Energy Efficient Pump Control for an Offshore Oil Processing System

(cooperated with Rambøll Oil & Gas A/S)

Introduction

Pump systems have been extensively used in offshore oil & gas industries, for instance, in order to get the crude oil/gas out of reservoirs, transport the produced oil/gas to the onshore or nearby offshore processing platforms, and move the products from one processing facility to the next one. There is no doubt that pump systems consume significantly large amount of energy every year. European Commission pointed out that the largest energy saving of pump systems can be made through the better design and control of pump systems. In order to have a good pump design for specific applications, the pump manufactures often need to closely cooperate with customers. The pump control can be regarded as a type of soft mechanism to further improve the pump system's efficiency (\cite{Shiels:2001,{Westerlund_Pettersson_Grossmann:1994}}.

Objectives

This project will focus on development of an energy efficient pump control for an offshore oil processing system, where a pump system with three identical centrifugal pumps arranged in parallel is used to drain the cold seawater so as to cool down the crude oil flowing out of a first-stage three-phase separator

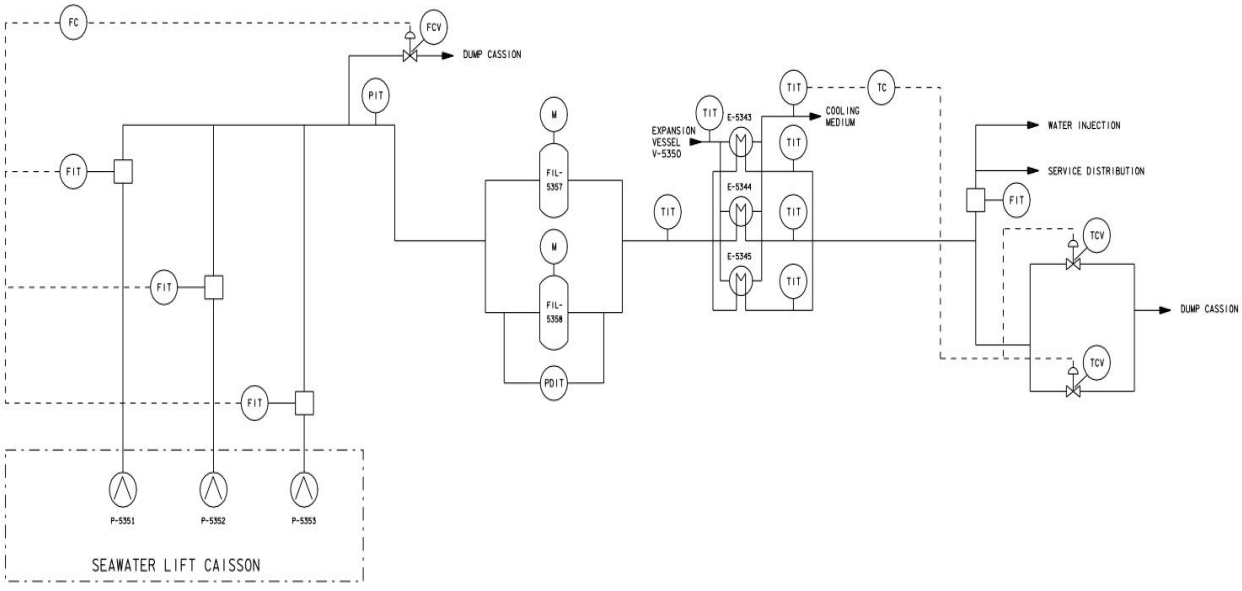

Fig.1 Schematic diagram of the considered system

Considered system

The considered system, as shown in Fig.1, consists of a pump system, a filter system, a heat exchange system and the outlet flow control system. The pump system is employed to drain the pre-treated seawater from a seawater caisson. This pump system consists of three identical centrifugal pumps arranged in parallel. The whole seawater or part of that passes through a filter system, where two identical filter containers are arranged in parallel. If necessary, the rest of drained seawater can be directly dumped back to seawater caisson. The filtered seawater enters a heat exchange system, where three identical plate-type heat exchangers are arranged in parallel. The cold seawater is used to cool down a type of cooling medium flowing through another set of closed pipelines inside the heat exchange system. The cooled cooling medium is then used to cool down the crude oil flowing out of a first-stage three-phase separator on one offshore platform. The part of seawater flowing out of the heat exchange will be used for other facilities, such as water injection etc, and the rest of water will be dumped back to seawater caisson.

Technical content

In our previous work [1], a hierarchical pump-speed control strategy is developed for the considered system by minimizing the pump power consumption subject to keeping a satisfactory system performance. The proposed control strategy consists of online estimation of some system operating parameters, optimization of pump configurations, and a real-time feedback control, as shown in Fig.2. The project could investigate (1) design and develop a lab-sized testing setup; (2) test the strategy proposed in [1] on the constructed setup.

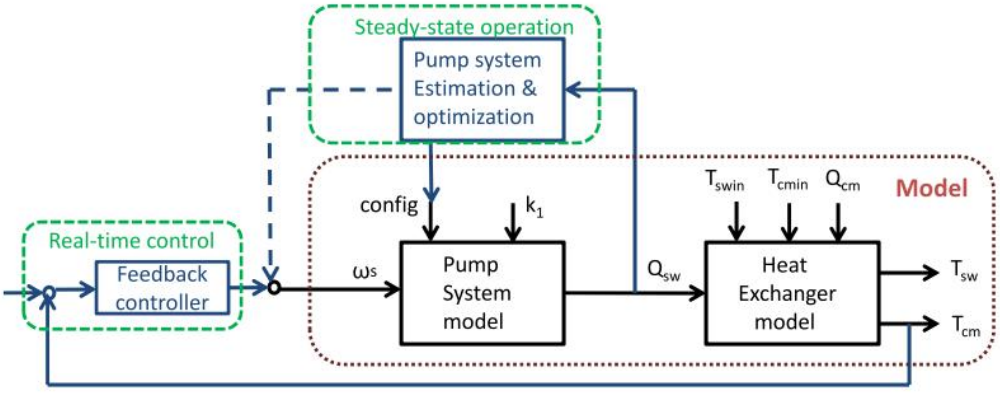

Fig.2 Schematic diagram of control strategy [1]

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References

[1] Yang, Zhenyu; Soleiman, Kian; Løhndorf, Bo. "Energy Efficient Pump Control for an Offshore Oil Processing System", submitted to IFAC Workshop - Automatic Control in Offshore Oil and Gas production, July 2012.