

Optimising pump systems for improved efficiency

3 years ago



Given the global rise in energy costs, there has never been a better time to review and assess the efficiency of your pumping systems – whatever their size, complexity or indeed area of operation.

In this article, Gary Wilde, Technical Services Officer at the British Pump Manufacturers Association (BPMA) offers some basic information and guidance on purchasing, maintaining, and designing pump systems for optimum energy efficiency, CO₂ reduction and capital expenditure payback time.

Pump systems account for 20% of the world's electrical energy demand and between 25% – 50% of the electrical energy usage in certain applications. Pumps are the single largest user of electricity within industry across the European Union, consuming over 300 TWhpa of electricity, which in turn accounts for over 65 Mton of CO₂ emissions.

It is also well documented that rotodynamic pumps which account for 80% of the installed base are between 20-30% oversized. There is therefore a major potential to save energy if rotodynamic pumps are properly sized and operated.

Where to start – Assess the potential for savings

Understand your pumping system:

To identify if a pumping system is sized correctly make the following checks;

- Are you wasting liquid flow?

- Are you creating additional pressure?
- What is the monitoring & controls philosophy?
- Are there any oversized pumps installed for your required duty?
- Are there any old pumps employed in the system?
- Is there excessive noise in the system?
- Are there any throttling valves installed in the system?
- Have you the correct size of pipework installed?
- Inadequate maintenance lowers pump system efficiency, so what maintenance procedures are in place?
- Are you adopting a proactive equipment replacement programme to current EU legislation

Available Technology – Choosing the right equipment

Understanding Drive Technology:

Use latest EU regulation to achieve best possible drive efficiency;

- Variable speed drive (vsd)
- Integrated control and monitoring
- Permanent magnet technology

Choose your supplier – Making the right choice

This article does not suggest or promote any single supplier or technology. It does however recommend that you choose a supplier that is a member of the BPMA, and as such offers the assurance that it operates within the organisations agreed standards and Code of Practice.

The vast majority of existing pump systems operating today were not originally designed with energy conservation as a major consideration. If pump systems are initially designed on an energy efficient basis and pumps are correctly applied and sized the energy savings will often be in excess of 50%.

To design an energy efficient pump system all the following criteria should be considered:

- Basic plant layout
- Pipe size, configuration, and restrictions to limited pipe work losses
- Information on the liquid, (viscosity, density, aggressiveness, temperature)
- System characteristics and pump selection

- Pump/System control
- Avoid oversizing of the pump units
- Selecting the most energy efficient pumps at the best efficient point
- Fitting VSD's to match the system design & demand

Reduced energy costs are a direct result of selecting the correct pump and matching it to the system.

When selecting a pump, it is important to determine the required flow and pressure to be generated by the pump. The flow may be determined by a process requirement, by the heating or cooling required in the system or by the peak water demand for utilities. The pressure required may be to elevate the liquid within the system or to overcome the pressure losses in the system created as liquid passes through it.

It is important to know as much about the pump system as possible and to create a pressure/flow profile for the system. The energy required to drive the pump is directly related to the flow and pressure required. To generate high pressures generally leads to designs which may be inefficient and therefore it is important that neither the flow nor the pressure is over specified.

Variable Speed Drives can save energy

It is estimated that significant energy savings have already been made by using Variable Speed Drive and High Efficiency motors. Generally, Variable Speed Drives are used to continually adjust the speed of the pump to the demand.

The savings can be determined by the affinity laws:

$$\frac{Q_2}{Q_1} = \frac{n_2}{n_1}$$

$$\frac{H_2}{H_1} = \left(\frac{n_2}{n_1} \right)^2$$

$$\frac{P_2}{P_1} = \left(\frac{n_2}{n_1} \right)^3$$

Q= Flow, H= Head, P = Power and n = Rotational Speed

When building a new pumping system, most Pumps are selected with a “safety factor” for potential future uprates or to allow for wear in the pump or fouling of the system. Often there are many different parties involved in specifying and building a system and the safety factor can grow exponentially. This results in the pump delivering much higher flows than required. There may also be the need to vary the flow due to process conditions or varying heating and cooling needs within buildings.

Traditionally, throttling is used to regulate flow in a pumping system. While throttling reduces the flow, the motor is still running at full speed and works even harder as it must work against a restriction. By reducing the speed of the motor, the variable speed drive ensures no more energy than necessary is used to achieve the required flow. A centrifugal pump running at half speed consumes only one-eighth of the energy compared to one running at full speed. Utilising an Electrical Variable Speed Drive is the simplest and most economical way of controlling the pump and matching it to the pump system.

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Here are some key considerations when looking to optimise the energy use in pumping systems:

Has an alternative configuration been considered?

In some cases, moving from an existing pump layout to an alternative can offer energy saving possibilities.

Is the Pump Performance Monitored?

By looking for early signs of pump wear which can include increased noise, vibration or power consumption, major energy and maintenance savings can be achieved.

Has ease of maintenance been allowed for?

When designing or replacing pumps, ease of future maintenance requirements should be considered.

Variable Speed Drive Considerations

When fitting VSD to a pumping system, output and input filters should be considered, along with insulated motor bearings.

Maintenance

When maintaining pumping systems it is recommended to use original manufacturers' recommendations and parts.

Reliability / Security

Efficient, well-maintained pumps are more likely to be reliable and unlikely to fail prematurely causing loss of production or services.

Valves

Valves are considered to waste energy within a pumping system, however if installed they should be checked for correct operation.

Pumps not in use

Stand by pump units or pumps with no demand should be switched off to save energy.

Is the pump working most of the time close to its best efficiency point?

Rotodynamic pumps operating away from BEP not only waste energy, but also reduce the life expectancy of the pump.

System Alterations

When upgrading, changing, or expanding a pumping system the demand may have changed and existing pumps may not be the most efficient solution.

Purchasing the correct pump set

When purchasing a pump set, price should not be the deciding factor. If a pump is sized correctly the return on investment is shorter, likewise if a pump is oversized and is wasting energy going forward you will have this additional cost for the anticipated life of the pump set.

Has an energy check been undertaken on existing systems?

Under UK ESOS regulation all non-SME organizations are mandated to carry out energy audits, and pumping systems can offer substantial energy savings.

When specifying a new pump, ask for a high efficiency motor to be fitted. If you are replacing or rewinding a motor, then evaluate the cost of fitting a High Efficiency motor remembering to factor in the running savings which will pay back any increase in cost. Invest in carrying out an energy audit. Review your utility bills and understand the energy you are using. Carry out an audit if:

- Your energy bills are high
- You have continuously operating pumps
- You have many pumps in the system

- You have processes with varying flows
- You have throttled pumps
- You have pumps which are on bypass
- You have noisy valves or pipework
- You have critical systems which have been subject to breakdowns

The purpose of an energy audit is to reduce operating costs by reducing energy consumption and the government has estimated that most companies can reduce their energy consumption by 10% to 20%. Energy audits conducted by BPMA members have shown that savings from 30% to 50% are not unusual. When deciding whether or not to carry out an energy audit a good starting point is to assume that you will save at least 10% of your current energy consumption. By reviewing utility bills, you can get an indication of the savings to be made and the investment that you should be prepared to put into the auditing process.

Across most industrial sites, some two-thirds of the total energy consumption is used to power electric motors. Furthermore, the overall cost associated with operating these essential pieces of equipment throughout their entire life span can be broken down as follows; 5% accounts for the initial purchase/installation costs, 10% for ongoing maintenance and a massive 85% for the energy used to run them. Clearly, any reduction in the energy consumed by electric motors is important, and with modern designs that reduction can be as much as 30%. It is also evident that many pumps and motors are constantly operated at full power, irrespective of process needs, and so across the installed base there is the potential for significant energy savings; savings which can in turn drop to the bottom line and increase the profitability of any business.

BPMA involvement

Given the amount of energy consumed by pumps through their normal operation, and the potential for energy efficiency gains within pump systems, the BPMA have worked to develop a Certified Pump System Auditor Scheme (CPSA).

Through the CPSA, pump engineers are being trained to correctly assess the efficiency of pump systems, and to provide appropriate recommendations in order to improve the efficiency of those systems. The CPSA accreditation is achieved by successfully completing a four-day residential course, followed by the satisfactory completion of a pump system audit. Only then can 'Certified Pump System Auditor' status be achieved.

Within the full ESOS Guidance document, the ISO/14414-Pump System Energy Assessment standard is referenced as an auditing methodology that can be accepted by "Lead Assessors" approved by the Environment Agency. Accordingly, it is hoped that CPSA accredited persons (who are trained according to the ISO 14414 standard) will be recommended by Lead Assessors to undertake the pumping system elements of company-wide energy audits.

The next CPSA Training Course is scheduled for 7th-10th November, with a further session already set for 9th-12th May 2023. For more detailed information, please visit <http://www.bpma-cpsa.co.uk>.