TO REVIEW ON ENERGY CONSUMPTION IN CENTRIFUGAL PUMP

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Abstract- **A centrifugal pump is one of the simplest equipment in any process plant. Its purpose is to convert the energy of a prime mover (an electric motor or turbine) first into velocity or kinetic energy and then into pressure energy of a fluid that is being pumped. The energy changes occur by virtue of two main parts of the pump, the impeller and the volute or diffuser. Pumping systems account for nearly 20% of the world's electrical energy demand and range from 25-50% of the energy usage in certain industrial plant operations. In this paper the energy consumption test is investigated in operating characteristic and demand characteristic. Variable frequency drives (VFD's) are often recommended as a way to save pumping energy. Actual energy savings will vary greatly depending on how the discharge pressure of the constant speed pump is controlled and how it is operated after the VFD is installed.**

Index Terms- **centrifugal pump, Head, Pressure, Energy, Frequency.**

I. INTRODUCTION

A pump can be defined as a machine that uses several energy transformations to increase the pressure of a liquid. In the industry the pump are widely used to provide cooling and lubrication services, to transfer fluids for processing and to provide the motive force in hydraulic systems. 20% of the electrical energy demand in country is satisfied the pumping system and range from 25-50% of the energy usage in certain industrial plant operations [1]. Therefore, energy reduction and conservation of these pumping systems must be highlighted. Therefore, producers and users of pumps must design or adopt highly efficient pumping systems. The efficiency of these systems must be evaluated to differentiate an efficient system from an inefficient one as well as to focus on systems that are likely to consume less energy.

According to the American Hydraulics Institute, 30% of the total electrical energy consumed by these systems can be conserved by designing highly efficient systems and by using appropriate pumps. China fails to conserve more energy because it uses pumping systems with practical operating efficiency levels that are 10% to 30% lower than the advanced systems being used in foreign countries [2].

II. GENERAL PUMP OPERATING CHARACTERISTIC

A review on the general operating characteristic of pumps is discussed. This discussion is aimed specifically at centrifugal pump since they form the vast majority of petrochemical pump application. The fig 1.1 represents a general performance curve for a centrifugal pump as a plot of head (pressure) as a function of flow. Centrifugal pump are variable capacity and variable head device as represented by the D_1 and D_2. Curve D_1 and D_2 can represent two different two different pumps, the same pump at different speeds.[3] Pump output is determined by point where the system resistance equal the pump head as shown by point 1 and point 2.

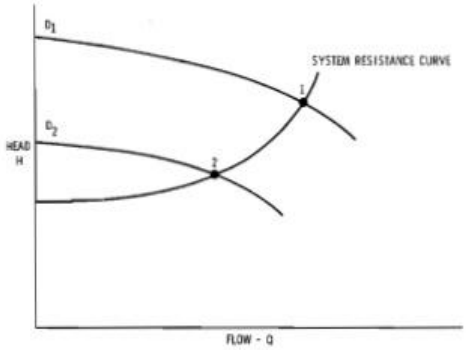

Fig2.1 Characteristic Curve Of Centrifugal Pump

Pump energy losses are expressed in unit of energy (horse power, btu's or watts). the most basic equation for evaluating pump performance is:

Pump Horsepower = (flow × Head × specific gravity) / pump Efficiency

III. ENERGY CONSUMPTION TEST OF THE PUMPING SYSTEM

To understand the energy consumption of the pumping system the test are categorized into two groups:

(1) The operation characteristics of the pump.
(2) The demand characteristics of the pump.

3.1. Measuring the Operation Characteristics of the Pump

The operation characteristics of the pump are investigated to determine the head, shaft power, and efficiency of the real flow rate. The condition of the actual operation significantly differs from that of the standard test because of construction and wear loss. An online test must be conducted because of its importance in energy assessment.

Figure shows the basic test condition of the pump characteristics, and Table 1 shows the test system and the involved instruments. To evaluate the processes that are unaffected by the online test, the test time is set when the evaporator 2 is not working. Valve F22 is opened, valve F21 is closed, and the water in evaporator 2 is drained through valve F22. Valve F21 is used to adjust the flow. During the test, the flow starts with the highest possible rate and then decreases to a rate that must not be lower than the minimum flow 1000m^3/h. More than 10 operation points are identified during the test through a uniform selection. Each test point has a stable operation time longer than 1 min. The inlet pressure, flow rate, outlet pressure, speed, voltage, current, and power input data must be read at least thrice at 1min intervals.

Table 1: Test System Instrument

Instrument	Specification	Precision	Number
Ultrasonic flowmeter	60 TDS-1000 ± 32 m/s	1.0	2
Pressure transmitter	07MF4033-1DB10-3AC6-Z 16–1600 Kpa	0.438	160
Revolution meter		0.1	1
Power transmitter		0.5	1
Voltage transformer		0.5	2
Current transformer		0.5	2

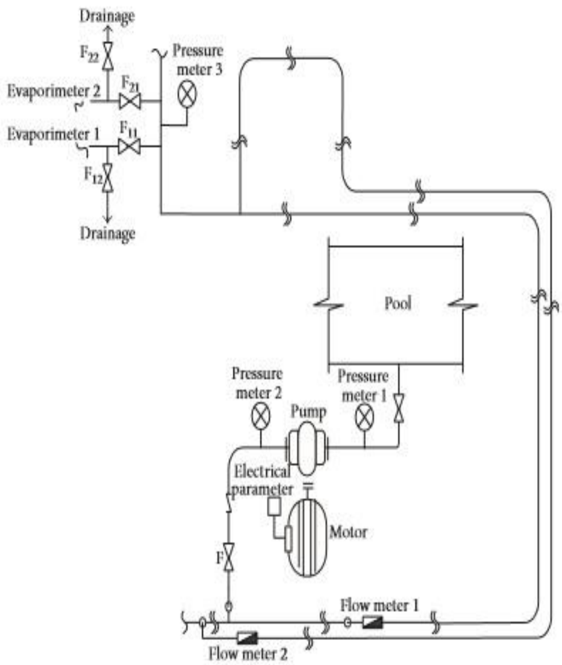

Fig.3.1. Online Test System Scheme

3.2 Measuring the Demand Characteristics.

To determine the requirements of the user, the function of the pumping system must be investigated. The pumping system can be divided into two types: power and flow rate use types.

In the engineering field, power use type often considers both flow and pressure as power-related factors. Therefore, the flow and pressure supply are restricted by the progress of the operation. Energy loss occurs when the flow and pressure supply are low, which indicates that the flow rate use type focuses on efficiency when conserving energy.

Flow rate use type observes a certain flow rate to transport liquids between different grounds or to accomplish engineering activities that rely on flow rates, such as the cooling and heat circulation cycles.

The pump efficiency evaluation method is often used to examine the energy consumption of the pumping system by calculating the pump efficiency under different conditions. However, the energy consumption of a pumping system is not only determined by pump efficiency, but also by user demand.

Therefore, the water cycle process must be analyzed to calculate user demand.

In the water cycle, the mother liquor evaporation process is the main user, and the requirement of the evaporator is the key determinant of the demand. The vertical distance Hgeo between the evaporator and the cooling water pool is 22m, and the evaporation requires a operation pressure of 0.2MPa.[4]

This pumping system is used as a flow use type, and its flow demand is determined by the water cycle progress to ensure the stability of the system. The daily energy consumption of the pumping system is used to calculate the demand characteristic and energy consumption

IV. ENERGY SAVING METHOD

Based on the analysis of the energy consumption of the pumping system, the equipment variable speed can be used for energy conservation, and the frequency converter can be used to maintain the continuous change of the flow. The variable frequency drive (VFD) converts the supply frequency and voltage to the required frequency and voltage to drive a motor. Hence, VFD converts the supply frequency and voltage to the frequency and voltage required to drive a motor at a desired speed other than its rated speed. The variable speed drive consists of rectifier, inverter and control components.

The majority of general purpose VFDs produced today has four fundamental sections. These are:

1. The input rectifier or converter.
2. The DC bus.
3. The output stack or VFD.
4. The controller.

. This input rectifier converts the Vac input into Vdc and charges the capacitors in this part of the circuit. The DC bus acts as a small reservoir for power on which the output VFD draws. If any regenerated energy from the load remains, it is stored on the DC bus in the capacitors. The output stack or VFD draws power from the DC bus and creates a synthesized Vac power supply, the frequency of which can be varied by the controller. The output of the converter is used to drive the electric motor [5].

The following factors/criteria should be considered for selection of appropriate VFD and its successful implementation.

A. Constant Torque Load

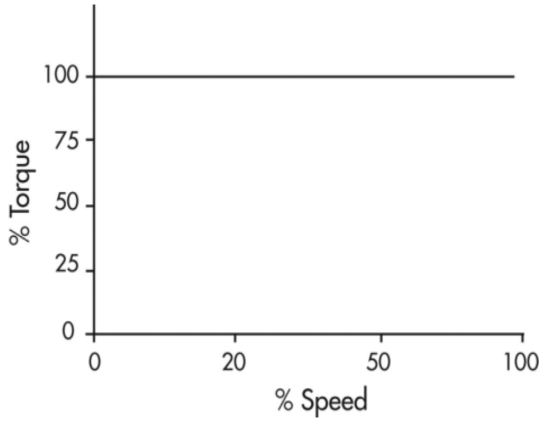

Fig.4.1. Constant Torque Load

A constant torque load is characterized as one in which the torque is constant regardless of speed. As a result the horsepower requirement is directly proportional to the operating speed of the application and varied directly with speed.

B. Constant Horse Power Load

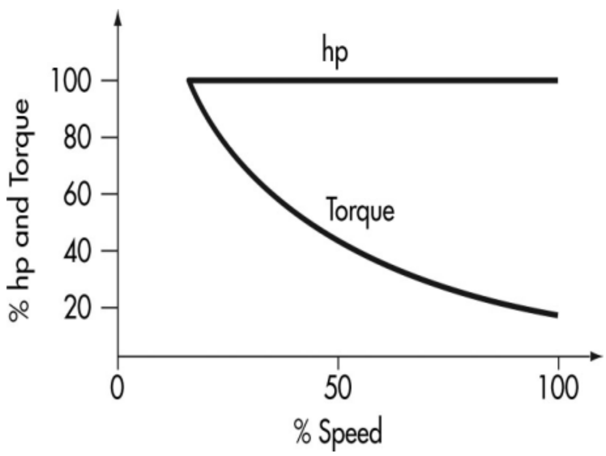

Fig.4.2. Constant Horse Power Load

The second type of load characteristic is constant power. In these applications the torque requirement varies inversely with speed. As the torque increases the speed must decrease to have a constant horsepower load.

C. Variable Torque Load

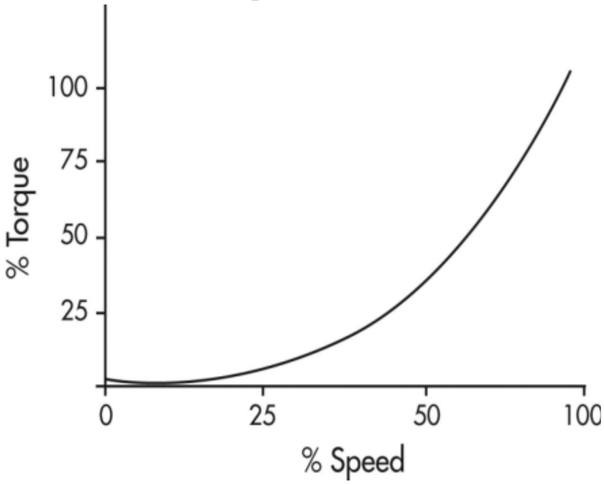

Fig.4.3. Variable Torque Load

The third type of load characteristic is a variable torque load. Examples include centrifugal fans, blowers and pumps. The use of a VFD with a variable torque load may return significant energy savings.

V. RESULT

It can be seen the three fundamental causes of wasted energy

1. Excess flow.
2. Higher than necessary load.
3. Lower pump efficiency.

The power consumption increases with reducing the flow rate which is shown in figure

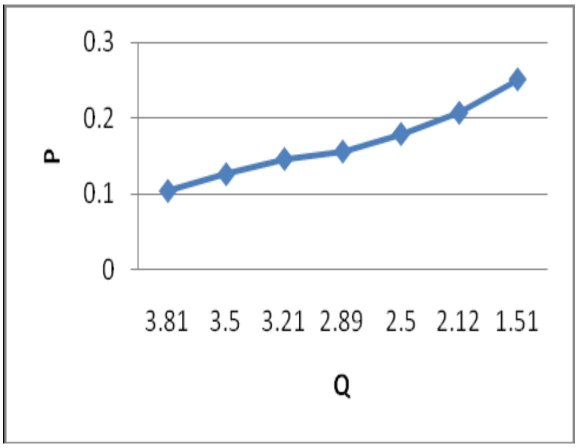

Fig. power vs flow

After installing VFD it can be seen that reducing the flow with throttling, power consumption increase while for VFD power consumption reduces

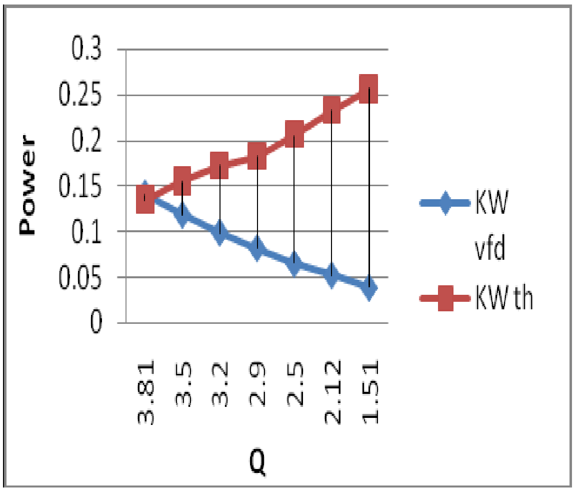

Fig. power vs flow for VFD

VI. CONCLUSION

The output hydraulic power of the pump can be divided into three parts based on the effect of the pump. These parts include the effective output power (to produce the static head), the necessary output (to overcome the system loss), and the actual output of the pump. The operation control track for meeting the minimum requirement can be obtained through an online test based on the system characteristic and process requirements. This track can be used to calculate the energy saving potential and the control setting of the invert. VFD offers a very good response to pumping system. Reduces the flow with VFD, motor consume very less power, so significant amount of power can be saved with the help of Variable Frequency drive.

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