Modeling a Positive Displacement Pump by Inputting a Manual Pump Curve

We are frequently asked how to model a positive displacement (PD) pump in PIPE-FLO and/or Flow of Fluids software. The purpose of this article is to help PIPE-FLO Professional users understand what pump data is needed and how to apply the data to PIPE-FLO FLO and Flow of Fluids. For the remainder of this article, we will refer only to PIPE-FLO, but Flow of Fluids users may assume that the same steps apply.

There are two methods for modeling a PD pump. One is to create a pump bypass line with a component that represents the slippage in the pump. This method is discussed in the Knowledge Base article, "Modeling Positive Displacement Pumps."

The second method is to read the flow rate versus pressure data from the manufacturer pump curve and input this data into PIPE-FLO as a manual pump curve. Both methods accurately model a PD pump and in both cases, you have to apply realistic flow limits to the model based on the actual performance of the pump. This article reviews different PD pump curves, the second method of adding the pump curve data into PIPE-FLO, the pump affinity rules and also a possible error message.

Positive Displacement Curves:

PD pump manufacturers display their pump curves differently. The key data is flow rate and pressure drop corresponding to the viscosity of the fluid and the speed of the pump. The following graphs are PD pump curve examples for gear, lobe, and vane pumps.

<table>
<thead>
<tr>
<th>Manufacture:</th>
<th>Pulsafeeder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type:</td>
<td>Eclipse Gear Pump, Model 5</td>
</tr>
<tr>
<td>Graph Axes:</td>
<td>Pressure vs Flow Rate with speed lines</td>
</tr>
</tbody>
</table>
Manufacture: Viking Pumps  
Type: RL Industrial Lobe Pump, Model RL 150  
Graph Axes: Flow Rate vs. Pump Speed with Pressure Lines
Manufacture: Corken
Type: Coro-Vane Pump for LPG and NH3, Model 1021, 950 RPM's
Graph Axes: Flow Rate vs. Differential Pressure at a fixed speed
All three of these curves display the flow rate, pressure drop and pump speed in different formats.

**Adding the PD Pump Curve Data to PIPE-FLO**

Adding the PD pump curve data to PIPE-FLO consist of four steps. The first step is to choose the PD pump curve that represents the viscosity of your fluid. Next, read the line or individual graph that represents the revolutions per minute (RPM) of the pump. For the Viking Lobe pump curve shown above, the viscosity is 150 CentiStokes and the RPM is along the horizontal axis.

For this article, flow and pressure data for 400 RPM is illustrated. If you zoom into the graph and read up the 400 rpm axis, you can read the flow rate off the vertical axes that corresponds to the individual pressure lines.

The following is the PD curve data from this lobe pump.

<table>
<thead>
<tr>
<th>Flow Rate (gpm)</th>
<th>Pressure Line (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>420</td>
<td>300</td>
</tr>
<tr>
<td>450</td>
<td>200</td>
</tr>
<tr>
<td>490</td>
<td>100</td>
</tr>
<tr>
<td>520</td>
<td>50</td>
</tr>
<tr>
<td>540</td>
<td>25</td>
</tr>
</tbody>
</table>
The next step is to determine the pressure value when the flow is zero. This will be the Y Intercept. The Y Intercept is needed because the first entry in the PIPE-FLO manual pump curve dialog box is the shut off head, or the pressure at a zero flow rate.

Although this value has no real meaning for a PD Pump, it is necessary for using the centrifugal pump dialog box to model the PD Pump. An easy way of doing this is adding this information to an Excel® spreadsheet and using the INTERCEPT (Y range, X range) function. The Y intercept is 1240 for the above data.

The last step is adding the data to PIPE-FLO as a manual pump curve using the centrifugal pump device. This is done by opening the pump dialog box, selecting the Enter Curve button, and filling in the data. An example is shown below.

Additional information needed is the RPMs and diameter of the gear, lobe, vane or piston of the PD pump. The pressure unit from the original PD pump curve is pounds per square inch (psi), so the Head units in the dialog box needs to be switched to psi.

It is not recommended to manually enter pump efficiency data. PIPE-FLO uses efficiency data for viscosity correction and this could lead to inaccurate total head results as the ANSI/HI method that PIPE-FLO uses only applies to centrifugal pumps.

PIPE-FLO will create a pump curve based on the manual imputed data. The Viking Lobe pump curve is shown below.
The user needs to apply realistic flow limits to the model based on the actual performance of the pump. The above example shows at 400 RPM, the flow range is between 420 and 540 gpm and this is the realistic flow. Any flow values outside of this range would not be accurate because it is not practical based on the extrapolated pump data at 400 RPMs.

**Pump Affinity Rules**

The pump affinity rules for PD pumps are not the same as for centrifugal pumps, so the variable speed setting cannot be used.

**Warning Message**

One warning message that the software may produce is shown below.

This message is communicating that the pump has no pump efficiency data. This warning does not affect any calculation
and can be turned off by selecting the Toggle Calculation Off icon.

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