ENERGY SAVING WITH VARIABLE SPEED DRIVES

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Abstract: *The paper considers problem of energy savings in industry based on variable speed drives. The control valve dissipates hydraulic energy in controlled manner. Recent development in the power electronics, have resulted in an increased applications of electronic variable frequency regulator is to vary motor speed and to avoid hydraulic energy dissipation. In such system the central problem is extremely relevant. The practically important controller has: (i) fixed order (ii) capabilities to deal with amplitude and rate saturation of control signal (iii) possibilities for stochastic time delay compensation.*

Key words: *Energy saving, variable speed drives, fixed order controllers*

1. INTRODUCTION

In current industrial practice the control valves are used extensimely as final control elements to manipulate the process by varying a restriction in a flaming fluid. In essence a control valve is device that dissipates hydraulic energy in controlled manner. The control valve is important final controlling elements and is expected to maintain its position for many years to come. But, main drawback of control valve is energy dissipation [1].

During the last a few decades the alternative final control element is introduced. Normally, recent technical development and cost reduction, primarily in the field of semiconductor technology, have resulted in increased applications of electronic variable frequency drive technology [2]. Variable frequency drive technology employs solid - stable electronic techniques to vary motor speed, thereby varying the operating speed of a piece of equipment (for example centrifugal pumps). The main feature of such solution is energy saving owing the avoidance hydraulic energy dissipation. The main areas of application are: power stations, water distribution systems, HVAC systems, compressors systems etc.

Important part of the problem are, also, control algorithms. On the field of theory the significant progress is established. Kalman work on the linear quadratic regulator problem introduced state space based optimal control for multivariable feedback control systems [3]. In the meantime, also, are developed H^{∞} and $l^{\wedge}$ theory [4] and [5]. Unification H^2 and H^{∞} theory is presented in [6]. Nevertheless, more then 90% controllers in the industry are PID controllers. The main reasons are

(i) optimization methods (H^2, H^{∞}, $l^{\wedge}$) are numerical methods and engineering intuition is absent
(ii) the order of optimal controllers is high (for $l^{\wedge}$ in continuous domain the dimension of optimal controller is infinite)
(iii) the coefficient values of controllers is much different
(iv) small change controller parameters induces back of optimality and, even, instability.

Owing the above fact the controller of fixed structure (low order controllers) such as PID controller is extremely important. But synthesis of fixed structure controllers is very difficult task about which we will discus on the end of the paper.

In the paper we will first describe the control valves with flow characteristic and hydraulic energy dissipation. After that we will consider problem how one can replace control valve with combination: centrifugal pump-AC motor variable speed drive. Here is explained the concept of energy saving. Finally, the problem of fixed order controller synthesis and possible directions of solution is considered.

2. TYPICAL CONTROL LOOP IN INDYSTRY

Port of the controlled process is presented on the next figure.

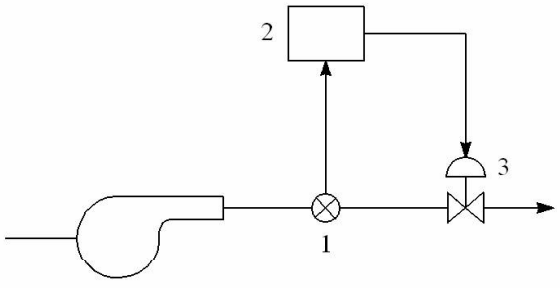

Fig. 1. Typical control loop
1-sensor; 2-PID controller; 3-control valve

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