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College of   
Petroleum Engineering and Geoscience

Petroleum   
Engineering Department

Well Completion   
- PETE (302)

Enhanced Gas Well Extraction:

Using Combined System of Foam & Gas Lift

Term 171 Project

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Abstract

Liquid droplets that load in gas wells cause several serious issues. To   
solve these problems, different lifting method were developed. Lifting system   
that are used now for horizontal gas well were originally developed for oil   
wells. Moreover, this research is targeted mainly toward gas well deliquification   
(remove liquid from wellbore or dewatering).

Introduction

In natural gas well, the produced gas particles are attached to a load   
of liquid droplets (oil condensate or water). Moreover, the produced gas can   
lift liquid droplets to the surface at the early age of the production when the   
gas pressure is high enough to provide such critical velocity to carry the   
liquid to surface.

After period of production when the well become mature, an amount of   
liquid that present inside the tubing along with gas produced result in   
disperse within gas that drag gas flow downward by gravity. Therefore, gas   
velocity falls and leads to extra decreases in extracted liquid volume that   
cause accumulation which rise the burden of the ability to carry up liquid   
droplets, which lead to gather more liquid and extra builds up accumulation of   
liquid that cause a reduction or complete stop of the gas production.

Objective

·   
To discuss the improvement   
in deliquification.

·   
To discuss new design   
method.

Methodology

I collected the data for a research in Well completion course that is   
about summarizing some latest improvement in the field. Moreover, I collected   
data using OnePetro website from different journals and SPE papers.

Discussion

Gas well deliquification or gas well dewatering is a method of   
completion that used to get rid of liquid (oil condensate or water) that occur   
with gas during production from gas well. To deliquefy liquid in well, there   
are different possible solutions such as:

·   
Natural flow.

·   
Removing hydrostatic   
barrier using pump

·   
Capillary string

·   
Intermitting (cease the   
production for a time)

·   
Rocking

·   
Equalizing

·   
Venting

·   
Soaping

·   
Velocity string

·   
Compression

·   
Gas lift

·   
Beam lift

·   
Plunger lift

·   
Foam lift

·   
ESP and HSP

·   
PCP

·   
Diaphragm pump

·   
Jet pup

In this research we will focus on foamer injection that is used to   
increase gas production. The foam performance depends on different parameters   
such as pressure, temperature, hydrocarbon fraction, and foamer agitation   
velocity. In addition, Foam Assisted Gas Lift may be used and it is considered   
to be   
an economical choice due to its increased gas production rate and it   
requires less injected gas. There are three types of tests that applies on foam   
to test its performance that are:

·   
Foam buildup test

·   
Collapse test

·   
Liquid carryover test

In addition to that there are system consideration such as:

·   
Cost of production and   
amount of pay

·   
Solution life

·   
CO2 and H2S corrosion

·   
Acid resistant

·   
Amount of water and the   
ability to control it

·   
The cause of condensation

·   
The depth of condensation

·   
Safety valve

·   
The power required

·   
The costs and risks of   
workover

The gas velocity is affected by the design of the well bore (such as   
sudden expansion/contraction). Moreover, the gas condensate is affected by the   
rate of production

Slower velocity => poorer lift => longer transit time => more   
heat loss => water condensate.

Some of the methods are depend on recharging the well from near   
formation

Recharging from low permeability zones to higher permeable zone

Method such as:

·   
High permeability streaks

·   
Natural fracture

·   
Stimulated fractures

Liquid behavior is affected by the deviation of the well. Where in the   
vertical well, all the liquid droplets are lifted by flowing gas. However, in a   
deviated well, a separation is possible due gravity where liquid droplets will   
be accumulating down hole

A.     Gas Lift

The method of gas lift is used to improve the production rate and to   
deliquefy the gas well as an artificial lift technique by decreasing the   
hydrostatic pressure of the liquid. This method is applied by injecting high   
pressure gas in the well pipe through valves on the annulus string.

B.     Foam Assisted Lift

Foam assisted lift is a new technique that is used to dewater the gas   
well by decreasing the liquid surface tension and its density. This method   
depends on injecting soap from surface in the tubing through capillary string.   
Moreover, the system components are:

·   
Capillary   
soap

·   
Stainless   
steel capillary string

·   
Foot valve   
(soap injection valve)

·   
Capillary   
hanger

·   
Soap pump

·   
Soap tank

And   
the systematic process is:

C.     Foam Assisted Gas Lift

It   
hybrid technique that use both Gas lift and Foam assisted lift to improve the   
effectiveness of the two methods by injecting soap and gas. In other words, the   
soap is increasing the liquid column and the injected gas energize the flow.   
This method is most effective when:

·   
The well   
flow is very low, and much liquid was accumulated

·   
The liquid   
column is lower than gas valve.

D.     The study case

This is an example of natural flow gas well that has been completed   
three times after depletion:

i.   
Natural   
Flow

The cumulative production after perforation of Sand Y is around 18 MMMCF   
and around 1 MMSCFD initially that is increasing with time and loads in the   
tubing. After 8 years of production, the flow rate of gas fall to 1 MMSCF per   
day and the Water-Gas ratio was 300 STB/MMSCF. Therefore, Sand Z was perforated   
to comminglally produce around 7 MMSCFD. Moreover, wellhead gas compression   
systems was applied for 10 years to rise flow up to 12 MMSCFD and 30STBMMSCF of   
Water-Gas ratio. In 2011, the was depleted due to loss of energy to flow the   
gas with around 57% recovery rate.

ii.   
Gas   
Lift

The Gas lift system was introduced in M-1 well in 2012 to deliquefy the   
gas well by inject 0. 4 MMSCFD of gas the produced around 1. 7 MMSCFD and 225   
STBD of water. Shortly, the gas flow dropped to 1. 2 MMSCFD with larger   
Water-Gas ratio that show liquid droplets are loading in the tubing. After 6   
Months, Gas lift system has produced only 1. 6 BCF that is 2. 4 % recovery.

iii.   
Foam   
Assisted Lift

After Gas lift system was suspended, a Foam assisted lift was introduced   
in the gas well. Soap was injected close to the perforation using capillary   
string. In the beginning of injection, Soap was injected at rate of a   
half-gallon per day and raised gradually to a rate of 5 gallons per day that   
result in 1. 5 MMSCFD of gas. However, any further increment of injected soap   
leads to drop in the production rate. After three months, a liquid droplets   
load occurs and requires gas lift to provide sufficient energy to flow the gas   
well. Therefore, new lifting system were introduced in the well. One of   
limitation of foam that is affected by temperature.

iv.   
Foam   
Assisted Gas Lift

After 5 months in 2013, a combined system of Gas lift and Foam assisted   
lift was applied to dissolve the liquid loading of the gas well. In fact, it   
was a challenge to determine the optimum rate of soap and gas injection rate at   
that time because there were no standard values for this combined system.   
Therefore, several trial and error were applied and the best values for M1 well   
were 2 Gallon per day of soap and 0. 3 MMSCFD of injected gas. After 21 days of   
instable production, the production stabilizes at 1. 3 MMSCFD with 300 BBL of   
water per day.

Conclusion

·   
It is advantageous to use a   
combined system of Gas lift and Foam assisted lift that optimize production   
rate of gas well and overcomes limitation of two methods alone.

·   
Soap injection has an   
optimum rate; any variation affects the production negatively.

·   
High temperature reduce the   
effectiveness of Foam performance.

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