Energy efficiency

Reducing avoidable pressure losses:

Industrial plants frequently employ oversized pumps out of caution. Pressure losses, and consequently energy consumption, may thus be unnecessarily high. Neoflux explains in detail how such avoidable pressure drops can be determined both, theoretically and in the field, as well as examining how to reduce them.

In nearly all industrial plants, and especially in the process industry, pumping systems require a considerable share of the total energy consumption. Therefore, saving energy in an economically feasible way is a constant concern for plant managers and engineers alike. Experience shows that in existing plants pump systems are often not optimized, in particular where energy consumption is concerned, utilizing 'wrongly' sized (mostly oversized) pumps. This is the result of adding safety margins in the planning process covering uncertainties concerning pipe runs, layout, the range of physical data of the fluid, the manufacturer's tolerance, etc. In addition, the price of energy may have changed in the course of time triggering a rethink on reducing power consumption.

There are several ways to achieve energy savings in an existing plant, an important one being to trim the impeller of centrifugal pumps. Trimming, changing or even replacing the impeller of a multistage pump with a vaneless one (i.e. a plain disk) is likely to be economical if the pump is relatively small and running most of the time at high load.

The starting point for any consideration is of course the measurement of the actual data, namely, determining the operating point at the design load, which ought to be the maximum load. This comprises measuring flow (if necessary by means of a clamp-on flow meter), pressure and power consumption.

To achieve the design flow in a system with an oversized pump, the flow must be throttled until the design value is reached. This throttling could be performed by an operator who adjusts a manual valve. If there is a control system, the control valve is adjusted automatically. In cases where the pump system features more than one branch, every branch has to be throttled to achieve its design flow in such a way that the total pump pressure (i.e. the head) is reached. Normally one and only one branch will require the highest pressure, thus determining the pressure the pump has to deliver. If the pressure drop in this determining flow path could be reduced, the pump head could be reduced accordingly by this 'unnecessary' pressure loss, thus allowing a reduction in energy consumption. To realize this reduction this avoidable pressure loss has first to be determined.

Reducing pressure drop in general:

Data on further and/or additional possible reductions of pressure drop in the determining flow path may also be obtained by analyzing its losses in detail and modifying the system. However, with existing systems, changes will seldom be economically sensible where geodetic height, static pressure, pipe diameters or pipe runs are concerned. This does not necessarily apply to fittings, valves and other associated components. Thus thought might be given to substituting a plug disk valve with a ball valve, even if it means deviating from a company's piping standard, etc. Similarly, the pressure losses of major equipment items such as heat exchangers, etc. should be scrutinized critically. In some rare cases a substitution may make sense. However, substituting in-line instruments causing a high pressure drop – for example, an orifice flow meter with a magnetic inductive one, etc. – would be economically more promising. It should be mentioned that the procedures described in this paper could also be applied to estimate the possibilities of debottlenecking a pump system.

Conclusion:

In most cases it will be possible to determine the unnecessary pressure drop for oversized pumps while the plant is operating by measurements in the field plus some calculations. This yields the operating point of the pump with a trimmed impeller. To ensure the functioning of a system utilizing a pump with a trimmed impeller, especially with regard to the response of the control system, the maximum flow limit of the system should be established.