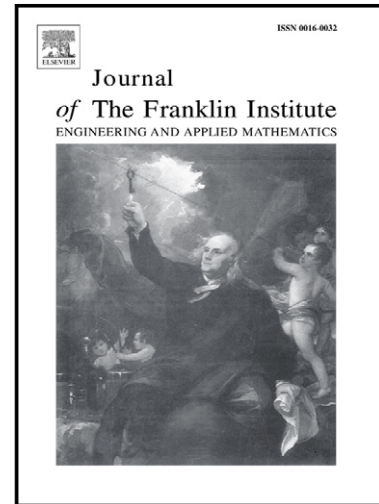


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Design of Gain Scheduling Control Strategy for Artificial Gas Lift in Oil Production through Modified Relay Feedback Test

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Abstract

Artificial gas lift technology is widely used in oil production to sustain oil flow from the well to the surface when reservoir pressure drops. Dynamic model that describes artificial gas lift system is highly nonlinear, which makes the controller design for this system not an easy task. A dynamic model of this system is further detailed with respect to the models available in the literature to account for the depth of the well. Two approaches to controller design are implemented: the first one is based on the local linearization in a number of operating (equilibrium) points that are characterized by different gas flow set points; the other approach is based on the use of the modified relay feedback test (MRFT) applied incrementally in different operating points. In both approaches, the controller is designed as a gain-scheduled PI controller.

Index Terms - Artificial gas lift, Process control, Dynamics identification, Parametric tuning, Optimization, Linearization, Relay feedback.

1. Nomenclature

m_{ga} – mass of gas in the annulus (Kg)

m_{gt} – mass of gas in the tubing (Kg)

m_{lt} – mass of liquid in the tubing (Kg)

w_{ga} – mass flow of gas into the annulus (Kg/s)

w_{gi} – mass flow of gas injected into the tubing (Kg/s)

w_{gp} – mass flow of gas produced from the tubing (Kg/s)

w_{lr} – mass flow of liquid from the reservoir into the tubing (Kg/s)

w_{lp} – mass flow of liquid from the tubing (Kg/s)

μ – molar mass (Kg/mol)

h – height of the tubing (m)

R – ideal gas constant (J/(K.mol))

P_p – pressure at the top at the production choke (Pa)

P_{ii} – pressure at the bottom of the tubing, at the point of gas injection (Pa)

P_a – pressure at the top of the annulus (Pa)

P_{ai} – pressure at the bottom of the annulus, at the point of gas injection (Pa)

P_r – pressure in the reservoir (Pa)

P_m – pressure in the gas injection manifold (Pa)

ρ_l – density of the liquid (Kg/m³)

ρ_m – density of the mixture of liquid (oil) and gas (Kg/m³)

$T_{a,t}$ – temperature in the annulus and tubing (K)

$A_{a,t}$ – area of the annulus and tubing (m²)

$A_{pc,iv,ga}$ – area of orifice of the production choke, injection valve, and the gas lift valve (m²)

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