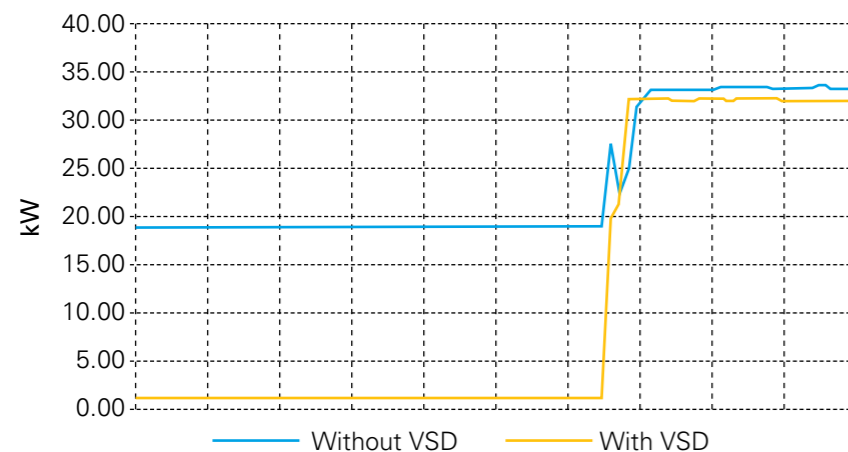


The result

To determine the actual power and cost savings achieved by installing the VSD, the pump power demand was logged before and after the installation.

A snapshot comparing the before and after kW demands over comparable cycle period in the cooling cycle is shown in the graph below.



It can be seen from the logging that the pump power demand during a batch, when reactor cooling is required, is about the same before and after the VSD was installed.

However, the minimum power demand has changed markedly. Before fitting the VSD the minimum power consumed was 19 kW while after the VSD was fitted this dropped down to 1 kW. The 18 kW reduction achieved was as expected from the pump curves.

Conclusion

From the data logging and advice for plant management, it was determined that process cooling is not required for 2,760 operating hours per year. That is, there are 2,760 hours per year during which the installation of the VSD will save Rohm and Haas 18 kW of power use.

With the cost of electricity at 11 cents per kWh, the 49,680 kWh electricity saving amounts to a cost saving of \$5,464 per year.

The simple payback period payback for Rohm and Haas' investment is 1.7 years.

Rohm and Haas proves the value of VSD pump control

Rohm and Haas NZ Ltd manufacture a range of products, mainly for use in the manufacture of paints from their long established factory located in Auckland's Otahuhu industrial area.

One of the company's key processes is the reaction of monomers and additives to produce high quality polymers. The process reactors require heating in order to get the process under way but, once a critical temperature is reached the reaction produces its own heat and cooling is required to keep the reaction under control and maintain product quality.

An energy audit conducted by Energy NZ Ltd identified that more efficient control of the cooling water pump provided a significant electricity saving opportunity.

Of the options considered, installation of a VSD proved to be the most practicable solution with a very favourable financial return.

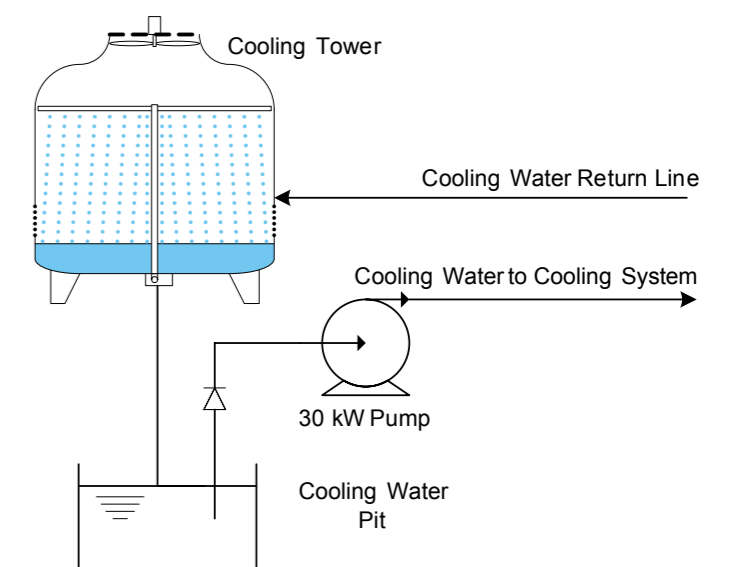


The cooling water system

To keep the polymer production process under control, cooling water is taken from cooling water pits and circulated via a centrifugal pump. The cooling water flow rate required varies depending on which product is being manufactured and the stage of the batch process. Control valves adjust the flow rate of cooling water and keep the process at the optimum temperature.

The pump, with a 30 kW motor, runs continuously for long periods of time. Prior to the installation of the VSD, the pump's discharge was throttled by a valve limiting the flow to approximately 50% of maximum in order to limit the head and flow.

In between batches, valves allowing water to the cooling system were closed and the only flow through the pump was through a return line that ensured the pump's minimum flow requirement was met. The diagram illustrates the configuration of the original cooling system.



The problem – inefficient control of the water pump

Depending on the product being made, the original system used 27–35 kW of power to pump cooling water through the cooling system. And between batches, when no cooling is required, the pump still consumed 19 kW of power.

Inefficient control of the cooling water pump was resulting in significant unnecessary electricity wastage and costs.

An obvious solution was to simply switch off the pump between batches. However, switching off the pump was not practicable because when the reaction becomes exothermic, and heat needs to be removed, it is crucial to have reliable availability of cooling water.

The pump intake is not under pressure but has a suction lift of about 1.0m from the cooling water pits. Although there is a foot valve to prevent the pump from draining water and losing prime while not operating, it is possible that debris can prevent the foot valve from adequately sealing. This has occurred on a number of occasions.

Installing a solenoid valve from the reticulated water supply to have automatic priming the pump was also considered but was not viable due to the strict regulations about connecting up process pumps to the reticulated supply.

To keep the pump primed and thereby ensure the reliable availability of cooling water, it is considered essential that the pump is kept running for the entire time that reactions may take place.



“When no cooling is required, the pump still consumed 19 kW of power”

The VSD control solution

To match the need to keep the pump running to maintain prime with the desire to reduce power consumption when process cooling is not required, it was decided to fit a VSD to the pump motor.

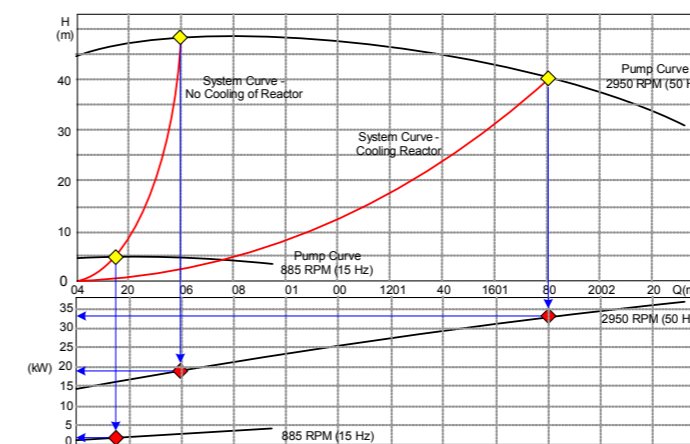
A VSD allows the running speed of an AC motor to be changed, by increasing or decreasing the AC power supply frequency to the motor.

The power that an AC power driven centrifugal pump uses has a cubic relationship to the pump speed. That is, doubling the pump speed will increase the power consumption by 8 times; and halving the pump speed will result in an 8 fold reduction in power use.

In the case of the cooling water system at Rohm and Haas, the VSD control system solution was configured so that when the valve that controls the flow of water to the reactor cooling is closed, the cooling pump speed is dropped to 15 Hz.

The total installation cost of this system, including the VSD purchase price was approximately \$9,500.

The expected results from varying the pump speed can be determined by inspecting the pump and system curves for the overall system. These are shown in the figure below.



“Halving the pump speed results in an 8 fold reduction in power use”



The system curve, which indicates how hard it is to pump fluid through the system, is much steeper when cooling is not required than when cooling is required. This is because when no cooling is required all the flow must go through the pump minimum-flow line.

If the pump is running at 50 Hz, the operating point of the pump is the intersection of the 'System Curve – No Cooling of Reactor' and the 'Pump Curve 2950 RPM'. The power consumed at that operating point can be found by dropping a line from the operating point to the power curve for operation at 2950 RPM. This gives a value of 19 kW.

If the pump speed is slowed down by running at 15 Hz, the system curve remains the same but the pump curve changes. This time the pump operating point is the intersection of the 'System Curve – No Cooling of Reactor' and the 'Pump Curve 885 RPM'. The power consumption is again found by dropping a line from the operating point to the power curve for 885 RPM. This gives a value of about 1 kW.

From the review of these curves, an 18 kW power reduction was expected during the times when no cooling is required.