M: 0478 378 454
E: admin@variableefficiency.com.au
PO Box 784, Rockhampton Q 4700

Example of Pump Selection and Speed Control Analysis.

Analysis of the service area of a reservoir determines that to meet forecast 20 year growth the pump station that transfers water to that reservoir will ultimately need to deliver:

Nominated Duty 100 L/s @ 50m Lift (Pump Head) with 40m Static Lift (Elevation difference)
→ 100 L/s = 360 m^3/Hr or 8.6 ML/Day

Efficiency is considered an important consideration and they realise that the ultimate duty will not be realised for some years, and even then it will only be on peak consumption days. So, a variable speed drive is being included in the project scope so the pump can be slowed down and be more energy efficient.

Summary of Results

Depending on the application, if the nominated duty is not expected to be required for the majority of the life of the pump, the pump offered as the alternative selection in this example gives:

- Better turn down potential
- Reduced electrical capacity, with a range of cost savings such as:
  → Smaller generator for standby power
  → Reduced demand from electricity supplier
- Pump running at or near BEP at 60-70 L/s
  → Reduced vibration
  → Increased life of pump seals, bearings, and wear rings

Assuming that the pump was in service for 18 hours per day and lasted 20 years, and that for 40% of its service life it operated at 70 L/s, 30% at 80 L/s, 20% at 90 L/s, and 10% at Nominated duty of 100 L/s, **the total Lifetime energy saving by installing the alternative selection would be 214,161 kWh**.

Table 1 – Comparison of Pump Power, Efficiency, and Specific Energy for 200x150-400 and 150x125-400

Flow Rate (L/S)	Head Developed (m)	Traditional Selection			Alternative Selection		
		Combined Efficiency (%)	Specific Energy (kWh/ML)	Lifetime Energy (kWh)	Combined Efficiency (%)	Specific Energy (kWh/ML)	Lifetime Energy (kWh)
0	40.0	n/a	n/a		n/a	n/a	
10	40.1	27%	400		34%	323	
20	40.4	43%	259		52%	211	
30	40.9	52%	215		63%	177	
40	41.6	59%	193		70%	162	
50	42.5	63%	183		73%	158	
60	43.6	67%	178		75%	158	
70	44.9	69%	176	2335242	75%	163	2160702
80	46.4	71%	178	2017468	74%	171	1940504
90	48.1	72%	181	1543390	72%	181	1545361
100	50.0	73%	187	882985	70%	194	918358
Total				6779085			6564924

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On the cost of the electricity consumed alone, if a rate of 10 cents per kWh could be secured for the entire 20 years, the alternative solution presented could save $21,416.

An analysis of the options analysed follows:

Traditional Pump Selection

Traditionally pumps are selected with the nominated duty to the left of BEP. A reasonable example of a pump that may be offered in this scenario might be an end suction ISO 200x150-400 with the impeller trimmed to 410mm coupled to a 90kW 4 pole motor.

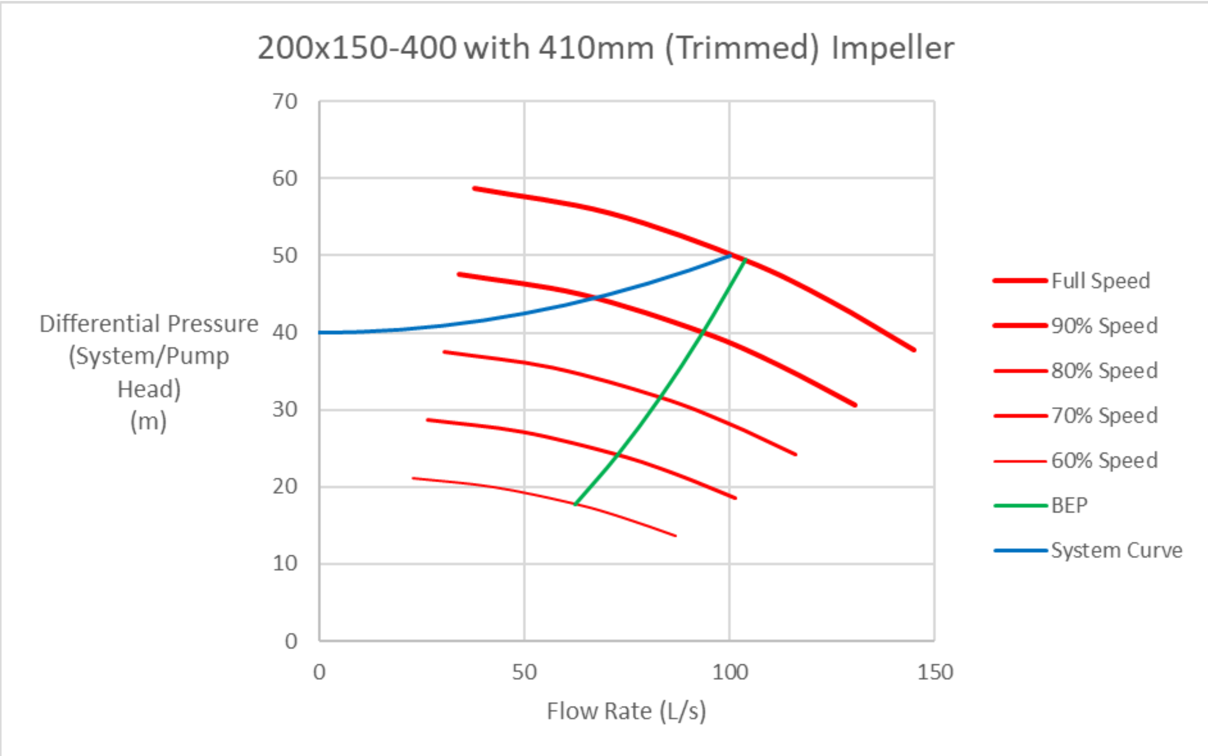

Figure A – 200x150-400

Figure A shows the pump characteristic curve with a calculated 410mm trim and system curve shown. Table 2 shows a typical analysis of this pump selection.

It can be seen in Table 2, the power decreases the slower the pump is run, but the pump efficiency also decreases as the pump is slowed down. However, the specific energy is at a minimum at 70 L/s or 1344 RPM. At 70 L/s the pump would use 5% less energy than pumping at full speed.

If this pump were selected there would be no energy efficiency benefit from running the pump at a flow rate less than 70 L/s. In fact, pumping at less than 50 L/s or 1280 RPM would use virtually the same amount of energy as pumping at full speed.

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Table 2 - VSD Analysis 200x150-400 with 410mm impeller

Flow Rate (L/S)	Head Developed (m)	Pump Speed (RPM)	Pump Power (kW)	Pump Efficiency (%)	Motor Efficiency (%)	Motor Power (kW)	Specific Energy (kWh/ML)
0	40.0	1220	8	n/a	76%	11	n/a
10	40.1	1218	13	31%	87%	14	400
20	40.4	1223	17	47%	91%	19	259
30	40.9	1234	21	56%	92%	23	215
40	41.6	1252	26	63%	93%	28	193
50	42.5	1277	31	67%	94%	33	183
60	43.6	1307	36	71%	95%	38	178
70	44.9	1342	42	73%	95%	44	176
80	46.4	1383	49	75%	95%	51	178
90	48.1	1428	56	76%	95%	59	181
100	50.0	1476	64	77%	95%	67	187

Alternate Pump Selection

If, instead a 150x125-400 with a full size impeller coupled to a 75kW 4 pole motor were selected, the motor would be smaller and cost less. Additionally, every element of the electrical system needed to run the pump would be able to be rated for the smaller motor, and would typically cost less; and the capacity required from the electricity distributor would be less. However, if the pump were installed without the VSD it would not be able to deliver the nominated duty, and the nominated duty is to the right of BEP, so for both of these reasons this pump would not generally be offered.

But, the data in table 3 shows that as the flow rate and speed is reduced the efficiency actually improves as far down as 50 L/s or 1226 RPM, which also coincides with the minimum specific energy. The pump needs to be run slightly faster than the nominated speed for a 4 pole motor, but with a VSD this is achievable, and the motor has ample capacity even above nominated speed.

The main disadvantage for this arrangement is that at the nominated duty it has a lower efficiency and greater specific energy than the traditional selection. However, in many instances the nominated duty may only be required for a minor portion of the life of the pump, and the slower flow rates can be utilised for the remainder of the pump's service life. Therefore, the savings potential is far greater for this selection than a traditional selection.

The minimum specific energy of the alternative selection 158 kWh/ML is a solid 10% less than the minimum for the traditional selection. Furthermore, the efficiency is better at the flow rate that the pump is expected to be used, this would strongly suggest a reduced rate of wear and increased service life further decreasing the lifetime cost.

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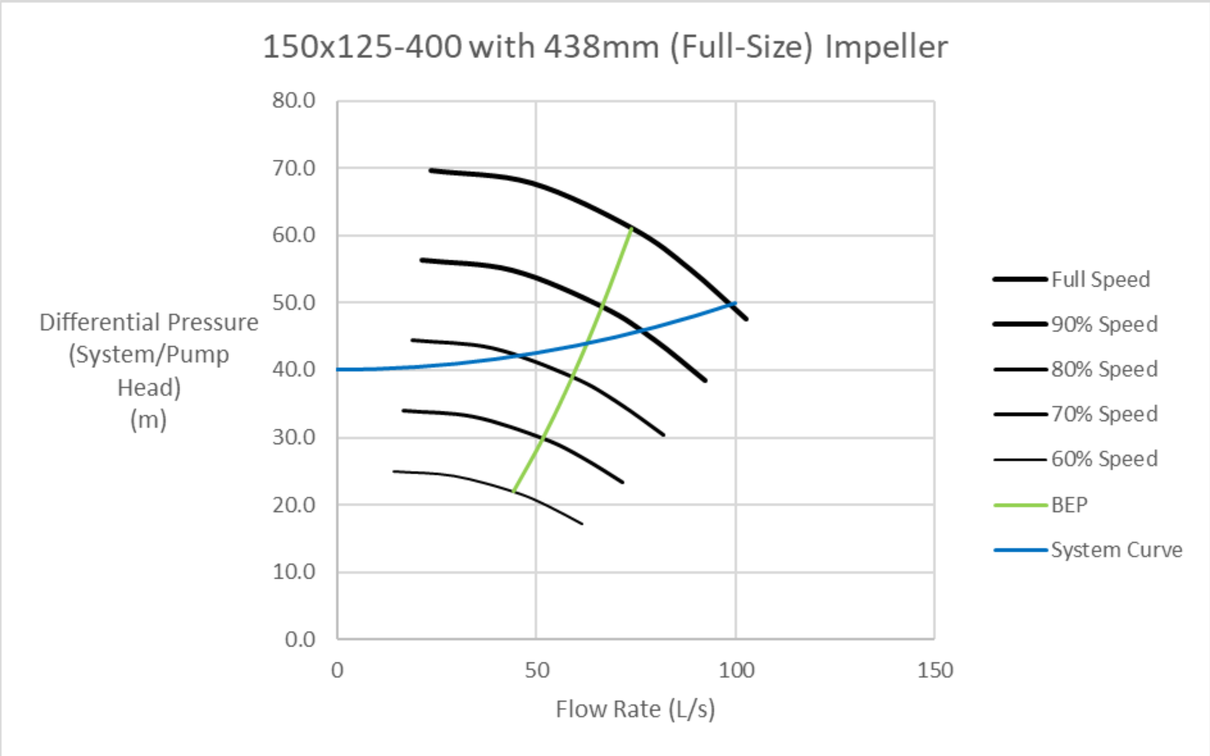

Figure B - 150x125-400

Table 3 - VSD Analysis 150x125-400 with full size impellor

Flow Rate (L/S)	Head Developed (m)	Pump Speed (RPM)	Pump Power (kW)	Pump Efficiency (%)	Motor Efficiency (%)	Motor Power (kW)	Specific Energy (kWh/ML)
0.0	40.0	1144	7	n/a	85%	8	n/a
10.0	40.1	1129	10	38%	88%	12	323
20.0	40.4	1128	14	57%	91%	15	211
30.0	40.9	1139	18	68%	92%	19	177
40.0	41.6	1163	22	75%	93%	23	162
50.0	42.5	1198	27	78%	94%	28	158
60.0	43.6	1243	32	79%	94%	34	158
70.0	44.9	1295	39	79%	95%	41	163
80.0	46.4	1354	47	78%	95%	49	171
90.0	48.1	1420	56	76%	95%	59	181
100.0	50.0	1490	66	74%	95%	70	194