Advanced Fuel Filtration System
vs.
Navy Shipboard Centrifugal Purifier
(tested onboard DDG 51 class ships)
A 90 GPM Advanced Fuel Filtration System (AFFS) was developed by FSI for the replacement of the Navy shipboard centrifugal purifier, which processes the marine diesel fuel (DFM) from the storage tank before being fed into the service tank.

A side-by-side comparison, the AFFS replaced the #1 FO PUR (centrifugal purifier) and running in parallel to the existing #2 FO PUR (centrifugal purifier), was performed onboard a DDG during a seven-month deployment for performance and operation evaluation.

Besides the daily fuel sampling from both units, a long term effect can also be observed through the replacement of downstream polisher filter set (service filters), i.e. a better fuel purifier would provide higher quality of processed fuel and thus would require less replacement of service filters.
A 90 GPM Fuel Filtration System
Installation Onboard a DDG
Fuel Quality Comparison between Centrifugal Purifier and AFFS

Debris Content: <2.64 mg/L
Particle Size: < 5 μm
Water Content: <10 ppm

Debris Content: ~4 mg/L
Particle Size: Varied (>> 5 μm)
Water Content: ~30 ppm
The advantage of AFFS really stands out when the ship received a bad load of fuel.
Shipboard Test Results – Filter Service Life

Accumulated Processed Fuel from AFFS Filter Cartridge Set

Note: AFFS filter cartridge set installed on 9 Feb 05, data per 1 Jul 05
Proof of Performance

One Single Pass!

Fuel Quality Measured*: Water Content < 3 PPM Sediment < 0.26 mg/l

* Fuel filtered from test fuel with 5% water and 100 mg/l test dust
## Centrifugal Purifier vs. AFFS

<table>
<thead>
<tr>
<th>Description</th>
<th>Centrifugal Purifier</th>
<th>FSI's Fuel Filtration Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment Cost</td>
<td>High</td>
<td>~1/2 Centrifugal Purifier Cost</td>
</tr>
<tr>
<td>Energy Cost</td>
<td>High (Driven by a 40 HP motor, @4500 RPM for continuous recirculation)</td>
<td>~1/10 of Centrifugal Purifier Cost (Stationary equipment, single pass process)</td>
</tr>
<tr>
<td>Maintenance &amp; Operation Cost</td>
<td>High</td>
<td>~1/4 Centrifugal Purifier Cost</td>
</tr>
<tr>
<td>Installation Cost</td>
<td>High</td>
<td>~1/2 Centrifugal Purifier Cost</td>
</tr>
<tr>
<td>Water &amp; Lube Oil Supplies</td>
<td>Required (Piping, Fittings, Valves)</td>
<td>Not Required</td>
</tr>
<tr>
<td>Processed Fuel Quality</td>
<td>Low (Debris Content: ~4mg/L, Particle Size: &gt;&gt; 5 µm, Water: ~30 ppm)</td>
<td>High (Debris Cont.: &lt;2.64mg/L, Particle Size: &lt; 5 µm, Water: &lt;10 ppm)</td>
</tr>
</tbody>
</table>
## Centrifugal Purifier vs. AFFS (continued)

<table>
<thead>
<tr>
<th>Description</th>
<th>Centrifugal Purifier</th>
<th>FSI's Fuel Filtration Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logistics Support Requirements</td>
<td>Many (126 spare part items, 17 special tools required)</td>
<td>Few (36 spare part items, no special tools required)</td>
</tr>
<tr>
<td>Reliability (based on Navy Casreps)</td>
<td>Low (fuel spills through &quot;breakover&quot;)</td>
<td>High (no &quot;breakover&quot; situation)</td>
</tr>
<tr>
<td>Shipboard Arrangement</td>
<td>Rigid (closed coupled, alignment and balance sensitive)</td>
<td>Flexible</td>
</tr>
<tr>
<td>Noise and Vibration</td>
<td>High</td>
<td>Low (Operational/tactical acoustic signature eliminated)</td>
</tr>
<tr>
<td>Weight &amp; Dimensions</td>
<td>Large</td>
<td>Small (~1/2 Weight of Centrifugal Purifier)</td>
</tr>
<tr>
<td>HAZMAT (based on deployment data)</td>
<td>Much (30 sets polisher filters consumed under 7 month deployment)</td>
<td>Little (9 sets polisher filters consumed under 7 month deployment)</td>
</tr>
</tbody>
</table>
AFFS Key Technologies

- Cross-flow filtration
- Dean Flow*
- Back-flushing
- Hydrophobic membrane*

* Proprietary from FSI
Conventional vs. Cross-Flow Filtration

“Dead-end” Filtration

Cross-flow Filtration

Suspension

Filtrate (Permeate)

Suspension

Filtrate (Permeate)
Anatomy of an Innovative Solution

Filtrate

Feed

Spiral Guides

Dean Flow

Filter Cartridge
Dean Flow: *What A Difference!*
Hydrophobic Membrane

- Emulsified Water Droplet (0.5-10μm)
- Debris
- Contaminant
- Membrane Pore
- Membrane
- Pressure Pushes Fuel Through Membrane
- Direction of Flow
- Fuel Molecules