Survey of Pump Energy Savings

An Online Continuing Education Course for Engineers

Course Number: M-2020

Credit: 2 Hours / 2 PDH / 2 CPD

Survey of Pump Energy Savings (2 PDH)

Overview

This course is designed as a follow-on to Course No. M-3005, Centrifugal Pumps, also available through PDHengineer.com, however, it is also a stand-alone course for those somewhat familiar with pumps in general, and centrifugal pumps in particular.

The majority of technical articles and reports today dealing with energy and resources conservation involve nuclear power, redesign of industrial plants and infrastructure, and new fuels such as agricultural by-products and hydrogen. The purpose of this paper is to describe some potential cost and energy savings that are available today, and have been for years. The design, selection, operation, and maintenance of centrifugal pumps is one of these potentials.

Introduction

The centrifugal pump is the second most widely used type of mechanical equipment in the world; only the electric motor outnumbers it. There are literally millions of them in service in every conceivable application. Fortunately, they are prime candidates for major energy savings, since the power required varies as the cube of the speed ratio; (i.e., cut the speed in half and reduce the power to one-eighth of the original value). The use of variable speed drives alone has a tremendous potential for cost and energy savings. There are, however, many other areas where this is practical.

The following subjects are discussed in this paper:

- System design
- Selection of pumps
- Pump construction and features
- Pump drives
- Maintenance
- Field changes and operation

System Design

Careful attention to system design can eliminate unnecessary static head and pressure drop by minimizing fittings, valves, and strainers. Proper selection of heat exchangers can also reduce pressure drop, as can increased pipe size and selection of pipe materials. On a large system an economic analysis should be done to compare first the cost of larger piping, fittings, valves, and heat exchangers relative to the economic benefits of the power saved because of lower frictional losses. Special attention should be paid to selection of control valves, since they can be one of the largest pressure drop components in a system.

Reduce Specific Gravity and Viscosity Prior to the Pump

The power requirement of a pump is proportional to the specific gravity and the viscosity of the fluid being pumped. Many times it is possible to reduce both by raising the temperature of the fluid. This often has to be done anyway as part of the process, so no there may be no increase in energy required. Be careful, however, when raising the fluid temperature to ensure that adequate NPSHa is maintained.

Increase available NPSH (NPSHa)

Most pump manufacturers have developed impellers with low NPSH required (NPSHr) characteristics, however, they generally have sacrificed efficiency to do this. By increasing the NPSH available, a more efficient impeller may often be selected. Figure 1 shows the performance of the same pump with a low NPSH and normal NPSH impeller

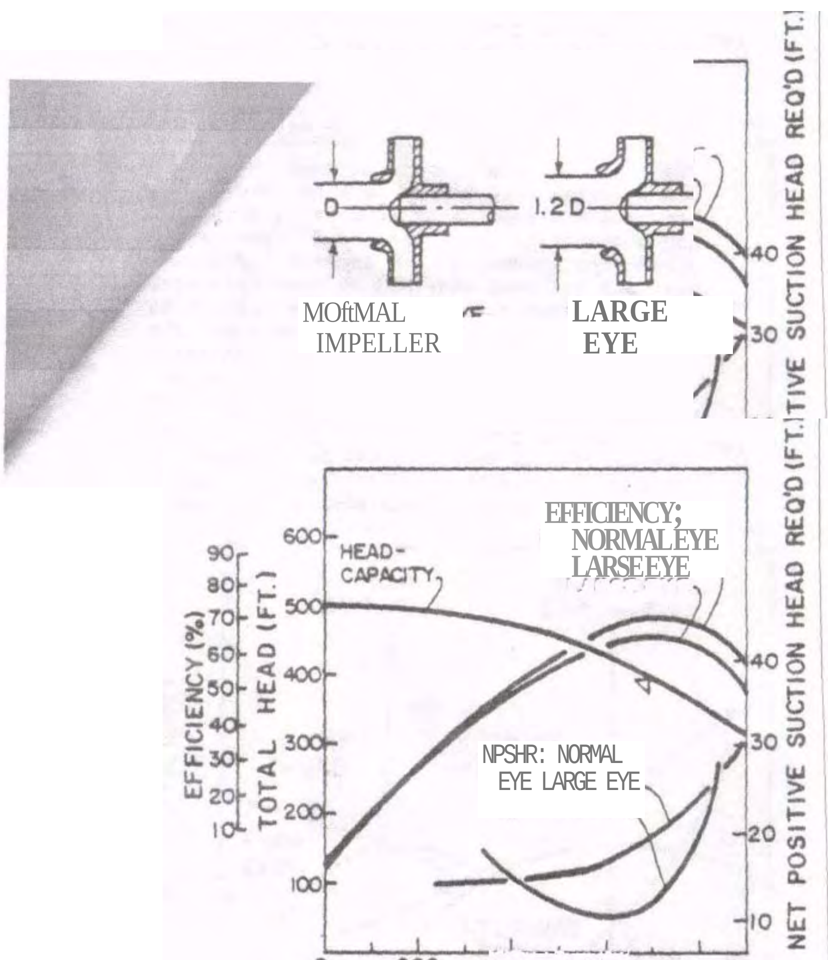


Figure 1.   Normal and Large Ey« Imp«ll«r Performance

400   to   600 FLOW(GPM)

SPEED »3550RPM

SPECIFIC SPEED Ns »1050

Note the difference in efficiency (5%) at the pump best efficiency point. Also, by increasing the NPSHa, the speed of the pump may be increased, thus allowing the selection of a more efficient specific speed pump. Care should be taken in this area, since the reverse can also occur; ie, an increase in speed could mean a less efficient specific speed, for example, going from a radial to a mixed flow, or from a mixed flow to an axial flow impeller design.

Avoid Gas Entrainment

The presence of undissolved gasses, or gas that evolves during pumping reduces the performance of the pump, and hence its efficiency. This reduced efficiency occurs because the hydraulic losses within the pump do not decrease at the same rate as the reduction in capacity and developed head. In fact, these gasses may increase the hydraulic losses due to increased turbulence and hindered flow passages.

Eliminate Fixed Orifice in Recirculation or Bypass Lines

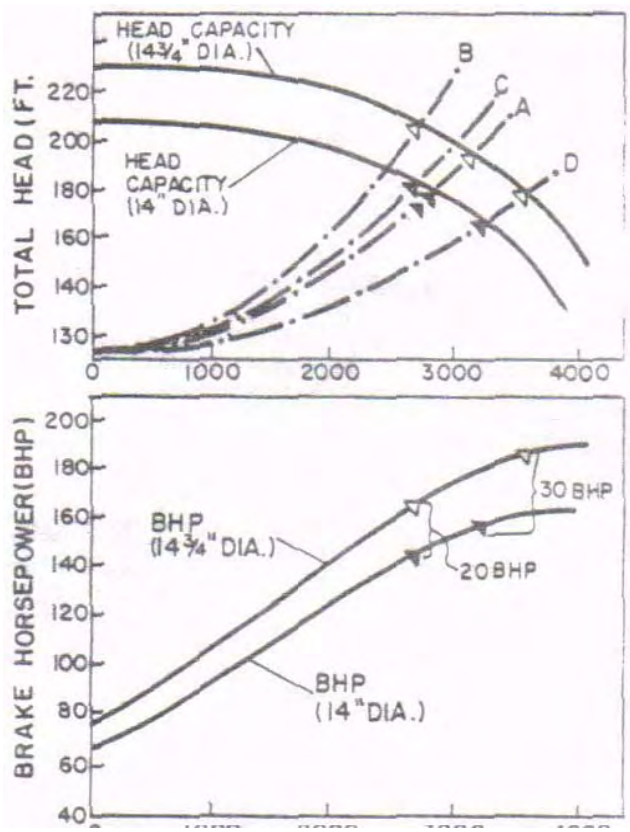
Most recirculation or bypass lines use fixed orifices that pass a constant flow from the pump suction source. Many of these orifices have valves upstream that open and close at preset flows to protect the pump. Thus there is a constant or intermittent flow through the bypass line with a commensurate power loss. There are available today modulating valves that regulate the bypass flow so that the total flow through the pump is always above the minimum flow requirement of the pump.

Eliminate Oversizing by Proper Use of Margins

Of all of the poor design practices, this is probably the most prevalent. There are thousands of pumps installed in systems with margins added to margins. Not only do the pumps run less efficiently because they require excessive throttling, but many times they cost more than the properly sized pump because they are larger, and the off-peak operation increases maintenance on the pump and the control valve. This is graphically shown in figure 2 on the next page.

Hydraulic Turbines

Centrifugal pumps have long been used as hydraulic turbines where there is a source of high pressure liquid that must be reduced to a lower pressure or to atmosphere. Pumps are quite efficient energy recovery devices when used as a hydraulic turbine to convert high pressure fluid power into electricity to drive other rotating equipment.



NOTE:
A* DESIGN SYSTEM CURVE WITH 13 **YEAR OLD** P!P£
B* THROTTLED SYSTEM CURVE WITH **EXCESS** MARGIN
C* THROTTLED **SYSTEM** CURVE WITH NORMAL MARGIN
D* ACTUAL SYSTEM CURVE WITH NEW PIPE

Figure 2. Effect of Excess Margin on Energy Consumption

Use Booster Pumps

Many times a system will have a number of users of the fluid, only a few of which require the full operating pressure of the system. The remainder use valves to reduce the pressure to their needs. It is often possible to design systems that use booster pumps to raise pressure for those portions of the system that require it. Usually the power savings and the cost reduction for the lower pressure main pumps more than offset the additional capital, installation and power consumption costs of the booster pumps.

Proper Pump Selection

In addition to selecting the proper pump from an application service standpoint, many times it is possible to select the most efficient category of pump. The major pump categories are centrifugal, rotary, and reciprocating. For instance, almost all reciprocating pumps of any capacity are over 90% efficient, while very few centrifugal pumps are over 90% efficient, no matter how large its capacity. In the normal area where a reciprocating pump is used; (i.e., low flow /high pressure), the difference in efficiency between a centrifugal and a reciprocating pump can be 40 or 50%. Of course, there are other considerations, such as maintenance, first cost, and availability, but efficiency is a very important consideration.

Optimum Specific Speed

For the normal range of fl… …pecific speed range will … …cked to see if it is poss… …p features, such as m…

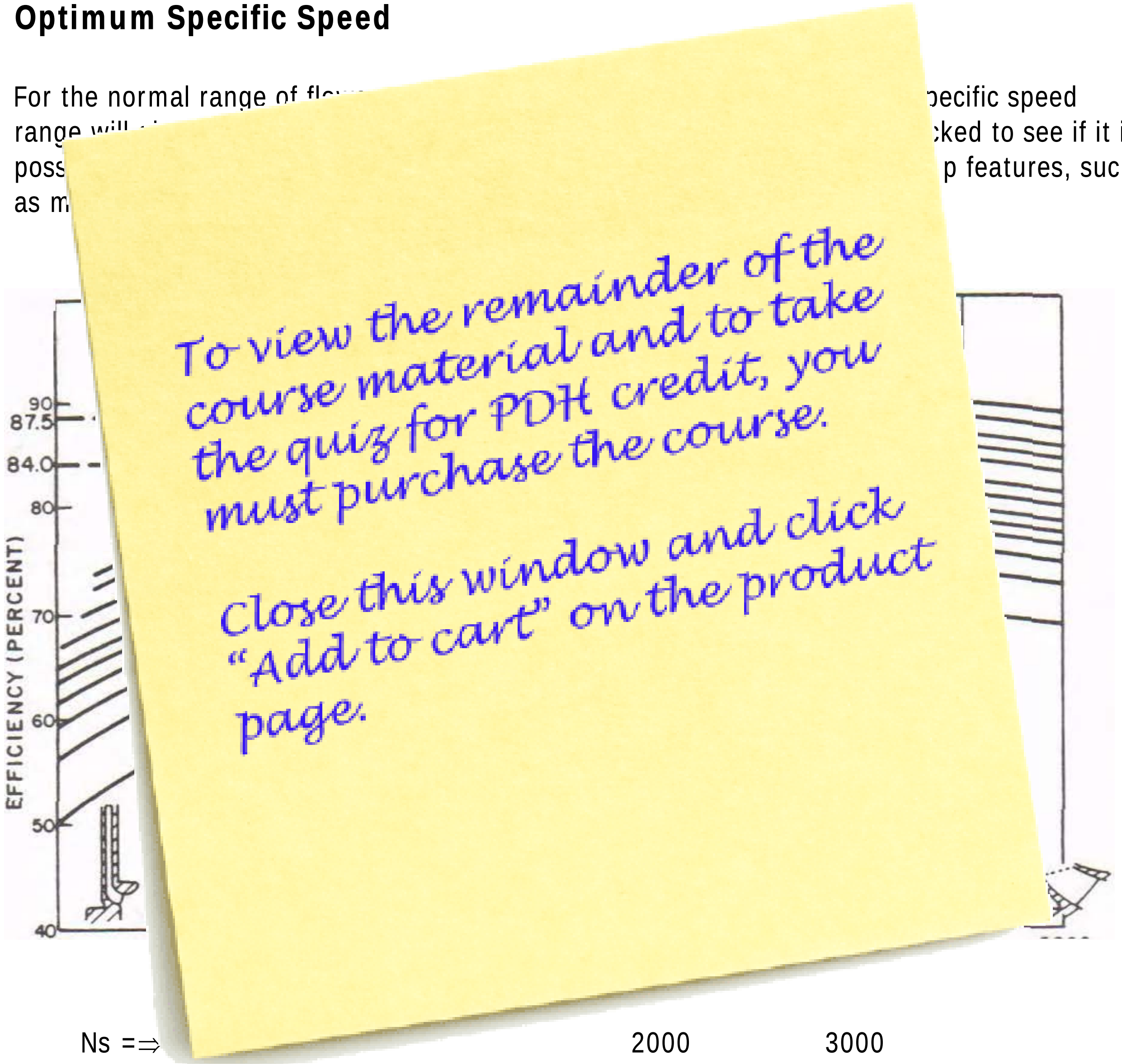


Figure 4 – Pump Specific Speed vs. Efficiency

Select the Most Efficient Pump