



DEPARTMENT OF PETROLEUM ENGINEERING

COVENANT UNIVERSITY

OTA, OGUN STATE, NIGERIA

**A NEW MODEL FOR PREDICTING LIQUID LOADING IN
MULTIPHASE GAS WELLS**

A MASTER OF ENGINEERING DISSERTATION

BY

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14PCN00720

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**A NEW MODEL FOR PREDICTING LIQUID LOADING IN
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A MASTER OF ENGINEERING DISSERTATION

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The Department of Petroleum Engineering**

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In Partial Fulfillment of the requirements for the Degree of Master of Engineering

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CERTIFICATION

This is to certify that the contained research project titled *A NEW MODEL FOR PREDICTING LIQUID LOADING IN MULTIPHASE GAS WELLS* was researched, and the results thoroughly analyzed under the supervision of the project supervisor and approved having satisfied the partial requirement for the award of Master of Engineering Degree in Petroleum Engineering (M. Eng.), Covenant University, Ota.

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DEDICATION

I dedicate this work to God almighty, the most gracious and merciful for his faithfulness and loving kindness. Glory be to your holy name.

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All the glory and honour be to God, for his mercies endureth forever. For the strength, wisdom and grace that he made available throughout the period of this work. I say thank you Lord.

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ABSTRACT

Liquid column that accumulates in the wellbore leading to the reduction or completely preventing the production of gas well is called liquid loading. This is one phenomenon that is essential because in order to optimize the recovery of hydrocarbon from the gas reservoir and to prevent the occurrence of liquid loading, pressure differential as a function of flow rate across the valves must not be neglected. Several options have been employed in well completions to predict liquid loading and how it can be mitigated but the results have shown varying degrees of discrepancies and hence cannot be easily used because of the challenges involved in predicting the bottomhole pressure in a multiphase flow. In the last decades, different techniques and correlations have been offered by many authors for determination of critical liquid loading rate. This new model considered the pressure drop at the bottomhole and along the functional nodes (valves). The model is an improvement on Fadairo model with the introduction of valve equation to the fundamental momentum equation. It described a systematic approach for estimating liquid loading in a gas well by numerical integration method. None of the previously described models considered pressure drop along the functional node. It is therefore, evidently effective when compared analytically with Turner, Guo and Fadairo models. The result shows that the flow rate during the transient stage is faster than that of Fadairo and it became stable at a certain time during production. It was also observed that the minimum energy required to lift liquid out of the wellbore is higher than that at the initial production stage. The numbers of incorrectly predicted wells as calculated by the new model are far lower than all the previously described models. This model is essential for field operators so as to equip them on how to tackle the risk of liquid loading during natural gas production.

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NOMENCLATURE

A	cross sectional area of conduit, ft ²
A _i	cross sectional area of conduit, in ²
C _d	drag coefficient.
D ^{DH}	Hydraulic diameter of the conduit, ft
E _K	gas specific kinetic energy, ibf-ft /ft ³
E _{ksl}	minimum kinetic energy required to keep liquid droplet from falling, ibf-ft/ft ³
E _{km}	minimum kinetic energy required to transport liquid droplet, ibf-ft/ft ³
f	Moody friction factor, dimensionless.
g _c	32.2 ft.s ²
L	conduit length, ft
P _{wf}	wellhead flowing pressure, psia
P	pressure, lb/ft ³
Q _g	insitu gas volumetric flow rate ft ³ /s
Q _{oil}	Oil volumetric flow rate, ft ³ /s
Q _s	Solid particle volumetric flow rate, ft ³ /s
Q _w	Water volumetric flow rate, ft ³ /s
S _g	Gas specific gravity, air = 1
S _o	Specific gravity of produced oil, fresh water = 1
S _s	Solid specific gravity, fresh water = 1
S _w	Specific gravity of produced water, fresh water = 1

V_{mx} mixture velocity, ft/s

W_o Oil weight flow rate, lb/s

W_g Gas weight flow rate, lb/s

W_s Solid particle weight flow rate, lb/s

W_w Water weight flow rate, lb/s

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