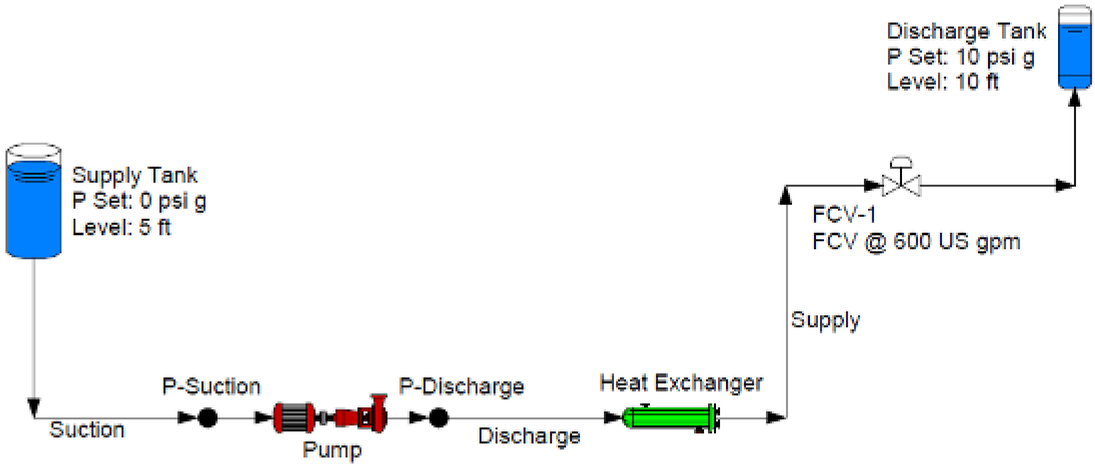
## Case Study – Minimising Pumping Costs

In this example we will see how selecting the proper design point can improve a pump's operation and minimize pumping cost. Before a pump is selected for a given application, a series of calculations must be performed to determine the system's static head and pipeline head loss for a given design flow rate. PIPE-FLO can quickly and easily determine the Total Head required for the pump application. If there are any design changes in the system, a re-calculation of the pump and system needs should be performed.

A change in a pump's operating design point can have a large effect on the operation of the pump, as well as the operating cost. You will quickly see how important it is to re-evaluate a system when a change occurs to the pump or any other aspect of the system.

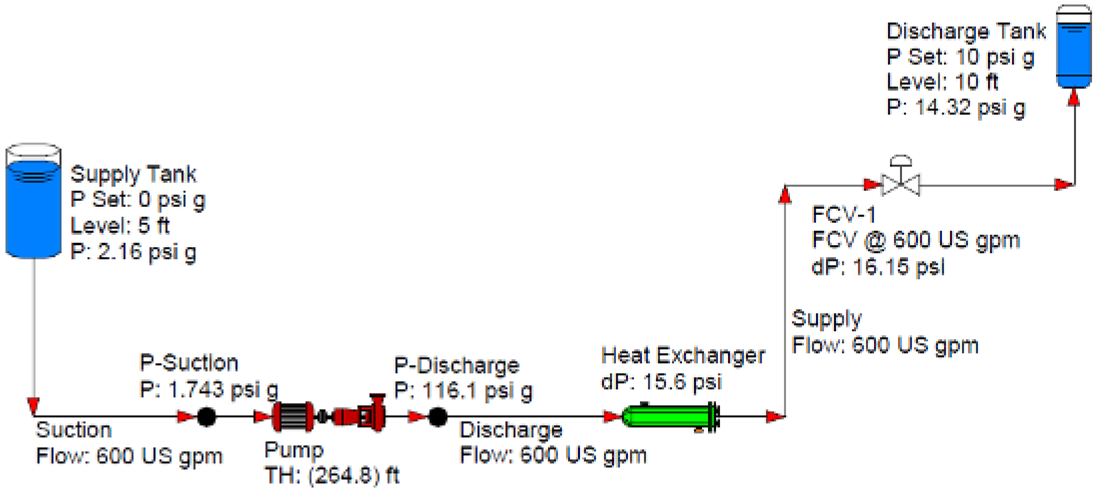
### Piping System

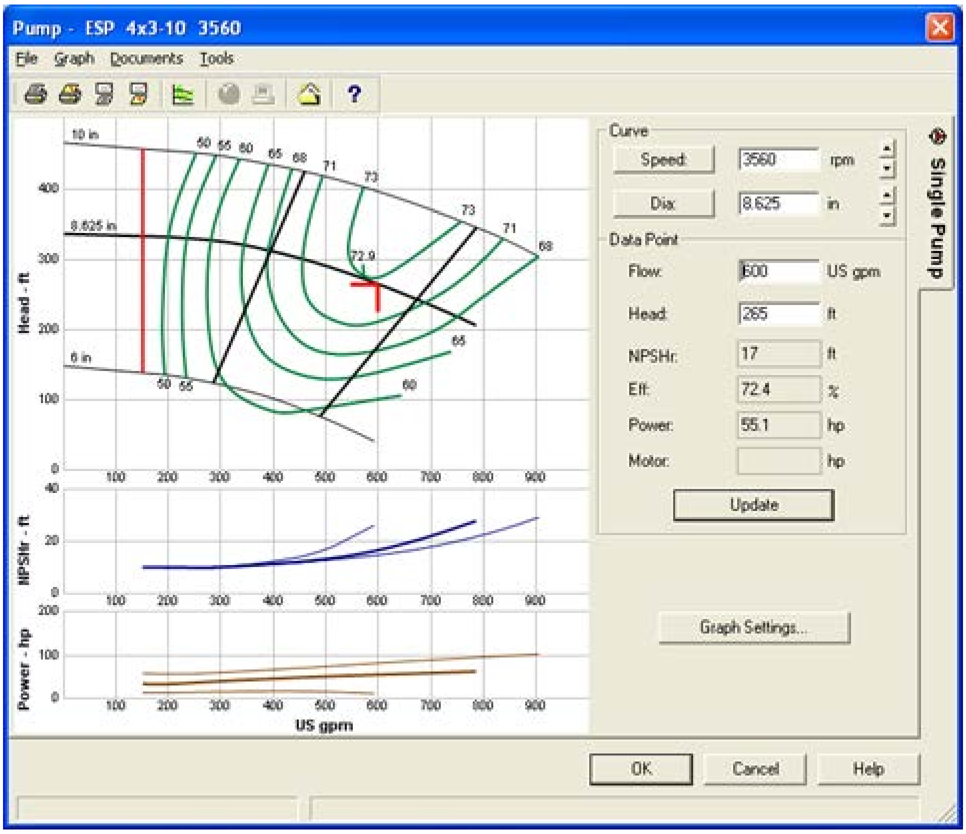



In this study we have a piping system that pumps from a Supply Tank to a pressurized Discharge Tank. The pump was sized to supply 600 gpm to the pressurized discharge tank, and a control valve was installed in the system to control the flow rate. The pump was selected using PIPE-FLO's Pump Selection module and a 4x3-10 ESP pump running at 3560 rpm, was selected for use in the system. Once the system was up and running, it was discovered that the flow rate through the system would be 400 gpm for the next three years, not the 600 gpm that was originally planned. Since that change occurred after the pump was selected, and we are changing the system flow rate, it is a good idea to see how this will effect pump operation.

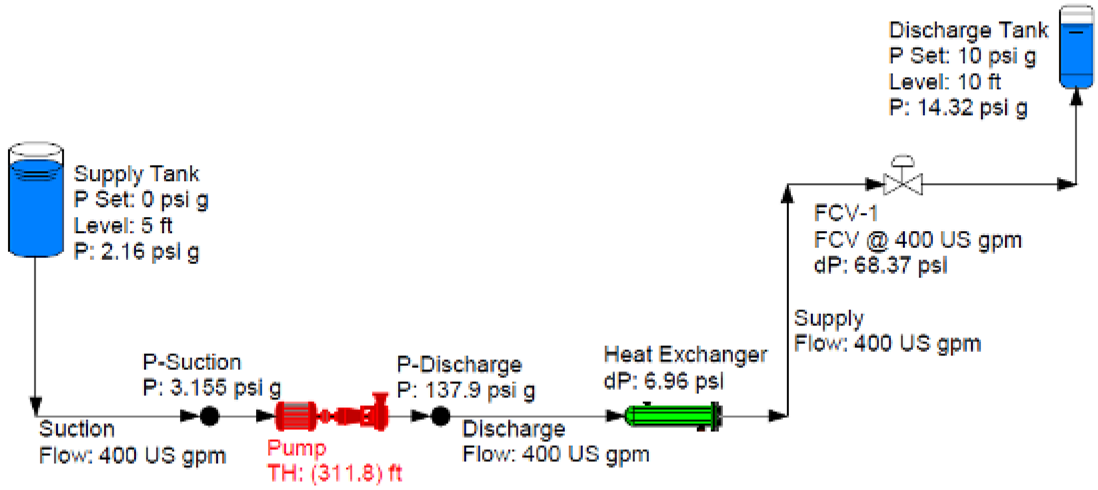
### Pump Operation

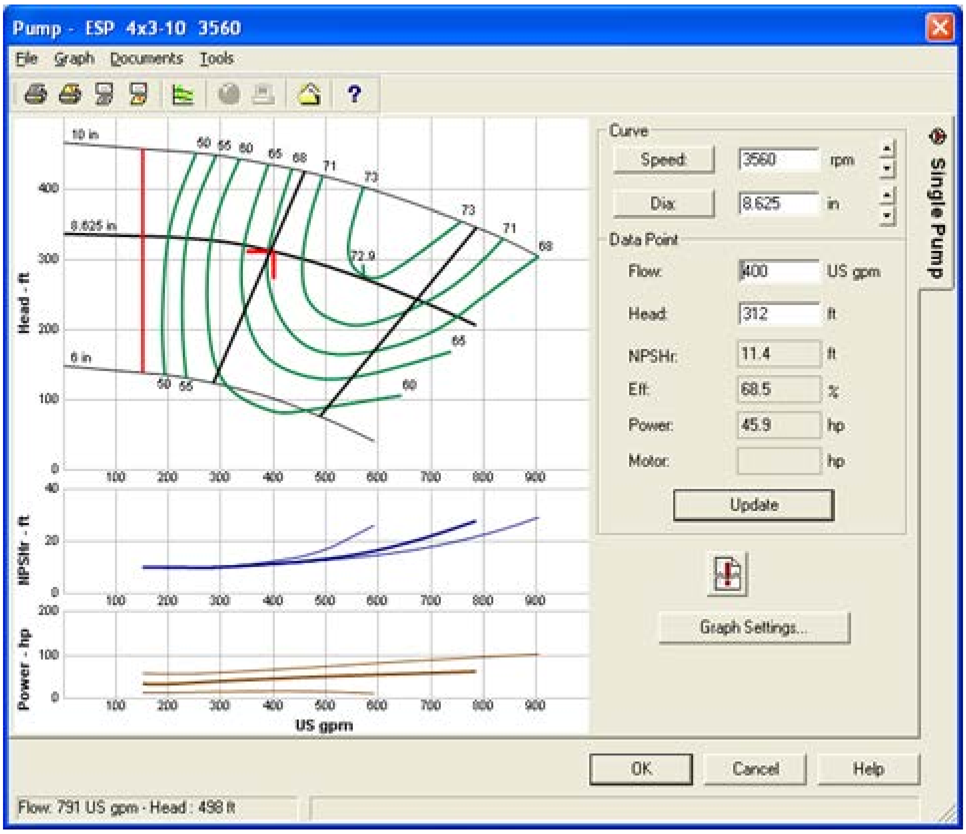
First let's observe how the system operates at the design flow rate of 600 gpm. Notice the differential pressure across the flow control valve is just over **16** psi, or just over **37** feet of head loss.You can also see from the pump curve that at 600 gpm the pump is operating very close to its best efficiency point (BEP).




Now let's see what happens when the flow rate to the discharge tank is throttled to 400 gpm.



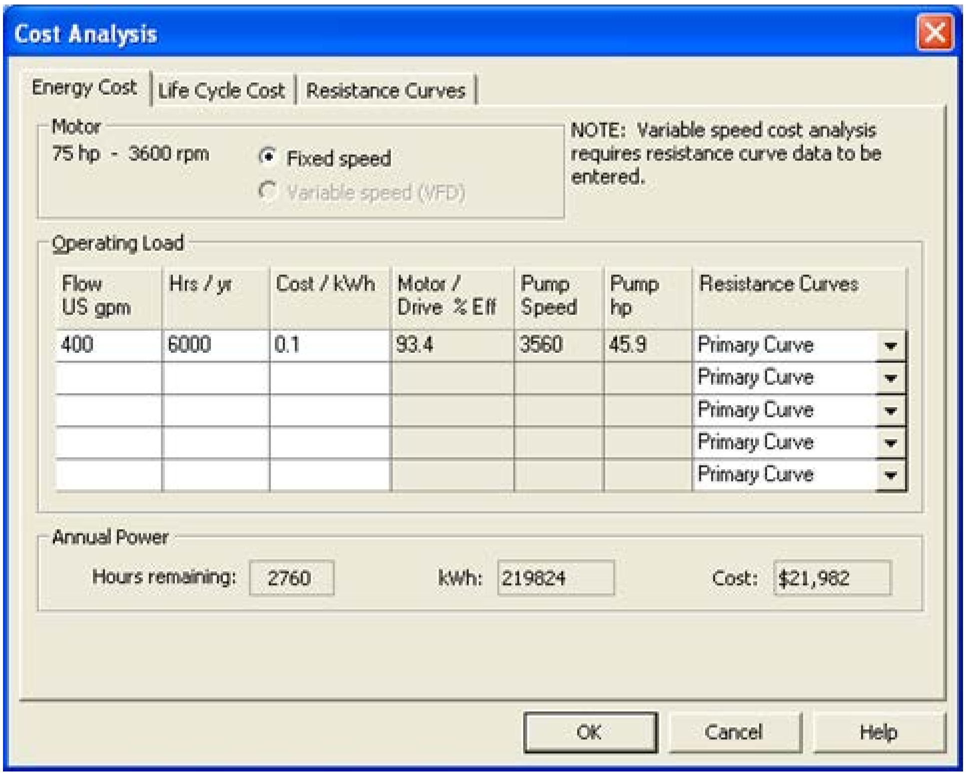




Notice the differential pressure across the FCV set to 400 gpm is over **68** psi, or a head loss of over **158** feet of fluid. In addition, the pump is running much further up on its curve with lower efficiency.

It is important to remember the control valve must absorb the excess energy. The excess energy is equal to the difference between the total head across the pump at the design flow rate, and the total head across the pump at the desired flow rate. In other word almost half of the 312 ft. of total head the pump is putting out is wasted across the control valve. In talking with the project group it appears that the system will be operating at this flow rate for another 3 years. Since this will be a long-term operation we should check to see how this would affect the operating cost of the pump.

**Annual Operating Costs**

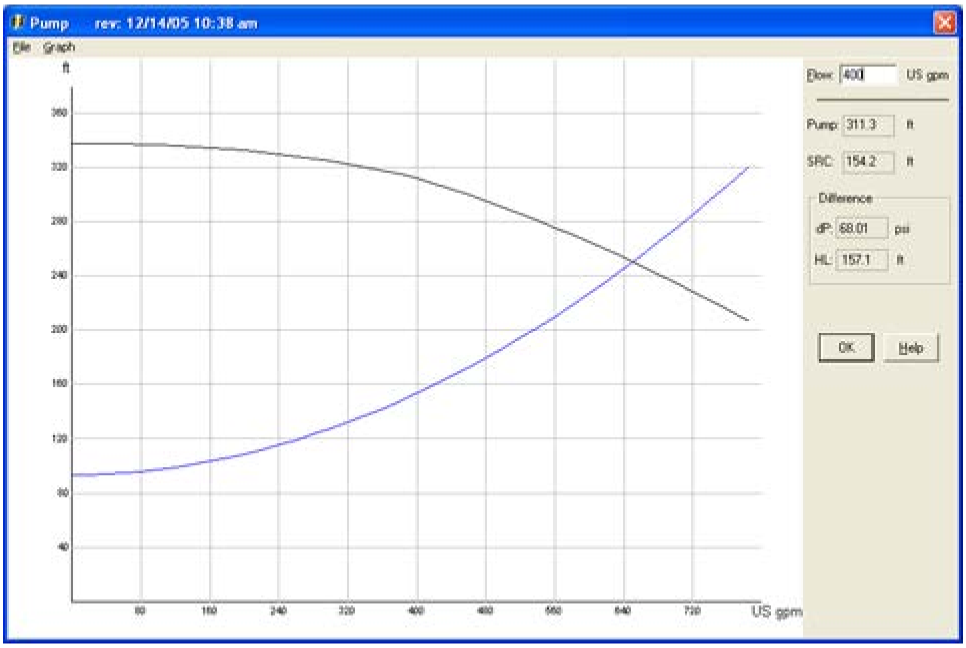
We will use the Pump Selection program to evaluate the pump. We will need to define an annual operating load profile for our piping system. In simpler words, we will need to specify the flow rate, hours per year operating at the flow rate and power cost. This system will run 6000 hours per year at 400 gpm with a power cost of $.10 per kWh.




Notice it cost $21,982 to run this pump for one year.

**Alternative Options**

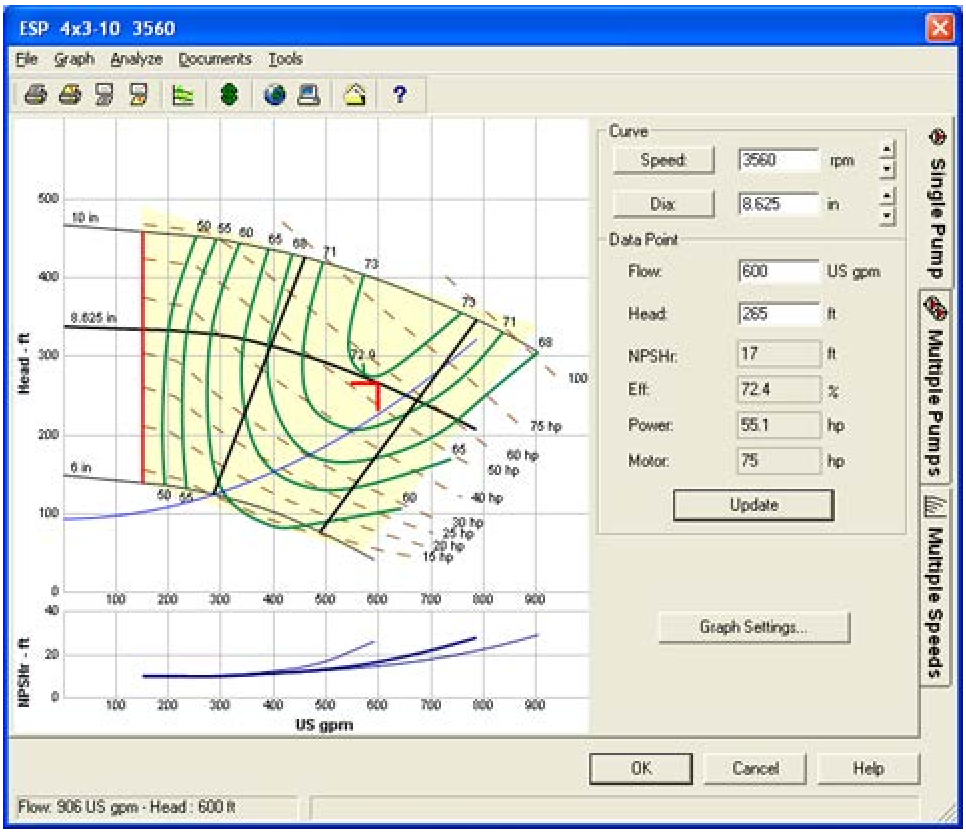
We know that if we reduce the impeller diameter or decrease the pump speed then the pump will produce less excess head. This will cause less wear and tear on the control valve as well as consume less power. These conditions will result in savings in pumping costs and valve maintenance costs. But exactly how much can be saved? To perform that calculation we will use the System Resistance Curve feature of PIPE-FLO and export the curve into the Pump Selection program. We can then change the impeller diameter, or pump speed to determine how much it will cost to operate the pump at 400 gpm.



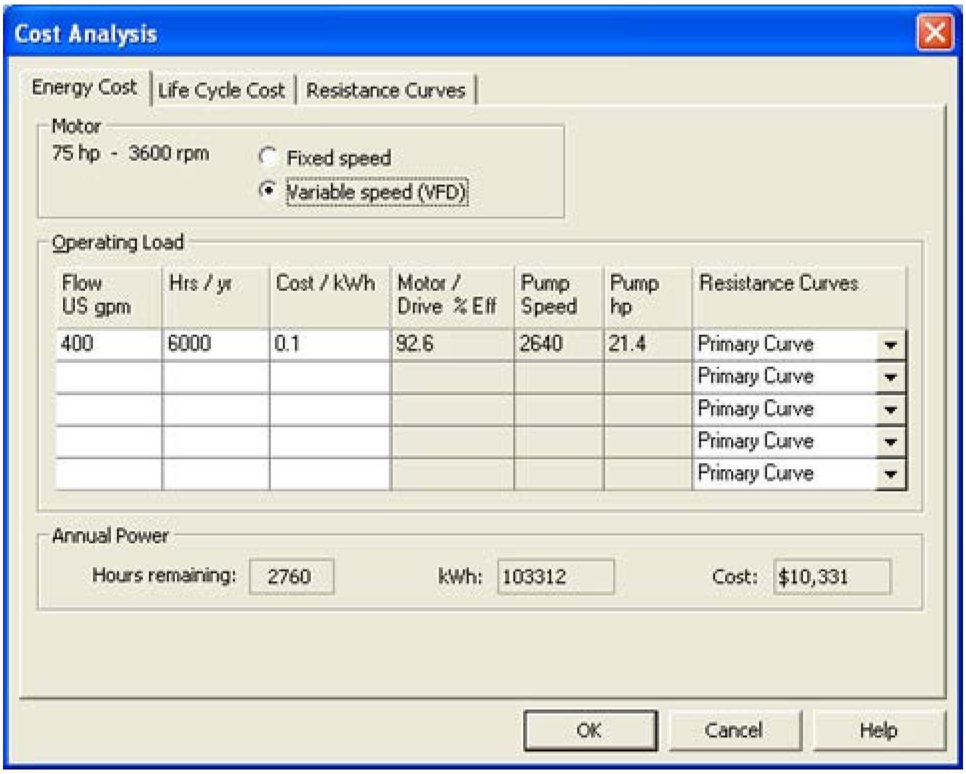

The black line is the pump curve and the blue line is the system resistance curve.You can see at 400 gpm the difference is 68.01 psi or 157.1 ft.

**Variable Frequency Drive**

We will now enter the resistance curve back into the Pump Selection program so we can do an economic cost analysis with a variable speed drive.



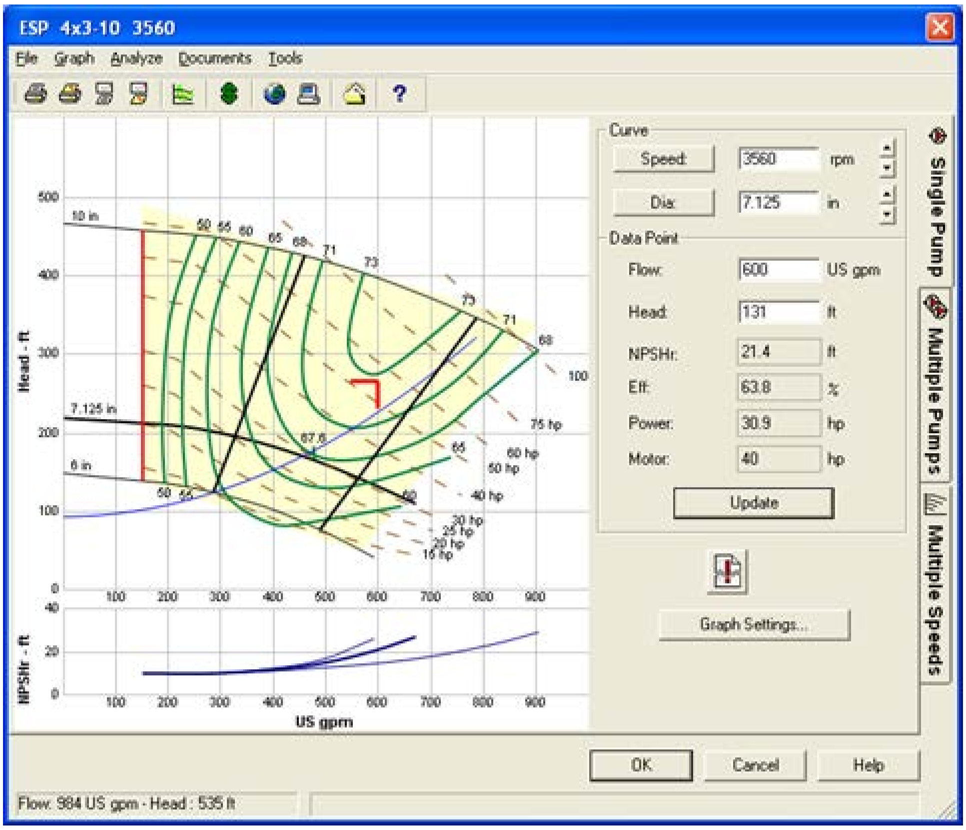

The blue line on the pump curve is the system resistance curve.To see how much it would cost to run the pump with a variable speed drive, we will do the cost analysis again with a variable speed instead of a fixed speed.

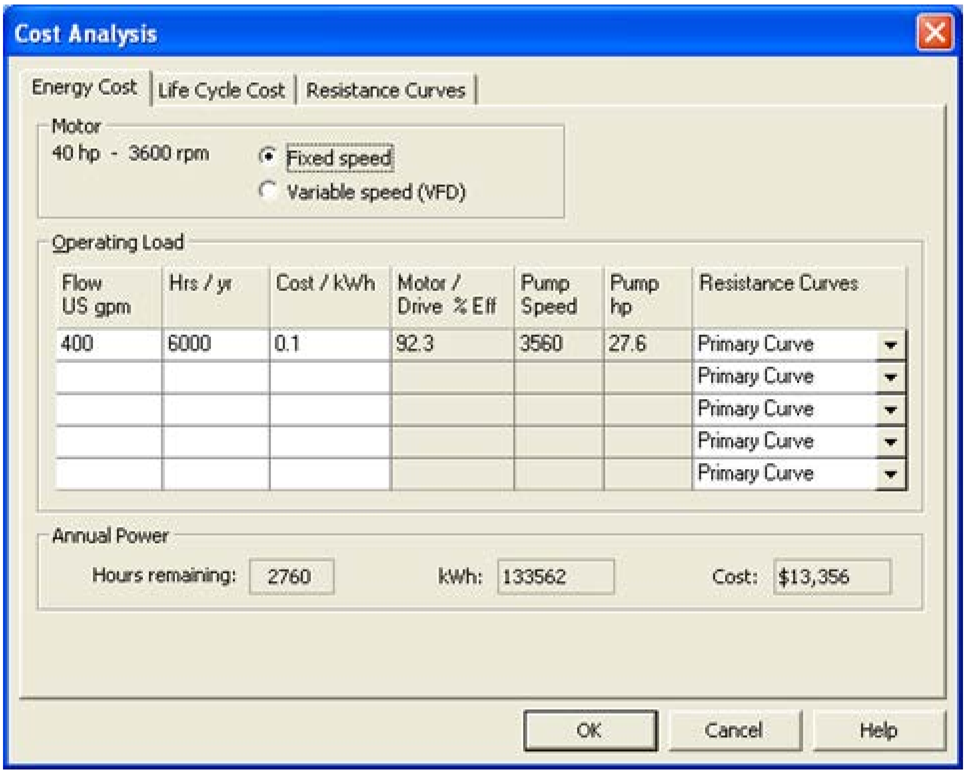


Notice the pumping cost for one year is $10,331.This is a savings of over $11,600 each year.

**Trimming Out the Impeller**

We will now take a look at the effect of trimming the impeller in the pump.Let's change the impeller diameter to 7.125 inches.






Notice the pump now cost $13,356 per year to operate.This is a savings of over $8600 each year from the original settings.

**Summary**

Using the PIPE-FLO and Pump Selection programs we discovered how easy it is to determine the actual operating costs under a variety of conditions. In many instances the pay back for system modifications can be less than a year.