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Real time simulation of Variable Speed Parallel Pumping system

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Abstract

Energy is the world's fundamental requirement to perform any work. Presently, insufficiency in energy is the major challenge faced throughout the world. Among the total installed loads, pumping contributes, 30% of them. Thus considerable improvement in energy savings is possible by increasing the energy efficiency of the pumping system. Nowadays, the usage of variable frequency drives (VFDs) for pumping system is becoming inevitable due to their control over flow rate variation. This paper presents the performance of real time simulated variable speed multi pumping system. The variable speed pumps using affinity laws reduces power up to 80% when there is a reduction in speed of 50%. The efficiency of the pumping system is identified by incorporating the efficiency of both motor and the variable frequency drive (VFD).

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Keywords: Affinity Laws, Centrifugal pumps; Efficiency calculation; Parallel pumps; Real-time simulation; Variable speed drives.

1. Introduction

Among the total energy demand in the industries, nearly one quarter to half of them are due to pumping system [1]. However, centrifugal pumps contribute 80% of the total pumps installed in buildings and industries [2]. Normally, energy efficiency of the pumping system can be improved by component selection, optimal design and the control algorithm used [3]. With optimal system design and control methods, energy efficiency of around 5% -

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50% can be achieved [4]. Moreover, regular maintenance and proper component selection results in 1% - 3% of increase in efficiency [5], [6].

Nomenclature

Abbreviations

N	Rotational Speed of pump [rpm]
Q	Flow rate [m3/hr]
H	Head developed [m]
ρ	Liquid density [kg/m3]
g	specific gravity
P	power drawn [W]
V	Volume of liquid [m3]
D	Pump impeller Diameter [mm]
E	Energy consumption
t	Time [sec]
VFD	Variable Frequency Drive
η	Efficiency [%]

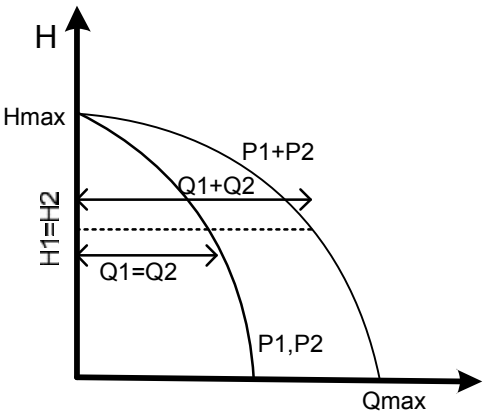
Superscripts/ Subscripts

1	Initial value
2	Estimated value
s	Specific energy
sys	Pumping System
in	Input
tot	Total input
i	Number of Parallel pumps

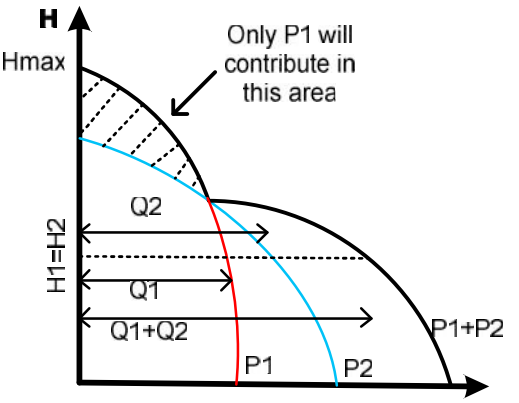
Replacing conventional valves by variable frequency drives for pumping systems benefits like, energy savings of nearly, 30% - 50%, increased process control and system reliability are achieved [7]. In this article the real time simulation of parallel pumping system is realized using PLECS. The variation of pumping parameters (i.e., flow rate and pressure) for different rotational speeds is observed. Also the total system efficiency exhibited by the entire pumping system is illustrated from the simulation results.

2. Performance curve of pumps

The curve drawn between flow rate (Q) and head (H) characterizes the performance curve of the pump. In industries, the usual practice is to commission two or more smaller pumps instead of a large single unit. The pumping units has to be connected appropriately (either in series or parallel) depending on the process demand. The flow rate gets added with the pump head remains constant when the pumps are added in parallel as shown in Fig. 1.



(a) Induvidual pump performance curves (Similar pumps)



(b) Induvidual pump performance curves (Dissimilar pumps)