Warman® Screw Flow (WSF) Pumps

Presented by
Basia Kielska – Sr. Business DvIpt Lead
Weir Minerals Europe
What is a Screw Centrifugal pump?
Single Vane Screw Centrifugal Pump

Screw Pump & Centrifugal Pump Hybrid

Unique Characteristics
Low NPSH
High Efficiency
Large Solids Passage
Screw Centrifugal Pump Curve

WARMAN® Centrifugal Screw Pump

Model SFF6-Y

High absolute efficiency
70% or higher
Wide efficiency band

200 mm Suction
150 mm Discharge
350 mm Impeller Diameter
110 mm Max Sphere Size

L/s = 3.6 x m³/hr
bar = m x 10.2
kW = m³/hr x m x SG / 367 x Efficiency

The power and efficiency shown is for pumps with packing. Pumps with mechanical seals will require additional power; please contact the factory for these values.

Performance tests certified to Hydraulic Institute Grade 2, Acceptance Grade 2B.

Copyright © 2018, 2015 Envirotech PumpSystems, Inc.. All rights reserved. WEIR and WEIR (logo) are trademarks and/or registered trademarks of Weir Engineering Services Ltd.

Rev. 00
March 2016
P25-D112-M
SFF6-Y
Trimming a screw centrifugal impeller is not practical due to the complex and unsymmetrical geometry of the impellers.
For conventional pumps, extended coverage is obtained by trimming an impeller.
Unique screw pump and a centrifugal pump hybrid

Requires some interesting design challenges to make the pumps competitive across a wide range of conditions with other designs.

The problem is how do address the different geometry required by this hybrid.

And still yield a high efficiency.

And provide the coverage range that conventional impellers can provide by trimming?

2 differently shapes impellers for the same pump necessary to cover a normal application range.
The answer is to design a number of impellers per size of pump by specific speed number to optimize efficiency for a given condition of service.
The answer is to design a number of impellers per size of pump by specific speed number to optimize efficiency for a given condition of service.

Different Impeller BEP Points for the SFE5 Series at 1800 rpm:
- L = 79%
- D = 77%
- Y = 80%
- J = 76%
- R = 76%
- B = 70%

All at 1800 rpm
Multiple impellers available per size of pump to optimize efficiency for a given condition of service
When making a selection for a screw centrifugal pump, there are more impeller options available than conventional designs.

### Screw Centrifugal Family Curve

<table>
<thead>
<tr>
<th>Size</th>
<th>Screw centrifugal pump selections</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFD3-L Horizontal</td>
<td></td>
</tr>
<tr>
<td>SFD3-R Horizontal</td>
<td></td>
</tr>
<tr>
<td>SFD3-Y Horizontal</td>
<td></td>
</tr>
<tr>
<td>SFD4-F Horizontal</td>
<td></td>
</tr>
<tr>
<td>SFD4-V Horizontal</td>
<td></td>
</tr>
<tr>
<td>SFD4-Y Horizontal</td>
<td></td>
</tr>
<tr>
<td>SFE4-Y Horizontal</td>
<td></td>
</tr>
<tr>
<td>SFE5-B Horizontal</td>
<td></td>
</tr>
<tr>
<td>SFE5-D Horizontal</td>
<td></td>
</tr>
<tr>
<td>SFE5-J Horizontal</td>
<td></td>
</tr>
<tr>
<td>SFE5-L Horizontal</td>
<td></td>
</tr>
<tr>
<td>SFE5-R Horizontal</td>
<td></td>
</tr>
<tr>
<td>SFE5-Y Horizontal</td>
<td></td>
</tr>
<tr>
<td>SFE8-B Horizontal</td>
<td></td>
</tr>
<tr>
<td>SFE8-D Horizontal</td>
<td></td>
</tr>
<tr>
<td>SFE8-T Horizontal</td>
<td></td>
</tr>
<tr>
<td>SFE8-Z Horizontal</td>
<td></td>
</tr>
<tr>
<td>SFF4-P Horizontal</td>
<td></td>
</tr>
<tr>
<td>SFF6-L Horizontal</td>
<td></td>
</tr>
<tr>
<td>SFF6-R Horizontal</td>
<td></td>
</tr>
<tr>
<td>SFF6-Y Horizontal</td>
<td></td>
</tr>
<tr>
<td>SFF10-N Horizontal</td>
<td></td>
</tr>
<tr>
<td>SFF10-T Horizontal</td>
<td></td>
</tr>
<tr>
<td>SFF10-Z Horizontal</td>
<td></td>
</tr>
</tbody>
</table>
Benefits
Conventional impeller designs have the highest efficiency, but they have impeller ports that have to be modified for solids.
2 port impeller modified for solids handling

- Depth and space between vanes for solid size
- Rounded edges to minimize textile build up
Multi-vane impellers are vulnerable to blockages
Rags and fibrous materials hang up on leading edge
As a conventional non-clog pump begins to clog it becomes less efficient
Rags/fibers which contact blade leading edge are swept to the center of the impeller where they are deposited into the flow and pass freely through the pump.
Impeller runs against a grooved liner - fibrous solids redirected and channeled through pump

Smooth liner available for gentle handling applications, such as:

- Live fish
- Food handling
- Oily water
- Carbon transfer
- Tomato paste
The screw centrifugal impeller pump is designed to eliminate clogging that occurs with standard non-clog type pumps.
The single vane impeller provides a single flow path through the pump. The grooved liner ensures any items that get trapped between the impeller and liner are forced back into the flow stream. The impeller tip is protected by the wear ring shoulder, ensuring it stays out of the flow path. The combination of these items ensures the design of the single vane screw centrifugal impeller provides amazing clog resistance.
Materials

High chrome impellers
- Standard, increased wear life over cast iron

High chrome grooved liners
- Standard, increased wear life over cast iron

Externally adjustable liners
- Standard (except on D-size pumps, which are adjusted via shims), allows for easier adjustment of impeller to liner clearance

Cast iron bearing frames
- Standard
Ease of maintenance
All pumps offering reasonably high efficiencies rely on some form of close clearance wearing parts to maintain the efficiency.
Wearing Parts

Abrasion resistant construction
450 Brinell Hi-chrome iron

Suction liner

Impeller
Screw Centrifugal Pump: Externally Adjustable Liner

Maintains optimal hydraulic efficiency
Increased longevity of impeller and suction liner
Fine thread pitch allow precise and easy clearance adjustment
No need to disassemble any components
Mechanical Seals

Outer seal is an AES model M010H.

Tungsten carbide vs. Silicon carbide faces.

Easy installation. Install stationary face in bore around shaft, then push the rotating assembly on. No set screws, no adjustments needed. A lip is provided for prying to help with removal.

Lip for prying seal off for repairs
Inner seal is an AES P04U, designed to directly replace a John Crane type 2. Carbon vs. Ceramic faces. Held in place with a snap ring. No scribing of shaft, no measurements needed.
Configurations
The impeller types are listed in order from lowest to highest performance.
The higher the letters in the alphabet, the higher the performance.
Type W Bearing Frame

- Impeller Bearing
- Drive Bearing
- Thrust Bearings
- Oil Filled chamber with tandem mechanical seals
Type S Bearing Frame

Conventional Stuffing box with packing - Can be modified to fit mechanical seal

- Impeller Bearing
- Thrust Bearings
- Drive Bearing
Bearing Frames

**BFD0S, BFE2S, BFF2S bearing frames**
- Packed bearing frame

**BFD0SM, BFE2SM, BFF2SM bearing frames**
- Modified S-type bearing frames to allow the installation of customer specified mechanical seals.

**BFD0W, BFE2W, BFF2W bearing frames**
- Tandem mechanical seals running in an oil bath.

**Configurations:**
- Horizontal belt drive
- Horizontal direct connect
- Vertical direct connect
Arrangements – available April 2016

Horizontal

Direct Connect

Belt Drive

Vertical
Arrangements – available end of 2016

Submersible with fastout / guideshoe
Submersible Motors - Features

All motors are inverter duty rated.
All motors come with 3 N/C thermostats (klixons).
All motors are UL and CSA rated (no FM) explosion proof.
Working on ATEX and IEC-Ex ratings, but not currently available.
Selection
How to select a pump
**Example: Selection for 700 GPM at 35 feet TDH**

What is the best selection?

<table>
<thead>
<tr>
<th>Result</th>
<th>Size</th>
<th>Stages</th>
<th>Speed (rpm)</th>
<th>Pump Efficiency (%)</th>
<th>Power (hp)</th>
<th>NPSH (ft)</th>
<th>Max. Power (hp)</th>
<th>% BEP</th>
<th>% Max Diameter of Pitch</th>
<th>Solids diameter limit (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔</td>
<td>SFD4-F Horizontal</td>
<td>1</td>
<td>2115</td>
<td>57.81</td>
<td>10.70</td>
<td>-</td>
<td>12.21</td>
<td>151.52</td>
<td>N/A</td>
<td>2.75</td>
</tr>
<tr>
<td>?</td>
<td>SFD4-Y Horizontal</td>
<td>1</td>
<td>1800</td>
<td>68.37</td>
<td>9.04</td>
<td>-</td>
<td>9.75</td>
<td>111.16</td>
<td>N/A</td>
<td>3.78</td>
</tr>
<tr>
<td>✔</td>
<td>SFE4-Y Horizontal</td>
<td>1</td>
<td>1455</td>
<td>68.86</td>
<td>8.99</td>
<td>-</td>
<td>8.99</td>
<td>127.21</td>
<td>N/A</td>
<td>2.50</td>
</tr>
<tr>
<td>✔</td>
<td>SFE5-B Horizontal</td>
<td>1</td>
<td>1585</td>
<td>69.20</td>
<td>8.94</td>
<td>-</td>
<td>9.53</td>
<td>82.72</td>
<td>N/A</td>
<td>4.00</td>
</tr>
<tr>
<td>✔</td>
<td>SFE5-D Horizontal</td>
<td>1</td>
<td>1480</td>
<td>70.08</td>
<td>8.86</td>
<td>-</td>
<td>9.97</td>
<td>84.14</td>
<td>N/A</td>
<td>4.00</td>
</tr>
<tr>
<td>✔</td>
<td>SFE5-J Horizontal</td>
<td>1</td>
<td>1560</td>
<td>76.50</td>
<td>8.09</td>
<td>-</td>
<td>8.27</td>
<td>97.53</td>
<td>N/A</td>
<td>3.00</td>
</tr>
<tr>
<td>✔</td>
<td>SFE5-L Horizontal</td>
<td>1</td>
<td>1400</td>
<td>77.64</td>
<td>8.00</td>
<td>-</td>
<td>8.06</td>
<td>90.34</td>
<td>N/A</td>
<td>3.50</td>
</tr>
<tr>
<td>✔</td>
<td>SFE5-R Horizontal</td>
<td>1</td>
<td>1310</td>
<td>74.76</td>
<td>8.28</td>
<td>-</td>
<td>9.44</td>
<td>83.05</td>
<td>N/A</td>
<td>4.00</td>
</tr>
<tr>
<td>✔</td>
<td>SFE5-Y Horizontal</td>
<td>1</td>
<td>1200</td>
<td>76.88</td>
<td>8.07</td>
<td>-</td>
<td>9.91</td>
<td>83.46</td>
<td>N/A</td>
<td>4.00</td>
</tr>
<tr>
<td>✔</td>
<td>SFE8-B Horizontal</td>
<td>1</td>
<td>1595</td>
<td>66.33</td>
<td>9.30</td>
<td>-</td>
<td>11.91</td>
<td>68.89</td>
<td>N/A</td>
<td>4.00</td>
</tr>
<tr>
<td>✔</td>
<td>SFE8-D Horizontal</td>
<td>1</td>
<td>1505</td>
<td>68.18</td>
<td>9.10</td>
<td>-</td>
<td>9.92</td>
<td>61.95</td>
<td>N/A</td>
<td>4.00</td>
</tr>
<tr>
<td>✔</td>
<td>SFE8-T Horizontal</td>
<td>1</td>
<td>1335</td>
<td>62.29</td>
<td>9.92</td>
<td>-</td>
<td>11.38</td>
<td>51.07</td>
<td>N/A</td>
<td>4.00</td>
</tr>
<tr>
<td>✔</td>
<td>SFE8-Z Horizontal</td>
<td>1</td>
<td>1240</td>
<td>63.90</td>
<td>9.71</td>
<td>-</td>
<td>11.63</td>
<td>51.00</td>
<td>N/A</td>
<td>4.00</td>
</tr>
<tr>
<td>✔</td>
<td>SFF10-N Horizontal</td>
<td>1</td>
<td>1065</td>
<td>54.67</td>
<td>11.32</td>
<td>-</td>
<td>11.35</td>
<td>45.69</td>
<td>N/A</td>
<td>4.50</td>
</tr>
<tr>
<td>?</td>
<td>SFF10-T Horizontal</td>
<td>1</td>
<td>975</td>
<td>54.48</td>
<td>11.35</td>
<td>-</td>
<td>11.59</td>
<td>33.27</td>
<td>N/A</td>
<td>4.75</td>
</tr>
<tr>
<td>?</td>
<td>SFF10-Z Horizontal</td>
<td>1</td>
<td>910</td>
<td>51.67</td>
<td>11.97</td>
<td>-</td>
<td>12.34</td>
<td>34.52</td>
<td>N/A</td>
<td>4.75</td>
</tr>
<tr>
<td>✔</td>
<td>SFF4-P Horizontal</td>
<td>1</td>
<td>1120</td>
<td>71.97</td>
<td>8.59</td>
<td>-</td>
<td>8.77</td>
<td>110.71</td>
<td>N/A</td>
<td>2.50</td>
</tr>
<tr>
<td>✔</td>
<td>SFF4-Y Horizontal</td>
<td>1</td>
<td>985</td>
<td>75.20</td>
<td>8.22</td>
<td>-</td>
<td>8.46</td>
<td>102.84</td>
<td>N/A</td>
<td>3.00</td>
</tr>
<tr>
<td>✔</td>
<td>SFF6-L Horizontal</td>
<td>1</td>
<td>1050</td>
<td>70.81</td>
<td>8.75</td>
<td>-</td>
<td>8.87</td>
<td>58.13</td>
<td>N/A</td>
<td>4.50</td>
</tr>
<tr>
<td>✔</td>
<td>SFF6-R Horizontal</td>
<td>1</td>
<td>950</td>
<td>68.04</td>
<td>9.10</td>
<td>-</td>
<td>10.04</td>
<td>66.04</td>
<td>N/A</td>
<td>4.50</td>
</tr>
</tbody>
</table>
Example: Selection for 700 GPM at 35 feet TDH

What is the best selection?

<table>
<thead>
<tr>
<th>Result</th>
<th>Size</th>
<th>Speed, rated (rpm)</th>
<th>Pump Efficiency (%)</th>
<th>Power, rated (hp)</th>
<th>NPSHr (ft)</th>
<th>Max. Power (hp)</th>
<th>% BEP</th>
<th>% Max Diameter or Pitch</th>
<th>Solids diameter limit (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓</td>
<td>SFD4-F Horizontal</td>
<td>2115</td>
<td>57.81</td>
<td>10.70</td>
<td>-</td>
<td>12.21</td>
<td>151.52</td>
<td>N/A</td>
<td>2.75</td>
</tr>
<tr>
<td>?</td>
<td>SFD4-Y Horizontal</td>
<td>7</td>
<td>9.04</td>
<td>-</td>
<td>-</td>
<td>9.75</td>
<td>111.16</td>
<td>N/A</td>
<td>3.78</td>
</tr>
<tr>
<td>✓</td>
<td>SFE4-Y Horizontal</td>
<td>1460</td>
<td>70.08</td>
<td>8.99</td>
<td>-</td>
<td>8.99</td>
<td>127.21</td>
<td>N/A</td>
<td>2.50</td>
</tr>
<tr>
<td>✓</td>
<td>SFE5-B Horizontal</td>
<td>1550</td>
<td>76.50</td>
<td>8.94</td>
<td>-</td>
<td>9.53</td>
<td>82.72</td>
<td>N/A</td>
<td>4.00</td>
</tr>
<tr>
<td>✓</td>
<td>SFE5-D Horizontal</td>
<td>1400</td>
<td>77.64</td>
<td>8.00</td>
<td>-</td>
<td>8.06</td>
<td>90.34</td>
<td>N/A</td>
<td>3.50</td>
</tr>
<tr>
<td>✓</td>
<td>SFE5-J Horizontal</td>
<td>1310</td>
<td>74.76</td>
<td>8.28</td>
<td>-</td>
<td>8.27</td>
<td>97.53</td>
<td>N/A</td>
<td>3.00</td>
</tr>
<tr>
<td>✓</td>
<td>SFE5-K Horizontal</td>
<td>1400</td>
<td>77.64</td>
<td>8.00</td>
<td>-</td>
<td>8.06</td>
<td>90.34</td>
<td>N/A</td>
<td>3.50</td>
</tr>
<tr>
<td>✓</td>
<td>SFE8-B Horizontal</td>
<td>1620</td>
<td>77.64</td>
<td>8.00</td>
<td>-</td>
<td>8.06</td>
<td>90.34</td>
<td>N/A</td>
<td>3.50</td>
</tr>
<tr>
<td>✓</td>
<td>SFE8-D Horizontal</td>
<td>1400</td>
<td>77.64</td>
<td>8.00</td>
<td>-</td>
<td>8.06</td>
<td>90.34</td>
<td>N/A</td>
<td>3.50</td>
</tr>
<tr>
<td>✓</td>
<td>SFE8-T Horizontal</td>
<td>1500</td>
<td>77.64</td>
<td>8.00</td>
<td>-</td>
<td>8.06</td>
<td>90.34</td>
<td>N/A</td>
<td>3.50</td>
</tr>
<tr>
<td>✓</td>
<td>SFF8-Z Horizontal</td>
<td>1240</td>
<td>77.64</td>
<td>8.00</td>
<td>-</td>
<td>8.06</td>
<td>90.34</td>
<td>N/A</td>
<td>3.50</td>
</tr>
<tr>
<td>✓</td>
<td>SFF10-N Horizontal</td>
<td>1065</td>
<td>77.64</td>
<td>8.00</td>
<td>-</td>
<td>8.06</td>
<td>90.34</td>
<td>N/A</td>
<td>3.50</td>
</tr>
<tr>
<td>✓</td>
<td>SFF10-T Horizontal</td>
<td>975</td>
<td>54.48</td>
<td>11.35</td>
<td>-</td>
<td>11.99</td>
<td>56.88</td>
<td>N/A</td>
<td>4.00</td>
</tr>
<tr>
<td>✓</td>
<td>SFF10-Z Horizontal</td>
<td>910</td>
<td>54.48</td>
<td>11.35</td>
<td>-</td>
<td>11.99</td>
<td>56.88</td>
<td>N/A</td>
<td>4.00</td>
</tr>
<tr>
<td>✓</td>
<td>SFF4-E Horizontal</td>
<td>1120</td>
<td>71.97</td>
<td>8.59</td>
<td>-</td>
<td>8.77</td>
<td>110.71</td>
<td>N/A</td>
<td>2.50</td>
</tr>
<tr>
<td>✓</td>
<td>SFF4-Y Horizontal</td>
<td>985</td>
<td>75.20</td>
<td>8.22</td>
<td>-</td>
<td>8.46</td>
<td>102.84</td>
<td>N/A</td>
<td>2.50</td>
</tr>
<tr>
<td>✓</td>
<td>SFF6-L Horizontal</td>
<td>1050</td>
<td>70.81</td>
<td>8.75</td>
<td>-</td>
<td>8.87</td>
<td>58.13</td>
<td>N/A</td>
<td>4.50</td>
</tr>
<tr>
<td>✓</td>
<td>SFF6-R Horizontal</td>
<td>950</td>
<td>68.04</td>
<td>9.10</td>
<td>-</td>
<td>10.04</td>
<td>66.04</td>
<td>N/A</td>
<td>4.50</td>
</tr>
</tbody>
</table>

- Lowest capital cost
- Highest wear rate
- Lowest operating cost
- Highest capital cost
- Same size motor
- Closest to BEP
- Less than 3” solids
## Example: Selection for 700 GPM at 35 feet TDH

### The best selection

<table>
<thead>
<tr>
<th>Result</th>
<th>Size</th>
<th>Stages</th>
<th>Speed, rated (rpm)</th>
<th>Pump Efficiency (%)</th>
<th>Power, rated (hp)</th>
<th>NPSHr (ft)</th>
<th>Max. Power (hp)</th>
<th>% BEP</th>
<th>% Max Diameter or Pitch</th>
<th>Solids diameter limit (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔</td>
<td>SFD4-F Horizontal</td>
<td>1</td>
<td>2115</td>
<td>57.81</td>
<td>10.70</td>
<td>-</td>
<td>12.21</td>
<td>151.52</td>
<td>N/A</td>
<td>2.75</td>
</tr>
<tr>
<td>?</td>
<td>SFD4-Y Horizontal</td>
<td>1</td>
<td>1800</td>
<td>68.37</td>
<td>9.04</td>
<td>-</td>
<td>9.75</td>
<td>111.16</td>
<td>N/A</td>
<td>3.78</td>
</tr>
<tr>
<td>✔</td>
<td>SFE4-Y Horizontal</td>
<td>1</td>
<td>1455</td>
<td>68.86</td>
<td>8.99</td>
<td>-</td>
<td>8.99</td>
<td>127.21</td>
<td>N/A</td>
<td>2.50</td>
</tr>
<tr>
<td>✔</td>
<td>SFE5-B Horizontal</td>
<td>1</td>
<td>1585</td>
<td>69.20</td>
<td>8.94</td>
<td>-</td>
<td>9.53</td>
<td>82.72</td>
<td>N/A</td>
<td>4.00</td>
</tr>
<tr>
<td>✔</td>
<td>SFE5-D Horizontal</td>
<td>1</td>
<td>1460</td>
<td>70.08</td>
<td>8.86</td>
<td>-</td>
<td>9.97</td>
<td>84.14</td>
<td>N/A</td>
<td>4.00</td>
</tr>
<tr>
<td>✔</td>
<td>SFE5-J Horizontal</td>
<td>1</td>
<td>1370</td>
<td>74.78</td>
<td>8.28</td>
<td>-</td>
<td>9.44</td>
<td>83.05</td>
<td>N/A</td>
<td>4.00</td>
</tr>
<tr>
<td>✔</td>
<td>SFE5-L Horizontal</td>
<td>1</td>
<td>1300</td>
<td>66.08</td>
<td>8.07</td>
<td>-</td>
<td>9.91</td>
<td>83.46</td>
<td>N/A</td>
<td>4.00</td>
</tr>
<tr>
<td>✔</td>
<td>SFE8-B Horizontal</td>
<td>1</td>
<td>1595</td>
<td>66.33</td>
<td>9.30</td>
<td>-</td>
<td>11.91</td>
<td>68.89</td>
<td>N/A</td>
<td>4.00</td>
</tr>
<tr>
<td>✔</td>
<td>SFE8-D Horizontal</td>
<td>1</td>
<td>1505</td>
<td>68.18</td>
<td>9.10</td>
<td>-</td>
<td>9.92</td>
<td>61.95</td>
<td>N/A</td>
<td>4.00</td>
</tr>
<tr>
<td>✔</td>
<td>SFE8-T Horizontal</td>
<td>1</td>
<td>1335</td>
<td>62.29</td>
<td>9.92</td>
<td>-</td>
<td>11.38</td>
<td>51.07</td>
<td>N/A</td>
<td>4.00</td>
</tr>
<tr>
<td>✔</td>
<td>SFE8-Z Horizontal</td>
<td>1</td>
<td>1240</td>
<td>63.90</td>
<td>9.71</td>
<td>-</td>
<td>11.63</td>
<td>51.00</td>
<td>N/A</td>
<td>4.00</td>
</tr>
<tr>
<td>✔</td>
<td>SFF10-N Horizontal</td>
<td>1</td>
<td>1065</td>
<td>54.67</td>
<td>11.32</td>
<td>-</td>
<td>11.35</td>
<td>45.69</td>
<td>N/A</td>
<td>4.50</td>
</tr>
<tr>
<td>?</td>
<td>SFF10-T Horizontal</td>
<td>1</td>
<td>975</td>
<td>54.48</td>
<td>11.35</td>
<td>-</td>
<td>11.59</td>
<td>33.27</td>
<td>N/A</td>
<td>4.75</td>
</tr>
<tr>
<td>?</td>
<td>SFF10-Z Horizontal</td>
<td>1</td>
<td>910</td>
<td>51.67</td>
<td>11.97</td>
<td>-</td>
<td>12.34</td>
<td>34.52</td>
<td>N/A</td>
<td>4.75</td>
</tr>
<tr>
<td>✔</td>
<td>SFF4-P Horizontal</td>
<td>1</td>
<td>1120</td>
<td>71.97</td>
<td>8.59</td>
<td>-</td>
<td>8.77</td>
<td>110.71</td>
<td>N/A</td>
<td>2.50</td>
</tr>
<tr>
<td>✔</td>
<td>SFF4-Y Horizontal</td>
<td>1</td>
<td>985</td>
<td>75.20</td>
<td>8.22</td>
<td>-</td>
<td>8.46</td>
<td>102.84</td>
<td>N/A</td>
<td>3.00</td>
</tr>
<tr>
<td>✔</td>
<td>SFF6-L Horizontal</td>
<td>1</td>
<td>1050</td>
<td>70.81</td>
<td>8.75</td>
<td>-</td>
<td>8.87</td>
<td>58.13</td>
<td>N/A</td>
<td>4.50</td>
</tr>
<tr>
<td>✔</td>
<td>SFF6-R Horizontal</td>
<td>1</td>
<td>950</td>
<td>68.04</td>
<td>9.10</td>
<td>-</td>
<td>10.04</td>
<td>66.04</td>
<td>N/A</td>
<td>4.50</td>
</tr>
</tbody>
</table>

A good mix of all features
Future Developments
Prerotation

Self cleaning wet wells

- Should be available after the submersible motor design is finished (end of 2016)
Applications
Applications - Industrial Plants

**Oily water from railyards & refineries**
- To meet EPA ecological standards

**Impoundment of contaminated storm water from large industrial plants**

**Railroad & truck wash stations**

**Viscous diesel oil agglomeration that collects in sumps**

**Pumping to API separators**
Applications - Industrial Plants

Pulp and paper & plywood mills

Mining – Carbon in the Pulp Circuit

Dredging

Gentle handling of:

- Rubber crumb
- Adipic acid
- Plastic pellets
- Food (cranberries, grapes, etc.)
- Industrial wastes
  - Hydrocarbon pumping and clean-up

Sugar Processing

Tomato Paste

Food Waste

- Chicken Processing
- Slaughter House Rendering
- Brewery Waste
- Cannery waste
Competition
Key Competition – Screw Centrifugal Pumps

- **Hidrostal**
  - **Advantages**
    - Original screw centrifugal pump
    - Large installed base – well-known in the market, in particular in Europe
    - Immersible motor
    - Range of materials (ie. Stainless steel)
    - Manufacturing in Europe (Switzerland and/or Hungary)
  - **Weaknesses**
    - Family-owned – slow to react to changing market conditions
    - Inability to meet delivery commitments – long lead times
    - Pricing

**Recent Developments**
- Moving away from distributor model and creating Hidrostal –owned subsidiaries in each country
- Expectation is that distributors will buy from local Hidrostal owned entity vs. direct from Hidrostal facility
- Ended agreement with Weir Specialty Pumps in USA
- Potential plan to manufacture in the US for US market
Key Competition – Screw Centrifugal Pumps

• **Hayward Gordon XCS Screw Centrifugal**
  
  • **Advantages:**
    • Ability to package with their mixers
    • Pricing – willing to take projects at low pricing levels
    • Viewed in the marketplace as an equal to Hidrostal
  
  • **Weaknesses:**
    • Bearing housing design

• **Vaughan Triton Screw Centrifugal**
  
  • **Advantages:**
  
  • **Weaknesses:**
    • Not a major player in the screw centrifugal market
    • Little to no installed base
    • US Based – limited references in Europe
Competition – Non Screw Centrifugal Design

- Flygt (Xylem) N-impeller

- KSB

- ABS (Sulzer) submersible pumps

- Grundfos Solids-Handling Pumps
Benefits
De-rag Program to Maintain capacity:

2 stations – twice a week; Bitter Pt (1), Slater (3)
2 stations – once a week; Westside (1), Seal Beach (2)
3 stations – once a month; MacArthur, Bay Bridge, Rocky Pt

Monitor run times of the lag pump(s) at the remaining 10 stations; increase in run time indicate lost capacity in lead pump, schedule de-rag

Goal: Looking to reduce costs by reducing or eliminating service calls due to clogs
Edinger Ave Pump Station

Case Study

- Cost: $82,000
- Service Calls per Month:
  - '98: 5
  - '99: 10
  - '00: 15
  - '01: 20
  - '02 to '06: 0
- Savings: $308,000
Edinger Ave Pump Station

**Additional Benefits**

- Higher pump efficiencies (reduces electrical costs)
- Retains flow capacity longer (reduces maintenance costs)

**Cost**

- $82,000

**Invested**

- $50,000

**Savings**

- $308,000

**Service Calls per Month**

- '97
- '98
- '99
- '00
- '01
- '02
- '03
- '04
- '05
- '06

Year
Features and Benefits

- Less emulsification of oil
- Less cost to remove floating oil than using mechanical skimmers
- Flow matching without VFD
- Solids handling capabilities
- Clog free pumping
- Can pump very viscous material