Optimal Control of an Industrial Beam Pump

Said Ayoub AL-Harrasi

Abstract

The main challenges facing the oil industry is to reduce development costs while accelerating recovery and maximizing crude production. Introducing of so called Smart well control is one of the key enabling technologies in the area of intelligent well completion and optimum design and operation. Being part of oil industry, Petroleum Development Oman (PDO) faces similar challenges where completion and optimized well design and operation smart wells is becoming the key of success with such unpredictable industry. Similarly beam pumping unit has gained an increasing attention over the recent years for enhancement and further optimization. PDO operates more 1200 beam pumping units which have been supplied by e-Production control system over the last 15 years.

Most of these wells have a pump capacity that exceeds the production rate of the well. These wells would operate more efficiently and at a lower cost with a device or philosophy that optimally minimizes a given cost function, while respecting a set of operational and dynamic constraints. This in turn decreases both operational and maintenance costs and resources requirements.A real pump unit is modeled and simulated after obtaining the governing differential equations of beam pump components linked together as one system. MATLAB built in optimization toolbox called SNOPT applied to design a torque profile that minimizes energy while respecting given sets of constraints.

The aim of this work is to find the optimal control methodology that produce optimum beam pump control policy by minimizing a given cost function (objective function) subject to various design and operational constraints.Optimal value for cyclic loading factor (CLF) will be obtained using developed optimization model. This value can be used in identifying the correct electrical motor sizing and optimum counter balance position.