Well Testing Plan

New York Marginal Well Study

Introduction

The Independent Oil and Gas Association of New York, Inc. (IOGANY) has been awarded funding for a Marginal Well Testing Program from the New York State Energy Research and Development Authority (NYSERDA). The objective of this program is to field test and evaluate approximately 100-125 marginal and shut-in natural gas wells to determine the potential for additional gas production. This project is designed to provide an opportunity for operators to have wells tested and evaluated at a low cost. The operator fee has been set by the Steering Committee at **$200** per well. This low per well fee is possible because of NYSERDA co-funding of this project. IOGA of New York is the contractor of this project and Universal Well Services, Inc. is the subcontractor and will coordinate and conduct well testing and evaluation.

This project provides a set of tests to assist operators in evaluating the potential of marginal and shut-in wells. These tests were selected by the project Steering Committee to provide a relatively quick and simple method of cost effective testing and evaluation. Operators will receive an individual report for each well tested. Reports will include the results of testing along with an interpretation of these results. Operators can use this informatin to assist in determining if evaluated wells warrant additional measures. The methodologies developed by this project will be available for testing and evaluating other wells in the future. No well rehabilitation will be conducted under the scope of this project.

The following describes the testing, analysis and reporting to be performed by Universal Well Services, Inc. under the scope of this project:

I. Tests to be Conducted

- Liquid Level Analysis
- Estimated Bottom Hole Pressure
- Slickline Service
- Production Water Analysis

II. Testing Procedures

Liquid Level Analysis
An echometer instrument is used to determine liquid level in gas wells. A pressure pulse is generated in the annulus of a well with a sealed wellhead attachment which is connected to the casing at the surface. The induced pulse travels down the casing annulus and is reflected by tubing collars, obstructions and liquid level. A microphone in the wellhead attachment converts

the pressure pulse echoes into electrical signals which are amplified, filtered, and recorded on a strip chart. A timer places one second timing marks on the chart. The liquid level is determined by counting the number of collar reflections above the liquid reflection. The distance to the liquid level can also be calculated by the travel time to the liquid reflection.

Bottom Hole Pressure
Static bottom hole pressure is the sum of casing pressure, gas column pressure and liquid column pressure. Casing pressure is measured at the surface. Gas column pressure is calculated using the length of the gas column and the specific gravity of the gas. Acoustic velocity can be used to determine specific gravity. Liquid column pressure is determined by the depth and the specific gravity of the liquid. Bottom hole pressure is calculated to the middle of the perforated interval(s).

Slickline Service
A combination weight and water sampling device is lowered into the well on a small wire cable. A device known as a lubricator is attached to the wellhead and allows the slickline to be run with the well under pressure. Water samples obtained are used for water analysis.

Water Analysis
Water sampling and analysis will be conducted in accordance with the American Petroleum Institute Recommended Practice for Analysis of Oil-Field Waters.

pH- An electrometric method is used to measure pH. This method uses a meter and electrodes to determine hydrogen ion activity. The electrodes consist of a glass half-cell and a reference half-cell which together form an electrode system. The glass half-cell contains a solution with known pH. The two half-cells are submersed in the liquid sample to be tested. The meter measures the difference in electrical potential between the solution in the glass half-cell and the sample solution in contact with reference half-cell. The difference in potential varies with the pH of the sample solution. This variation in potential per pH unit is linear when the temperature is constant. pH is measured in the field to prevent errors due to changes in pH following sampling.

Chlorides- Chloride concentration is determined by the Mohr titration method. This method is based on the reaction between potassium chromate indicator and the first excess of standard silver nitrate titrant. This reaction forms an insoluble red silver chromate precipitate at the end point.

Iron- Iron is oxidized to the ferric state and titrated with a standard EDTA solution in the presence of salicylic acid indicator. Salicylic acid forms a deep purple colored complex at an acidic pH. If necessary the pH is adjusted to between 2 and 3 with sodium acetate buffer solution. In this pH range the EDTA-ferric iron complex is much stronger than the salicylic acid-ferric complex. Therefore, there is a gradual disappaerance of the purple salicylic acid complex as the end point is reached. Water samples are "fixed" in the field by adding hydrochloric acid to the samples. This ensures that all dissolved iron is kept in solution until the sample is analyzed. Samples are filtered before the addition of HCl to prevent iron particles, corrosion products, or precipitated iron in samples from being dissolved and causing errors in results.

Specific Gravity- The Hydrometer Method is used to determine the specific gravity of a liquid sample. A weighted bulb with a graduated stem is immersed in a graduated cylinder filled with the water sample. The depth to which the hydrometer sinks is determined by the density of the liquid. The specific gravity is read directly from the graduated stem. Specific gravity is converted to density by multiplying by the density of water.

III. Analysis of Test Results

Liquid Level Analysis
High liquid level may be the cause of poor gas production in many gas wells. This is due to high bottom hole flowing pressure caused by the weight of a column of liquid in a well. This high back pressure inhibits the flow of gas into the wellbore. This condition can be identified from the determination of liquid level by echometer testing. If excess liquid is identified, measures can be taken to lower the liquid level and reduce bottom hole flowing pressure. This reduction in bottom hole flowing pressure can result in increased gas flow and allow wells to be returned to economical production.

Estimated Bottom Hole Pressure
Many wells are evaluated on the basis of pressures obtained from the well at the surface. These pressures may provide no indication of the true bottom hole pressure. An estimated bottom hole pressure allows for a much more accurate evaluation of a well's production potential.

Production Water Analysis
Production water analysis allows for the identification of conditions which are causes of poor production. Chloride concentration can be used to determine if produced water is connate water (production water) or water introduced to the well during stimulation. Low chloride concentration may also indicate invasion of fresh water into the well due to poor casing integrity. Iron concentrations can be used to predict the probability of formation damage from iron oxide precipitation. pH can also indicate the probability of metal oxide precipitation. Specific gravity is necessary to accurately determine bottom hole hydrostatic pressure in a well.

Slickline Service
A slickline (wireline) is used to detect sand fill-up in gas wells. Sand in the wellbore above the perforations can severely limit the production of a well. If this condition can be identified, measures can be taken to remove the sand and increase production. This can allow such wells to be returned to economic production. A slickline can also be used to verify or determine the depth at which tubing is set or to find obstructions in the tubing.

IV. Information Required of Operators:

Operators will be required to submit a Gas Well Submission Report for each well they wish to have considered for this project. Report forms will be provided to operators. The following information will be required to be included with the report:

- Well log with perforations indicated
- Copy of the Completion Report

- Wellbore Diagram Listing of tubulars with sizes, weights and lengths
- Wellhead configurations
- Topographic map with well indicated
- Recent production history with rates, pressures, days on-line, and pipeline pressure.
-

V. Conditions Required for Testing

Because necessary testing under this project requires that equipment be attached to the wellhead, it will be necessary for a well tender or other company representative to be present during testing and make the actual connections to the wellhead. Furthermore, all wells must be located in New York state.

Truck access to the wellhead must be available for testing.

VI. Presentation Format

Marginal Well Report and Evaluation

Company_____ County_____
Well_____ Township_____

Well Information

Reference datum: KB_____GL___ Total depth_____ft. Casing diameter (O.D.)____ in.

Tubing: Yes_No____ Diameter (O.D.)__ in. Depth_ft.

Plunger lift: Yes_No____Tubing lift_ Casing lift_____

Zone(s) completed: _____Depth _____ ft.
_____Depth _____ ft.
_____Depth _____ ft.

Test Results

Date tested_____
Liquid level _____ft. Height of liquid _____ft.
Casing pressure_____psi Tubing pressure_____psi
Estimated bottom hole pressure (mid perf)_____psi

Production Water Analysis: Specific Gravity _____ Density _____lb/gal pH___
Chloride(Cl) _____mg/l Iron(Fe) _____mg/l

Slickline: Slickline T.D. _____ft. Reported T.D. _____ft. Height of sand ____ft.

Sand over perforations? _____ Measured tubing depth _____ft.

Evaluation:_____
_____
_____
_____
_____
_____