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THROTTLING IN PUMPS AND SCOPE OF ENERGY SAVING

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ABSTRUCT : *Over the years, usage of energy-efficient pumps is gaining popularity in the process industry, which in turn is leading to finding new ways for conservation of energy. Most processes in chemical industry involve transportation of liquids and/or transfer from a lower to higher energy level Pumping systems are one of the major consumers of electrical energy globally. It is thus natural that pumping operation should be the primary target for energy reduction and conservation.*
The article will give an idea, how the throttling of pumps participates in biggest energy losses & the efforts on study how will this throttling losses can be overcome.

I. INTRODUCTION

1.1 Throttling in Pumps

Throttling can be carried out by opening and closing a discharge valve.
Throttling is energy inefficient since the energy to the pump is not reduced. Energy is wasted by increasing the dynamic loss.

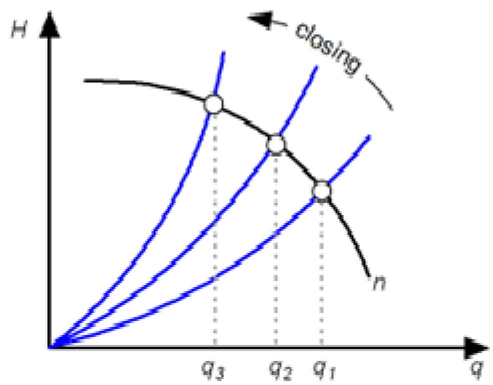


Figure – 1

1.1.1 Bypassing Flow

The discharge capacity can be regulated by leading a part of the discharge flow back to the suction side of the pump. Bypassing the flow is energy inefficient since the energy to the pump is not reduced.

1.1.2 Changing the Impeller Diameter

Reducing the impellers diameter is a permanent change and the method can be used where the change in process demand is not temporary. The method may be energy efficient if the motor is changed and the energy consumption reduced.
The change in power consumption, head and volume rate can be estimated with the affinity laws.

1.1.3 Modifying the Impeller

The flow rate and the head can be modulated by changing the pitch of the blades. Complicated and seldom used.

1.1.4 Pump Regulation and Power Consumption

Power consumption of some of the regulating methods are compared in the figure below:

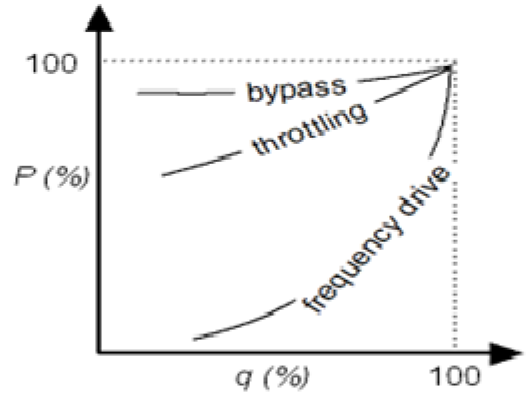


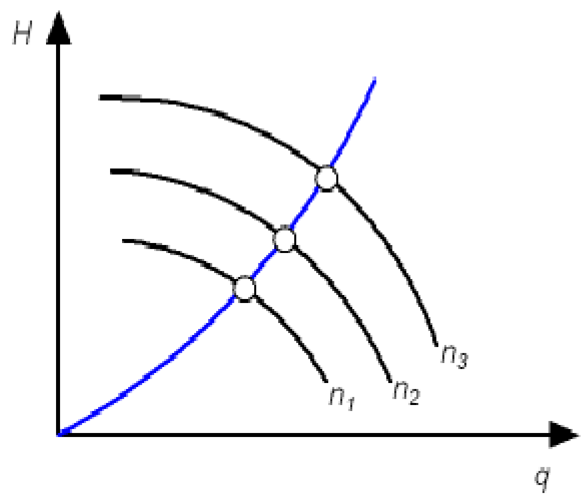
Figure - 2

It is often necessary to adapt the pump capacity to a temporary or permanent change in the process demand. The capacity of a centrifugal pump can be regulated either at

- constant speed, or
- varying speed

II. METHODS TO OVERCOME THE THROTTLING LOSSES

2.1 Capacity Regulating by Varying Speed



Fifure -3

Speed regulating is energy efficient since the energy to the pump is reduced with the decrease of speed. The speed of the pump can be varied with

- hydraulic/hydrostatic drives - hydraulic coupling between input and output shaft - speed ratio 5 to 1 is controlled by adjusting the volume of oil in the coupling
- mechanical drives - belt and sheave drive
- eddy current drive/clutch - magnetic coupling transfer load torque between input and output shaft
- variable speed drives - inverters - AC drives - adjustable frequency drives - operates by varying the frequency and voltage to the electric motor

The change in power consumption, head and volume rate can be estimated with the affinity laws.

2.2 Variable speed operation:

As explained earlier, the capacity delivered by the centrifugal pump is determined by the point of intersection between the head-capacity and system curves. Hence, to vary the pump capacity, profile of either or both the curves has to be changed. The usual practice is to alter the system curve by creating additional friction loss through a throttling valve. This is obviously a wasteful method as energy is unnecessarily expended in the throttling process. The more economical alternative is to change the pump's head-capacity curve, which is possible by changing the speed of the pump.

Energy saving method Savings	
Replacing throttling valves with variable speed drive	**10 - 60%**
Reduce speed for fixed load	5 - 40%
Pumps operating in parallel for highly variable loads	10 - 30%
Flow equalization using surge tanks	10 - 20%
Replace motor with a more efficient model	1 - 3%
Replace pump with a more efficient model	1 - 2%

There are different methods by which speed variation can be achieved:

• Multi speed motors, which however allow only discrete variation in two or three steps
• Hydraulic coupling, which is not a very efficient technique.
• Variable frequency drive, the most commonly used method, adjusts the frequency of the electric power supplied to the motor.

Speed control can keep pumps operating efficiently over a broad range of flows. When the pump speed is reduced, its head-capacity curve and efficiency curve shift to the left. The efficiency response is an icing on the cake, providing additional cost benefit, by keeping the operating efficiencies as high as possible across variations in the system's flow demand. However, the principal energy savings come form the reduction in friction losses by eliminating the need to throttle the flow.

Speed control cannot be applied indiscriminately to all situations. In applications where the system resistance is dominated by static head, reducing the speed can induce vibrations. Speed control devices are expensive, but the energy saves easily pays off the additional investment. In addition to savings in energy, reduced speed operation also decreases hydraulic forces on the impeller, which increases bearing life. Vibration and seal life also improves due to part load operation at lower speed.

2.3 Parallel pumps;

Another energy efficient method of meeting varying system demand is to install two or more pumps in parallel. Variation of low is achieved by operating the required number of pumps. Such parallel installations are provided when flow operations are possible over a considerable range. For example, distribution of utilities like cooling water. Meeting 50% of flow demand by operating at half load. In fact, it is possible to take advantage of the non-linearity of the head capacity and system curves and meet 60-70% of the flow demand by operating one 'half capacity' pump. Pumps that operate at reduced load have their life shortened, compared to those that operate close to their 'BEP'. Thus, running only one pump whenever it can handle the reduced demand provides additional benefit.

2.4 Minimize the Use of Throttling Valves or Bypass Operation

One generic best practice is to minimize the use of valve throttling and bypass losses in system control. Throttled valves convert hydraulic energy that the pump has imparted to the fluid into frictional heat, thus wasting a portion of the pump's energy. Bypass control simply routes some of the fluid that the pump has energized right back where it came from (dissipating the energy into heat in the process).

Even this best practice, which is about as close as one can get to simplistic rules of thumb in pumping systems, has its exceptions. And those exceptions are strongly influenced by the two previously mentioned knowledge-and-understanding best practices (Sections 7.2.1 and 7.2.2). Two examples of the exceptions are provided here.

• For pumping systems with very high static head requirements, such as boiler feed water applications, the fundamental nature of the pump and system curves often dictates that some level of adjustable friction (i.e., control valve) be injected into the system in order for it to be controllable across the entire operating range. It is simply not practical to use an adjustable speed drive (for example) to provide all of the flow regulation, particularly at reduced load conditions.

• For systems that operate in a very narrow window of flow rate and head but do not require relatively tight regulation, the use of a control valve may, almost paradoxically, be the lowest energy cost alternative. For example, consider the pump and system curves shown in Figure 7.7 below. The pump was selected based on flow and head requirements at 5000 gpm. While an adjustable speed drive could be used to slow the pump down to achieve the 4700 gpm instead of regulating with the control valve, the end result would be additional cost.

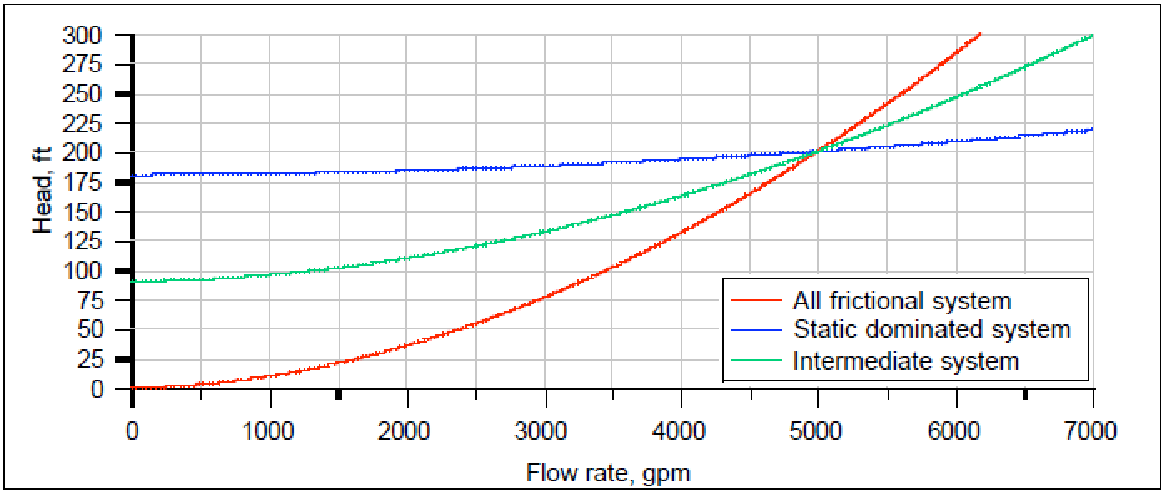


Figure - 4 Three different system curves with a single common flow rate/head point (5000 gpm/200 ft)

While the three systems do share the same head requirement at 5,000 gpm, at 1,000 gpm therequired head varies from 9 to 181 feet. This divergence should affect the choice of not only thecontrol system but the pump itself. Some general tendencies will be discussed below, but thepoint to be made here are that the nature of the static and frictional head distributions absolutelyshould be considered in selecting a control strategy. It is, therefore, an essential best practicethat the control designer must understand the system curve characteristic.It might also be noted that the transient protection considerations mentioned above would need tofactor into the nature of the system, including the static head as well as the general pipingdistribution—even when the system only operates at a single flow rate. So even in the simplestof control arenas, the nature of the system curve must be considered.

Best Practice—Consider and Apply the Best Control System and Pump

- Consider the divergence of system curves based on the frictional and static headdistributions of the pumping system in order to select/modify pumps and their controlsystems.

- Adjust the control system to fit the most appropriate system curve.

III. FOOTNOTES

- Whenever experts discuss about the pump efficiency & energy losses, common & biggest point of loss of energy is losses due to throttling.
- If we go through the data of domestic usage of water worldwide, this is nearly 60%.
- And maximum ignorance is also observed in domestic application of pumps, and also only in throttling.
- All manufacturers must make provision, for automatic control of throttling considering the particular applications.
- Like us, entire technical community have to made efforts to make all domestic users aware of proper use of throttling in pumps efficiently & effectively.

REFERENCES

[1.] O & M manual – Kolkota Metropolitan Water &Senitation Authority. (http://www.kmwsa.gov.in)
[2] http://www.energymanagertraining.com/announcements/issue28/Winners/1_Santosh%20Mahadeo%20Mestry
[3] http://www.energymanagertraining.com/Journal/08072005/Energy%20efficient%20pumping.pdf