

**DETERMINING THE MOST ECONOMICAL
SOLUTION FOR PUMPING APPLICATIONS USING
ONLINE LCC SOFTWARE**



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DETERMINING THE MOST ECONOMICAL SOLUTION FOR PUMPING APPLICATIONS USING ONLINE LCC SOFTWARE

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ABSTRACT

Calculating the LifeCycle Cost (LCC) of a pumping system has until recently been almost impossible due to the complicated mathematics required. Which Pump™ has revolutionised the industry with their new online LCC software offering end users the ability to accurately calculate their LCC based on real application information.

This article briefly explains the theory behind Which Pump's LCC method. It then walks through a LCC example illustrating the types of information required and briefly explains the results you would expect, demonstrating to the reader how real cost savings can be achieved on their pumping solutions.

1.0 History of LCC in pumping applications

In 1851 at Crystal Palace England, engineer John Appold developed a centrifugal pump measuring 68% pump efficiency. Since then, centrifugal pumps and motors have increased in efficiency to today where manufacturers have fully maximised efficiency improvements. More recently it has been recognised that the greatest means of increasing overall operating efficiency is via intelligent control methods such as Variable Frequency Drives (VFD). VFD's are used to reduce the pumps operating speeds which in turn reduces the flow, head and power. The theory is to operate a "control system" that allows the pump to match the duty required, rather than exceeding the required system configuration.

Today power consumption makes up the majority of the overall cost of operating and owning pumping equipment. In recent years pump manufacturers have recognised this and have started promoting this new means of measuring pumping equipment. Unfortunately up until now, calculating the LCC of an application was primarily based on "educated guesses" and usually based on extreme applications (where the pumps operating hours were excessive). As a result, manufacturers and suppliers have promoted the LCC method only in applications that they were certain their equipment would outperform their competitors.

To date there has been no way of gauging the potential financial gains (or losses) from a manufacturer's perspective, and there has been minimal effort to provide end-users with credible software or support to determine the LCC of a pumping application.

2.0 Introducing Which Pump™

Which Pump™ is an independent company who provide an online software program that allows a design engineer to accurately measure the LCC of a pumping application. Which Pump™ is not aligned with any pump (or other equipment) manufacturer, thus providing users with tangible independent LCC advice, accurately comparing pump systems against competing solutions and therefore determine the pumping system that best suits an application.

Which Pump™ produces results for “system curve”, “constant pressure” and “constant flow” applications. The type of information required range includes duty requirements, a pump’s associated capital costs, the pumps performance curve, service intervals, motor and VFD efficiencies.

For the remainder of this article, we will walk through a typical LCC example and provide summarised results. Some concepts and theories are explained in more detail to help the reader understand the rationale behind the approach.

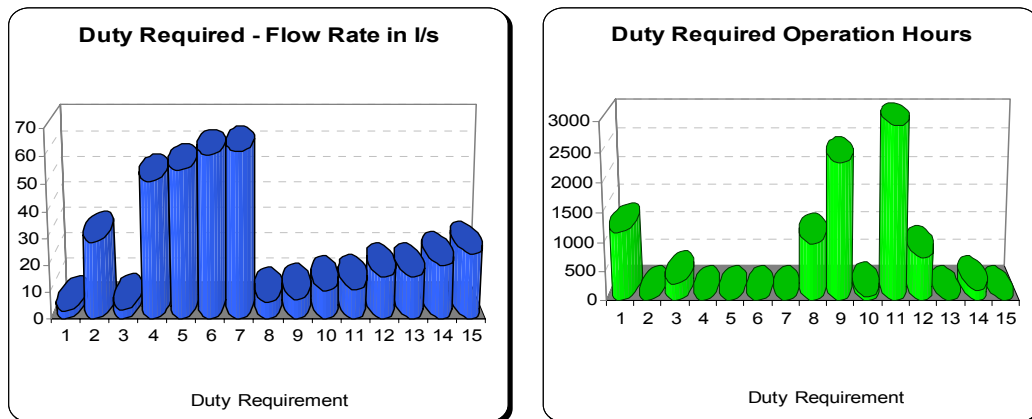
3.0 Duty Requirements

Traditionally duty requirements are based on an ultimate duty that, depending on the application the pump may never or rarely operate at. A typical example of this logic is in the waste water industry: to ensure that sewers don’t overflow from rain water infiltration during extreme rainfall a safety factor is used. Evaluating a pumping system at this maximum flow rate 100% of the time is the equivalent of operating a pump at fixed speed. This calculation does not differentiate between fixed speed and variable speed operation, and therefore provides no tangible indication of the most economical control system.

datetime	inFlow
8/04/2006 12:25	15.783333
8/04/2006 12:30	3.8833333
8/04/2006 12:35	4.7333334
8/04/2006 12:40	14.15
8/04/2006 12:45	4.266667
8/04/2006 12:50	16.1
8/04/2006 12:55	5.5833333
8/04/2006 13:00	1.65
8/04/2006 13:05	4
8/04/2006 13:10	13.683333
8/04/2006 13:15	3.5333333
8/04/2006 13:20	9.2666666
8/04/2006 13:25	12.933333
8/04/2006 13:30	2.916667

Figure 1: *Duty requirements calculated from the Scada data*

The most accurate method to determine your duty requirements is to upload your system Scada data directly into the Which Pump™ web site. Which Pump™ then calculates your actual duty requirements over that period of time. The diagram to the right illustrates typical Scada data. If Scada data is unavailable you can enter your specific duty requirements manually. A graphical illustration of the duty requirements calculated from the Scada data is depicted below.



Figures 2 & 3: *Duty requirements calculated from the Scada data*

4.0 What is a System Curve?

The starting point of a system curve is determined by the static head of the application (static head is the vertical height from the water surface to the highest elevation in the pump suction or discharge pipe work). The shape of a system curve is relevant to the resistance within the pump systems pipe work and fittings. This resistance is referred to as friction loss. The shape is affected by any increase or decrease in flow (this fluctuation changes the system head to the square). In practical terms if the pipe work used has a large flow rate and small diameter, the system curve becomes very steep (due to the high resistance from the pipe work). Likewise if the flow rate is small in relation to the pipe work size then the resistance is low, therefore producing a much flatter system curve. Which Pump™ requires a system curve.

5.0 Control Methods Generated

The most common type of application used for water transfer is the system curve application. For this type, Which Pump™ calculates LCC results for ten control methods (nine of which are VFD controlled, one fixed speed). In the following example the most economical VFD control system and the fixed speed results have been displayed. Full details are available at <http://www.whichpump.com/casestudy.html>

Note that for constant pressure and constant flow applications Which Pump™ calculate nine VFD control methods only (fixed speed is not recommended for these applications).

6.0 LCC Example

In this example an existing sewer pump station is fitted with two 54kW fixed speed pumps that operate for 694 hours annually (duty standby configuration). The pumping application used is a System Curve application using the Scada generated duty requirements above. Four pumps were submitted from the customer's preferred manufacturer to determine the most economical pumping solution over a lifecycle of 15 years.

7.0 Determining Maintenance Intervals and Costs

Which Pump™ determines the maintenance costs and most importantly the most economical time to perform maintenance using their patent pending method that simulates the pumps wear..

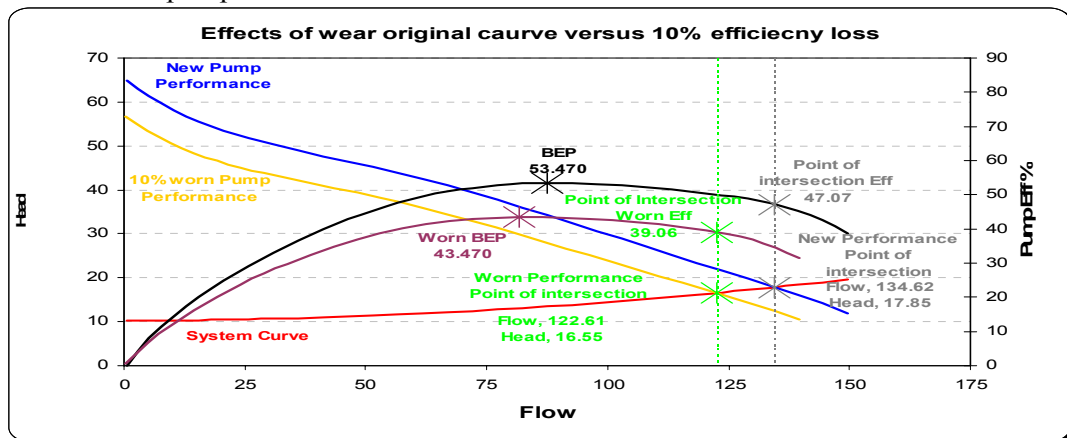


Figure 4: Effect of wear original curve V's 10% efficiency loss

The pumps performance is simulated from new (0% loss) down to a 30% loss in pumping efficiency in 1% increments. The recommended service interval is simply the most economical balance between power consumption, maintenance and capital investment

Figure 4 above illustrates the performance decline and change in pump performance with a 10% loss in pump efficiency due to wear. To achieve this, it recalculates the minimum number of pumps taking into consideration wear, pump configuration and the exact speed required to achieve each duty requirement.

8.0 Power Costs

Multiple power costs can be applied to your duty requirements to enable accurate calculation of your pumping system during peak and off peak power periods. The following graph relates to the power costs applied to the before mentioned duty requirements

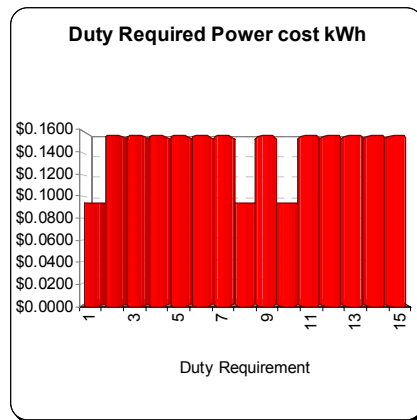


Figure 5: *Power costs for Duty Required*

9.0 Which Pump™ Reports

Some of the issues considered within our patent pending application are:

- Variable speed drives should only be used in a system curve application when the duty requirements, the shape of the system curve, the efficiency and the performance of the pump fit certain criteria. In order to accurately decide if there are financial benefits in using a VFD, an accurate assessment of the requirements, system curve and pump characteristics would need to take place. The Which Pump™ report takes these into consideration.
- Fixed Speed Pumps are calculated so that the minimum number of pumps and their recommended configuration always exceeds (or match) the duty required. From an application perspective this calculation method is simply starting and stopping pumps (operating hours will generally be lower than your duty requirement hours due to the pumped flow exceeding the duty required flow).
- During VFD applications the program calculates the minimum number of pumps, their configuration and exact speed required to achieve the specified duty requirements. This then provides power consumption which when combined with capital costs and maintenance costs results in the full LCC of the system.

- Which Pump™ considers various thresholds and different ways of configuring your pump systems. Three different minimum and maximum Hz techniques are used when producing the reports.

Minimum Hz:

1. No Minimum Hz setting;
2. Minimum Hz set by the lowest kWh/m³; and
3. Users Nominated Minimum Hz.

Maximum Hz:

1. The users desired maximum Hz;
2. Calculated Maximum Hz using the motors rated kW against the NOL kW of the pump; and
3. The NPSHA from the site against the maximum NPSHR from the pump.

10.0 Example Results: Existing Pump

The following LCC results do not include capital costs of pump(s) and associated control equipment

Variable Speed Result

The most economical operating system for the existing pump is operating via a VFD with a minimum Hz setting of 40Hz. Based on servicing pumps at the most economical service interval (751 hours) this equates to a total LCC of \$60,265 (of which \$57,100 is power costs and \$3,165 is maintenance and capital costs). This method will emit 508 tonnes of carbon dioxide over the assessment term (brown coal generated electricity).

Fixed Speed Result

The existing fixed speed pump system based on servicing pumps at the most economical service interval (640 hours) equates to a total LCC of \$83,575 (of which \$80,221 is power costs and \$3,353 is maintenance and capital costs). This method will emit 713 tonnes of carbon dioxide over the assessment term. Note: this is the current method of operation

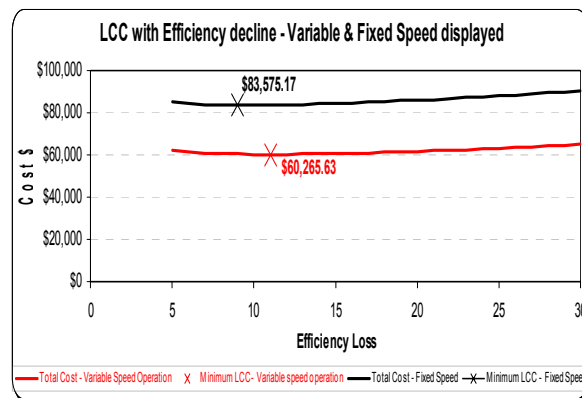


Figure 6: *LCC for Variable & Fixed Speed Pump*

Summary: if the existing pump was switched to VFD operation this will save a total of \$23,309 in operation costs over the assessment term.

11.0 Example Results: Alternative Pumping System

Variable Speed Result

The cheapest alternate pump was based on a 45kW pump with a Hz range of 31.54 - 55Hz. The service cost of this pump is purely labour costs (adjust the impeller clearance). The service interval for this pump is also greater than the existing pump due to harder materials of construction. This pump and control system has a total LCC of \$33,976 (\$32,289 of power costs and \$1,687 of maintenance and capital costs). This method will emit 287 tonnes of carbon dioxide over the assessment term. Figures are based on servicing pumps at the most economical service interval (1395 hours).

Fixed Speed Result

If this pump was installed and operated using the existing control system the total LCC excluding the pumps capital costs would be \$67,796 (\$66,831 power costs, \$965 maintenance and capital costs). This method would emit 593 tonnes of carbon dioxide over the assessment term. Figures are based on servicing pumps at the most economical service interval (653 hours).

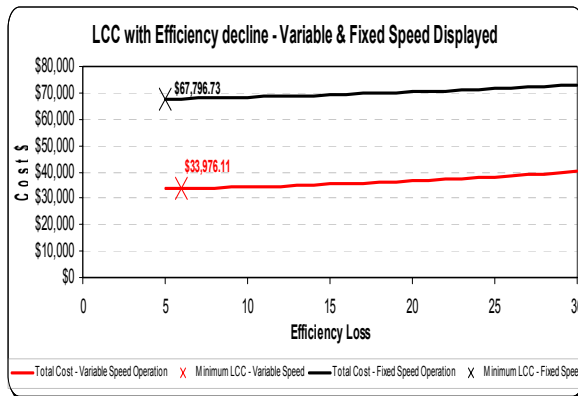


Figure 7: *LCC for Variable & Fixed Speed Pump*

Example Summary

There are significant financial savings to be made by changing the pump and control systems to the alternative system. Installing the 45kW pump and a VFD control system will save \$49,599 in power and maintenance costs over the assessment lifecycle when compared to the existing pumping system (29% reduction in green house gas emissions).

12.0 Conclusion

Which PumpTM offers the industries first independent LCC pumping application. This finally gives end users the ability to calculate both what their system actually costs today, as well as compare different system configuration options. Multiple pumps can be compared allowing users to determine which solution is truly the cheapest option available.

Benefits to end users are the ability to measure how their system actually performs and the ability to realise tangible cost savings if they elect to replace or reconfigure

equipment. Other benefits include tangible greenhouse gas emission reductions.
For more information visit our web site www.whichpump.com