space in a dryer.

AD-1® molecular sieve has proven chemically compatible with HFC-134a, 1234yf and with several industry standard compressor oils. Discuss other refrigerant applications with your Flow Dry representative.

**Bead Sizes Available**

AD-1® molecular sieve standard bead size is 8x12 mesh (2 mm). Other bead sizes may be made available.

**Quality Assurance**

AD-1® molecular sieve production is rigorously tested, using advanced testing equipment and methods, for strict compliance to industry standards.

**Why Molecular Sieves Are Used in the AC System**

The presence of moisture in the closed refrigerant loop can cause a number of problems:

- Freeze up in capillary tube or expansion valve
- Formation of sludge, which plugs the expansion valve
- Corrosion of metal parts
- Hydrolysis of the refrigerant that forms corrosive acids
- Hydrolysis of the lubricant which will degrade its performance

Molecular Sieve will remove and trap water from the refrigerant as long as it has capacity.

The Molecular Sieve quantity should provide enough adsorption capacity to handle initial water during assembly + water that migrates into the system during its life.

In early Automotive AC system, Silica Gel, a common desiccant was used. It was replaced by Molecular Sieve for several reasons:

- Molecular Sieve minimizes de-composure of Refrigerants – compatibility
- Molecular Sieve has a higher water capacity under changing temperature and pressure. It will not release moisture back into the system.
- Molecular Sieve absorbs water, but not refrigerant or oil.

**Typical Properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Capacity (wt%)</td>
<td>17%</td>
</tr>
<tr>
<td>LOI 960°C, max (wt%)</td>
<td>1.0%</td>
</tr>
<tr>
<td>Density, min (lbs/ft³)</td>
<td>53.0 (0.848 gm/ml)</td>
</tr>
<tr>
<td>Crush, avg 25 beads, min (lbs.f)</td>
<td>14 (62.0 N)</td>
</tr>
<tr>
<td>Attrition, max (wt%)</td>
<td>2.0%</td>
</tr>
</tbody>
</table>

AD-1® adsorbent specification sheet available upon request.

**Safety and Handling**

Contact your Flow Dry representative for a copy of the AD-1® molecular sieve MSDS and for any questions related to handling the product.

**For More Information**

For more detailed information regarding AD-1® molecular sieve technical data and competitive product comparisons, contact Flow Dry® Technology.

www.flowdry.com
Criteria for Selecting the right Molecular Sieve in the Automotive AC system

Chemical Compatibility
The Molecular sieve should not cause de-composure of the refrigerant or formation of Acids

High Water Capacity
The higher the capacity, the less Molecular Sieve is required

Reasons to Use only Approved Molecular Sieves

Avoid system failure caused by incompatible desiccant:
- Incompatibility with oil and refrigerant is indicated by excessive amounts of acids, copper, aluminum and iron
- Testing is performed using ASHRAE 97

Approved material with 16% or more Total Water Capacity provides System Protection
- Industry standard test method using McBain- Bakr test apparatus
- Typically the Raw Material should be under 1% moisture to start. (LOI)

Good Physical Strength
The Molecular Sieve should not “break apart” from vehicle vibration

- The industry standard is 2% Attrition or less, using the industry standard paint shaker test method: LPM-437-3 (UOP) or ADT-6 (FDT)
- Prior to UOP XH products, “Black Death” of the system occurred due to break up of beads
- The Attrition test was designed by UOP
- Test method is LPM-437-3 (UOP) or ADT-6 (FDT)
- Only Flow Dry has calibrated our attrition test to UOP test
- To our knowledge ONLY UOP XH-7™ (XH-9™) and Flow Dry AD-1® Molecular sieves meet the 2% maximum attrition test

Good physical Strength
Avoid system failure caused by higher than specified attrition rates:
- Attrition is the breakdown of desiccant particles due to vehicle vibration
**Paint Shaker Attrition Test ADT-6**

**A. Introduction:**
The hydrated paint shaker attrition test is important to insure the product will not breakdown in the system causing failure of other components in the A/C system. This test method will determine the attrition resistance of saturated molecular sieve beads. The molecular sieve bead has a higher attrition rate when hydrated than an activated bead making the hydrated test critical. A sample of molecular sieve will be placed in a glass jar with trichloroethylene. The jar will be placed into a paint shaker and shook for a specified time period and RPM (Revolutions - Per - Minute). The contents of the jar will then be flushed over a 100 mesh screen and the sample measured to determine the amount of attrition.

**B. Materials:** Molecular sieve.

**C. Apparatus:**
- Paint shaker (Red Devil)
- Two glass jars with lids
- Metal funnel with 100 mesh screen.
- Oven with operating temperature of 450°C and exhaust vent for trichloroethylene fumes.
- Oven of operating temperature of 1000°C
- Digital scale 1000 gram capacity with ±0.1 gram accuracy.

**D. Procedure:**
- Pour 454 grams of molecular sieve sample for testing onto a screen hydrator.
- Allow material to air equilibrate for 24 hours.
- Run 1000°C LOI test on a sample of the material and record LOI value.
- Weigh out 143.0 ±0.1 gram sample and record weight.
- Pour the sample into the jar.
- Pour enough trichloroethylene to completely immerse the sample in liquid. Leaving a free space at the top of jar.
- Tighten lid securely.
- Repeat previous steps for second sample.
- Install the two jars and tighten paint shaker clamp.
- Shake the two samples for specified time (two hours ±1 minute for AD-1)
- Remove jars from shaker.
- Remove one sample jar lid and pour the contents though 100 mesh funnel into a beaker.
- Rinse the sample material on the screen with 300 ml of clean trichloroethylene into the 400 ml beaker.
- Repeat previous two steps with second sample jar and 400 ml beaker.
- Let beakers stand for 30 minutes and decant to approximately 100 ml.
- Safely discard excess trichloroethylene.
- Place samples in oven at 200°C until residue appears dry.
- Increase oven temperature to 450°C and dry for 30 minutes.
- Remove samples and weigh immediately to ±0.1 gram.

**E. Calculation:**

\[
\text{weight loss \%} = \frac{\text{weight 100 mesh dry material in beaker}}{\text{sample weight}} \times 100.
\]
Typical Results for Approved Molecular Sieves vs. China Suppliers

<table>
<thead>
<tr>
<th>Specification</th>
<th>Water Capacity</th>
<th>Hydrated Attrition</th>
<th>Bead Strength</th>
<th>Compatibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>UOP XH-7™</td>
<td>16.8%</td>
<td>0.5%</td>
<td>13.0</td>
<td>Pass</td>
</tr>
<tr>
<td>FDT AD-1®</td>
<td>18.2%</td>
<td>0.4%</td>
<td>20.7</td>
<td>Pass</td>
</tr>
<tr>
<td>Supplier A</td>
<td>15.5%</td>
<td>2.3%</td>
<td>16.0</td>
<td>Results unknown</td>
</tr>
<tr>
<td>Supplier B</td>
<td>15.3%</td>
<td>3.8%</td>
<td>4.0</td>
<td>Results unknown</td>
</tr>
<tr>
<td>Supplier C</td>
<td>16.8%</td>
<td>4.3%</td>
<td>7.8</td>
<td>Pass</td>
</tr>
<tr>
<td>Supplier D</td>
<td>15.3%</td>
<td>11.4%</td>
<td>10.6</td>
<td>Results unknown</td>
</tr>
</tbody>
</table>

Customers must verify the exact origin and performance of the Molecular Sieve

Many China suppliers provide “copied” certifications. The Molecular Sieves in China may be very “cheap” but will likely damage the AC System instead of protecting it. If the RFQ game is fairly played, other Desiccant Bag Suppliers should only be using UOP XH-7™ or FDT AD-1® in the USA and Europe due to trademark and performance. If a customer is willing to accept the risk of a Molecular Sieve other than supplied by UOP or FDT, they should assure that the product is tested to the industry standards by an independent lab.

Flow Dry’s recommendation is UOP XH-7™ or AD-1® Molecular Sieve for R134a and 1234yf systems

Flow Dry has fully tested all the parameters of AD-1® according to same Industry Standard tests as UOP. Flow Dry has provided a full approval document with all this information to our customers. Many of our other customers have approved AD-1®. Flow Dry continues to test EVERY LOT of AD-1® Molecular Sieve before acceptance.
**USA**

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