A Hybrid Approach Based on Artificial Neural Network and Integrated Production Modeling for Gas Lift Optimization

By

Mazen Mohamed Bahaa El-Din Hussein Hamed

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
In
GAS PRODUCTION ENGINEERING

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Under the Supervision of

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Title of Thesis:

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Key Words:
Integrated production Modeling; Gas lift Optimization; artificial neural network modeling; estimating well bottom hole pressure; predicting well fluid rate.

Summary:

An artificial neural network model was developed to predict the values of the bottom hole flowing pressure and the total fluid rate per each well using the available field parameters like the water cut samples, static pressure surveys, reservoir gas oil ratio, the well head temperature and pressure in addition to the gas injection rate and gas injection pressure. This developed ANN used in building accurate individual well models on PROSPER and a full field network model gathering all the individuals' models with the surface network. This creates an integrated production model aiming to perform field wide gas lift optimization.

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Dedication

I would like to dedicate this thesis to my parents who stands beside me giving me the continuous assistance and support through my whole life. They are the main reason for any success in my life after the God almighty. They deserve a lot, there is nothing can express my love and pride toward them.

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Nomenclature

Symbols

C	Learning constant that determine the rate of learning
D	Inside pipe diameter, Inch
E	Least square error
E_K	Dimensionless kinetic-energy pressure gradient
F	Friction factor
PI	Productivity Index, BPD/PSI
P_{wf}	Well bore flowing pressure, PSI
P_r	Reservoir pressure, PSI
P_B	Bubble point pressure, PSI
PBTD	Plugged Back Total Depth, Ft
Q_{max}	Maximum liquid production, BPD
Q_f	total fluid rate of the well, BFPD
H_L	Liquid holdup
SCF/STB	Standard cubic feet/Stock tank barrel
STBPD	Stock Tank Barrel Per Day
o_i	Resulted neuron output
ID	Inner Diameter, Inch
R	Learning signal
RB/STB	Reservoir barrel/Stock tank barrel
wi(t)	Old values of t weight vector at time level t
wi(t + 1)	New values of weight vector at time level t+1
Δwi	Weight adjustment
θ	Inclination angle from vertical
ρ_{mn}	Mixture density, PCF
ρ_L	Liquid density, PC
ρ_n	No-slip density,PCF
ρ_{mn}	No-slip mixture density, PCF
V_m	Mixture velocity, FT/SEC

Abbreviations

ANN	Artificial neural network
BPNN	Back propagation neural network
BHFP	Bottom-Hole Flowing Pressure
BFPD	Barrel fluid per d y
BOPD	Barrel oil per day
CO_2	Carbon dioxide
FVF(Bo)	Formation Volume Factor
GOR	Gas Oil Ratio, SCF/STB
IPM	Integrated Production Modeling
PVT	Pressure, Volume, Temperature
H_2S	Hydrogen sulfide
N_2	Nitrogen
VLP	Vertical Lift Performance