# An Improved Model for the Prediction of Liquid Loading in gas Wells using Firefly and Particle Swarm Optimization Algorithms



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ABSTRACT: Liquid loading is an undesired phenomenon in gas wells that occurs when producing wells attain a flow rate below which liquid will not be able to flow to the surface. The inability of the energy from the gas to transport the liquid to the surface causes back flow and eventual accumulation of liquid at the wellbore. This is characterised by intermittent flow, which, if left unchecked, can eventually kill the well. An effective and reliable predictive method must therefore, be employed. In this study, improved models based on data set from condensate/water in a gas well were developed by applying firefly (FA) and particle swarm optimisation (PSO) algorithms. The results showed that the model developed outperform many of the existing models. The models predicted liquid loading in gas well at 86% level of accuracy compared to the 81% highest possible from published models. Although, the FA and PSO models predicted liquid loading at higher accuracy compared with Turner and Coleman models for higher wellhead pressure systems, the Coleman model appeared to perform better in the prediction of critical gas rate for low-pressure systems. However, the developed model can significantly improve the prediction of liquid loading in gas wells at a higher reliability and accuracy levels. Thus, the proposed models can be a veritable tool for accurately predicting liquid loading in gas wells.

KEYWORDS: Critical rate, firefly algorithm, particle swarm optimization, data-driven models, liquid loading

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#### I. INTRODUCTION

Gas wells experience decline in production during their lifetime due to reservoir pressure depletion. As the natural energy keeps depleting the gas flow from the wells decreases and a point is reached when the gas will be unable to transport the co-produced liquid, resulting in back flow and the liquid accumulates down hole. This phenomenon has been described as liquid loading (Lea et al., 2008). The accumulated liquid sometimes flows backward to the formation when the bottomhole pressure is greater than the pressure near wellbore area. As the near wellbore pressure becomes sufficiently lower, the fluid starts to flow again to the surface thereby causing the well to start producing again. This cyclic phenomenon is as shown in Figure 1. It is undesirable and can cause intermittence production which is unfriendly to topside facilities.

Liquid loading negatively affects gas wells production capacity and thus should be diagnosed early enough and adequate measures deployed for its mitigation. The production impairment occurs as liquid accumulates leading to increased bottomhole pressure. This eventually cause production to cease and ultimately kill the well and significant volume of gas then remain unproduced. It can also lead to increased operational cost in unloading the liquid.

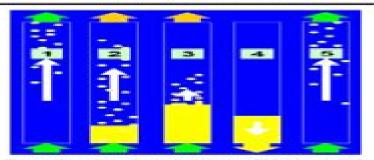


Figure 1: Gas well experiencing liquid loading (Waltrich et al., 2015).

The mechanism for the initiation of liquid loading has been extensively studied. Turner et al. (1969) posited that liquid loading is a consequence of backward flow through the tubing which occurs either as liquid film or entrained droplet. They conducted series of tests and analysis with field data and concluded that the backward flow was anticipated when entrained droplet occurs. Turner et al. (1969) model, hereafter referred to as Turner Model, gives the following critical velocity:

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