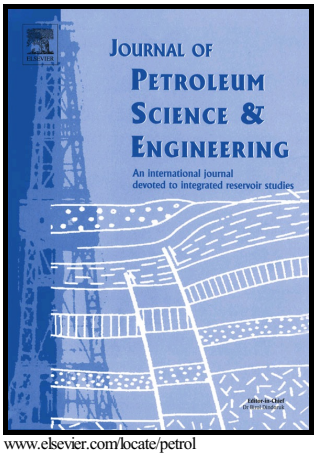

www.elsevier.com/locate/petrol

Effect of Well Trajectory on Liquid Removal in Horizontal Gas Wells

R. Brito, E. Pereyra, C. Sarica

PII: S0920-4105(17)30395-9
DOI: http://dx.doi.org/10.1016/j.petrol.2017.03.042
Reference: PETROL3930

To appear in: *Journal of Petroleum Science and Engineering*

Received date: 18 August 2016
Revised date: 18 March 2017
Accepted date: 22 March 2017

Cite this article as: R. Brito, E. Pereyra and C. Sarica, Effect of Well Trajectory on Liquid Removal in Horizontal Gas Wells, *Journal of Petroleum Science and Engineering,* http://dx.doi.org/10.1016/j.petrol.2017.03.042

Effect of Well Trajectory on Liquid Removal in Horizontal Gas Wells

R. Brito[a], E. Pereyra[b], C. Sarica[b]

[a]Colorado School of Mines
[b]The University of Tulsa

Abstract

A systematic experimental study on two-phase air-water was carried out to evaluate effect of well trajectory on liquid removal in horizontal gas wells. Experiments were conducted in a facility with a 2-in. ID and 62.6-ft. long lateral section and a 41-ft. vertical section, which mimics a horizontal well. Four well configurations were considered; namely, toe-down, toe-up, one-undulation with a sump and one-undulation with a hump. Additionally, different flow conditions were used to simulate the well production as the reservoir pressure depletes. The effect of well trajectory on the liquid removal was evaluated measuring the pressure gradient, liquid holdup, film reversal, and flow pattern.

Experimental results indicate that under stable conditions, toe-up is the best configuration for the displacement of the produced fluids from the toe to the kick-off point. However, at very low gas flow rates, severe slugging is observed in this configuration. Furthermore, for the toe-down, one-undulation with a sump, and one- undulation with a hump configurations liquid loading is observed in both lateral and vertical sections of the well. Consequently, significant liquid accumulation and an eventual slugging condition are observed in the well. It was observed that the measured critical gas velocity to avoid liquid loading is lower than gas velocity at the minimum pressure gradient, indicating that minimum pressure gradient criterion is not enough to determine whether the well will be under stable or unstable conditions. Finally, toe-down configuration presents the largest liquid accumulation in the lateral section, indicating lower efficiency to remove liquids from the toe to the kick-off point.

Keywords: Well trajectory, Liquid Loading, Severe Slugging, Undulations, Slugging

Nomenclature

Symbol		Description	SI Unit	Field Unit
AL	=	Artificial lift	°	°
β	=	Deviation angle	-	-
CP	=	Conducitivity probe	-	-
dp/dL	=	Pressure gradient	Pa/m	psi/1000 ft
dp/dL_{min}	=	Minimum pressure gradient	Pa/m	psi/1000 ft
f_s	=	Slug frequency	slug/min	slug/min
H_L	=	Liquid holdup	-	-
ID	=	Inside pipe diameter	m	in
L_s/D	=	Dimensionless slug length	-	-
Q_{g_min}	=	Minimum gas flow rate	m^3/s	Mscfd
v_{Sgo}	=	Superficial gas velocity at standard conditions	m/s	ft/s
$v_{Sgo\_dPdLmin}$	=	Superficial gas velocity at which the minimum pressure occurs gradient	m/s	ft/s
v_{Sgo_FR}	=	Superficial gas velocity at which the film reversal is detected	m/s	ft/s
v_{SL}	=	Superficial liquid velocity	m/s	ft/s
WMS	=	Wire-mesh sensor	-	-