

Gas Lift Optimization in Idd El Shargi North Dome

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Introduction

Occidental Petroleum of Qatar, Ltd. (OPQL) operates the Idd El Shargi North Dome field located offshore Qatar under a PSA from Qatar Petroleum (QP). Production is from 100 producing well bores, located on 40 assorted tripod and nine-slot jackets. Gas lift is the primary lift mechanism with a few wells still naturally flowing. The production is delivered to the PS-1 Production Station through a very complex and interactive gathering system of forty-four subsea pipelines. The pipelines vary in size from 6" to 20" lines.

The interaction between wells and pipelines is wide scale and complex. On some nine slots jackets, there could be 10-12 wells producing into a common manifold and then into two commingled pipelines producing to different endpoints at the production station. What might be good technical operations on a single well, may not be the optimum production from the jacket or from the field.

OPQL uses a commercially available software package to model the surface network linked to the subsurface field production. Each individual well is modeled with its own unique well bore characteristics including deviation, downhole equipment and vertical lift performance curves. The production model then links all the wells and pipelines together to calculate accurate production rates consistent with actual daily production, generally less than 1% of gross production.

The model accurately predicts pressure responses through out the system by utilizing data from bottomhole and wellhead pressures, flowline pressures, and arrival pressures at the central production station. Combining the surface network model with OPQL's SCADA system for real time operating data provides for a powerful tool in well and field surveillance and production optimization.

Background

OPQL began operating the ISND field in 1994. There were no gas lift operations at that time. Gas lift began within the next two years, with high pressure gas source wells located on individual jackets providing lift only to the local wells. The first gas lift compressor was installed along with the beginnings of a gas lift distribution system around 1997.

Production is primarily from two reservoirs, the Arab D and the Shuaiba with minor production is from the Arab C, Uwainat and Nahr Umr formations. Per well production ranges from 500 bpd to 10,000 bpd. Several of the reservoirs are under waterflood operations.

Beginning in 2002, an additional phase of development was implemented. This consisted of continued drilling, the installation of new production/water injection nine slots jackets, new production gathering lines, new gas lift lines and new water injection lines. Also, the capabilities of the PS-1 production station were increased with the addition of a new gas lift compressor, water injection plant and fluid handling facilities.

After two phase separation at PS-1, all produced fluids are sent via pipeline to Halul Island, where OPQL does final separation of oil and delivers to QP. Produced water is injected into disposal wells offshore of the island. Produced gas back at the station is used for fuel, gas lift and the remainder is exported to QP facilities at Masaieed.

Keeping the Model Evergreen

Every day, the model is updated to match current field conditions and operations. The real time data from the wells and the field from SCADA are reviewed. Wells are turned on or off, gas lift rate adjustments are made and model results are compared to the daily report. The tubing head pressures and flowline pressure are checked from real time data against the model. Any discrepancies between actual production and from the model are checked out immediately. Pressure differences more than one bar are also researched and generally can be explained.

Twice each month all well tests and water cut samples are reviewed. Adjustments are made to the model and the model is used to validate well tests. The model is then used to prepare a Potential List which establishes each well's production to be used for field wide allocations.

OPQL has installed Multi-phase flow meters (MPFM's) on all of the nine slot jackets. More than 80% of the wells in the field now can be tested using a MPFM. The MPFM's have been a big improvement compared to previous two phase separators tests that depended on a wellhead sample grab for water cuts. The MPFM data is also available real time from a web based system, allowing engineers to monitor and calculate well tests as they happen. OPQL has developed a unique system, where the well test results (tubing head pressure, water cut, GOR and gas lift rate are exported to the GAP model and production rates calculated using PI and Pres information. The calculated rates are compared to the observed test rates and after validation are automatically entered into the test data base.

It cannot be emphasized enough, that in production system as complex and interactive as this field, that gas lift optimization and production optimization is next to impossible without a good, up-to-date, calibrated production model.

Gas Lift Optimization

Gas lift optimization and oil production optimization are synonymous terms at OPQL. Both are made easier by a calibrated, up-to-date GAP production model. Optimization occurs daily by monitoring the field as described in the previous sections. By making the changes to the model in pressures/gas lift rates on a per well basis daily, the production engineer can see how operation changes in the field can affect overall field production.

Gas lift optimization begins at a per well basis using individual gas lift performance curves. OPQL uses the GAP/Prosper software to simplify this process. The production model is kept up-to-date daily on well status, gas lift rate and production flow routing and at least twice monthly with calibrated well tests, water cuts and GOR's . In addition, over half of OPQL's wells now have bottom hole pressure gauges installed in the tubing string and can also be monitored on a real time basis. In the twice monthly review process, the flowing or static bottom hole pressures from all the wells with gauges installed are also researched, and the GAP model updated as necessary.

Once a month, an OPQL produced routine uses macro's and the GAP software capabilities to develop Gas Lift Performance curves for each well. The macro opens the GAP software and reads current PI, Pres, GOR, water cut and flowing tubing head pressure for each well. It then opens the Prosper file for each well and calculates a gas lift performance curve. The program then dumps all data to an Excel spreadsheet which plots the performance curves and records all relevant data used for the calculations. The curves are reviewed by the production engineering department and supplied to the reservoir engineering department and offshore personnel.

Gas lift optimization then continues at the field level. Before gas lift optimization programs are implemented, they are thoroughly checked with the GAP production model. For example, an individual well may pick up 300 bpd production with an increase in gas lift, but the jacket/pipeline/field may lose 400 bpd due to increased back pressure on the wells in the system. In one recent program designed to lower gas lift usage, several wells totaling 5050 bopd (22,500 bpd gross using 15.0 mmcf/d gas lift) production were shut in, but the overall loss was only 3200 bopd. The rest of the wells in the field increased production due to less back pressure in the system.

Conclusions

A significant amount of activity is currently underway in OPQL drilling new wells and working over existing wells. This results in a need to continuously optimize the surface production model to account for the continuing change in the mix of the wells on line at any time. The process developed by OPQL to utilize these surface network models coupled with real time monitoring of SCADA data has led to a significant improvement in understanding of the production system which results in optimized production performance from a complex field infrastructure.