DEVELOPMENT OF TEST PROTOCOLS FOR INTERNATIONAL SPACE STATION PARTICULATE FILTERS

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OBJECTIVES

Develop test protocols for ISS filters
  after use
  in storage

Develop new test, storage and in use replacement protocol
HEPA-grade filters

21 Filters in US segment.

Replacement interval between 2-5 years
On-orbit frequent vacuuming of face screen.

Filters in stock reaching the end of “use life”.

BACKGROUND
FAILURE MECHANISMS

Deterioration of binder in the media

Oxidation or loss of volatile constituents in the sealing adhesive

Crystallization of the glass fiber media
ISS FILTER ELEMENT
FILTER DETAILS

Al frame mini pleat HEPA filter
29” x 4” x 4.375”.

20-mesh (0.84-mm clear opening) face screen, (Nomex™) at inlet;
aluminum at outlet.
TEST SPECIFICATION

99.9% efficiency @ 0.3 microns @ 70 CFM

Mil Std 282
IEST RP 001
IEST RP 034?
EXPERIMENT

Leak testing per IEST RP 034

Filters per spec as acquired
Failure will show as leak
  in storage
  after use
TEST SET UP

Leak testing

RP 034 recommended design

Overall efficiency (future needs)
NASA GRC FILTER TEST SYSTEM
TEST INSTRUMENTS

Laskin Nozzle  
(ATI Model 4B)

Photometer  
(TEC Services Model 4B)
FLOW MODELING

(a)

(b)

Velocity Vectors Colored By Velocity Magnitude (m/s)
FLOW MODELING

Good uniformity with screen
FLOW AND AEROSOL DISTRIBUTION MEASUREMENTS
FLOW AND AEROSOL DISTRIBUTION MEASUREMENTS

Light sheet visual aerosol uniformity
TEST FILTERS

One filter from ISS after ~ 1 year use

One filter after other engineering evaluations.
LEAK TESTING PRELIMINARY RESULTS

Test without Nomex screen

Scan entire filter cross-section

Follow IEST RP 034 guidelines
LEAK TESTING PRELIMINARY RESULTS (CONT.)

Filter #1:
Nominal penetration 0.2-5% with spikes in the readings as noted below.
Several readings did not correlate with known damage.

Filter #2: Scans showed values typically <0.001 with incidental readings in the 0.01 range.

<table>
<thead>
<tr>
<th>Test point</th>
<th>Location (in cm from LHS)</th>
<th>Measured penetration (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0 (left edge)</td>
<td>18-20%</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>0.0018-0.0021</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>0.0008</td>
</tr>
<tr>
<td>4</td>
<td>16.8</td>
<td>55.0, 52.4</td>
</tr>
<tr>
<td>5</td>
<td>20.3</td>
<td>0.64-0.66</td>
</tr>
<tr>
<td>6</td>
<td>28</td>
<td>6.80-7.00</td>
</tr>
<tr>
<td>7</td>
<td>34.3</td>
<td>19.0-23.9</td>
</tr>
<tr>
<td>8</td>
<td>36.5</td>
<td>47.9-48.5</td>
</tr>
<tr>
<td>9</td>
<td>45.7</td>
<td>0.0000</td>
</tr>
<tr>
<td>10</td>
<td>58.4</td>
<td>0.0000</td>
</tr>
<tr>
<td>11</td>
<td>73.7 (right edge)</td>
<td>0.54, 0.82, 0.93</td>
</tr>
</tbody>
</table>
LEAK TESTING PRELIMINARY RESULTS (CONT.)
SUMMARY

Test system met best practice for air and aerosol uniformity

Preliminary results indicate ability to detect leak

Better ability to validate good filter
FUTURE WORK

Improve fidelity of leak testing

Modify or develop revised test setup for efficiency testing.

Develop NASA acceptance test protocol for filters and test systems

Develop revised life and storage criteria.
THANK YOU (FINAL) PAGE

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