Upstream Produced Water Re-injection Facilities Optimization Study

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Abstract

Considering the reinjection of the produced water as a part of the overall injection flooding program can be a very costy proposition. It is therefore urged to build a reliable and an efficient system and to follow up on the changes that take place with time as field is produced. The changes in reservoir properties, injection well intake and the water cut rates all make revising and implementing a new water injection strategy inevitable. This papers discuses the evaluation methods and results conducted on six produced water reinjection systems. In this particular case, the study was trigged by a new production forecast was, indicating changes in the produced water rates.

Introduction

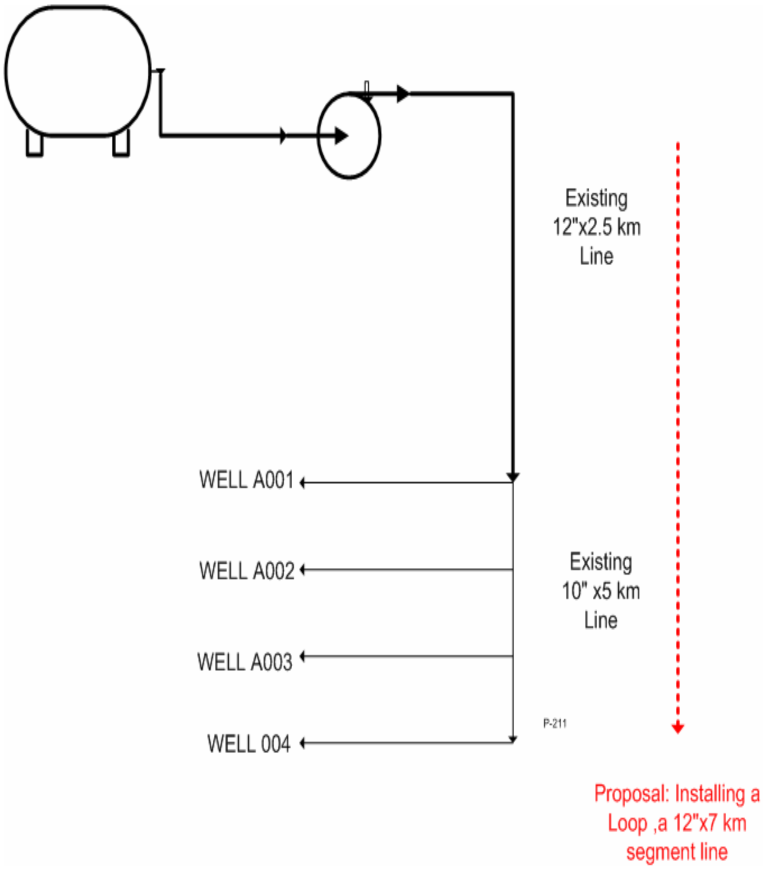
An integral part of an upstream production facility is a produced water reinjection system. The reinjection facility compromises of pumps, valves, flowlines an injection wells. Control elements, choke valves and monitors are installed across the system and on wells to control the rate per well. This is necessary to meet the targeted injection distribution schemes. Wells are often get plugged, losing injectivity or are purposely restricted to control the water flood fronts. The system is always subject to changing operational conditions, specially the produced water rates, causing back pressure on the pumps. The rate of the produced water fluctuates due to changes in production strategy and the maturing of field. Although, many subsurface measures are taken to control and reduce the water rates, the overall the water rate keeps increasing with time.

To ensure that the reinjection system is always performing at optimum level, periodic evaluations are conducted. A complete water reinjection system evaluation covers the system overall hydraulic, the injection well intake, the flowlines integrity, the pumps performance and the chokes & valves effectiveness. The evaluation is done by running simulations of the entire system, checking for bottlenecks in the system, high velocities in flowlines, wells low intake. Remedial Solutions range from adding pumps ,new injection wells, stimulating low intake wells, looping or replacing lines, de-staging or up-staging pumps to replacing impellers.

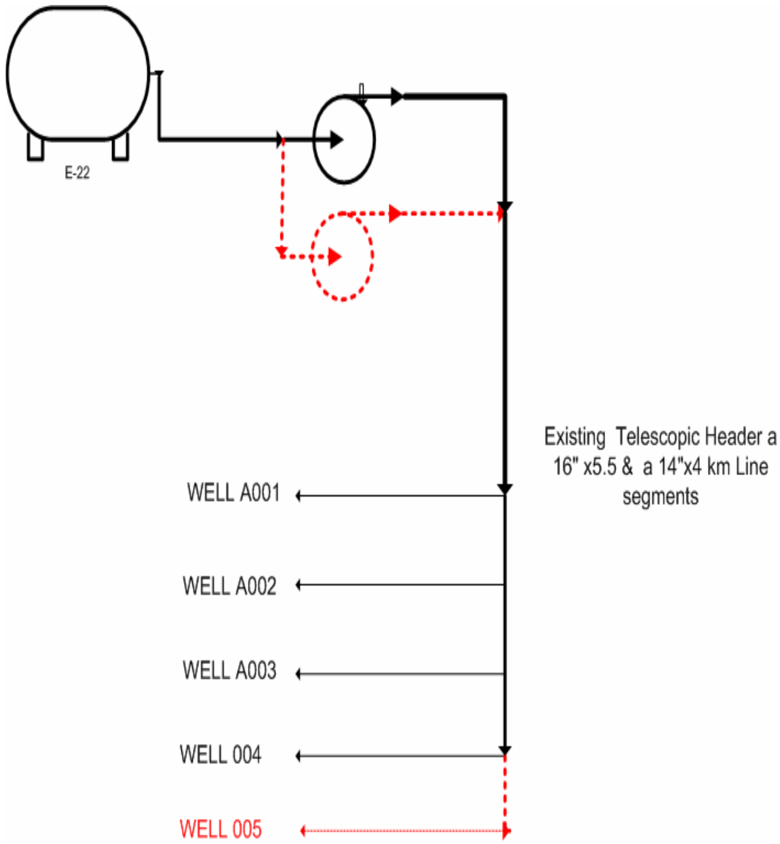
Discussion :

In this evaluation, six water reinjection systems were covered. A hydraulic model was built for each and calibrated to actual field conditions. The simulation runs results were cross- checked against numerous field tests.

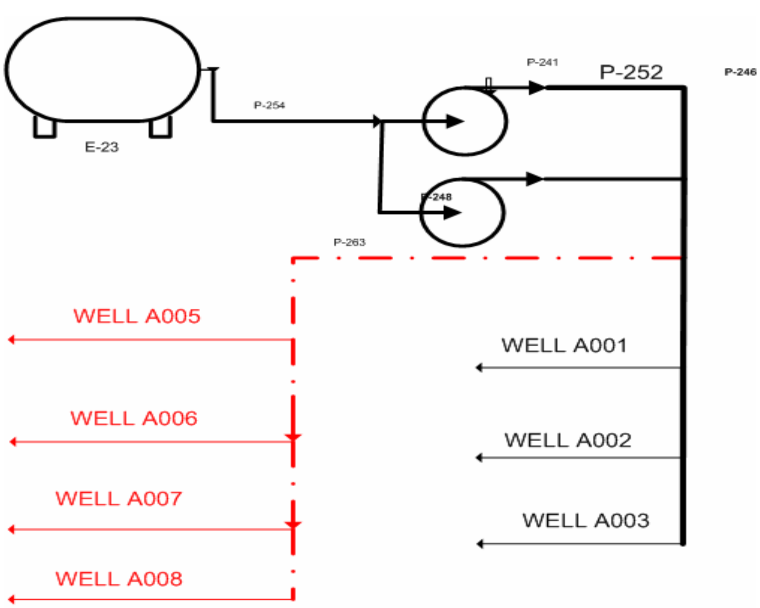
Case A Plant AX001: The investigation showed that as produced water increased, more back pressure problems arose and the pump started operating at the low efficiency point. This was due to the small size of the main line. The proposed solution called for looping the line to reduce the back pressure.



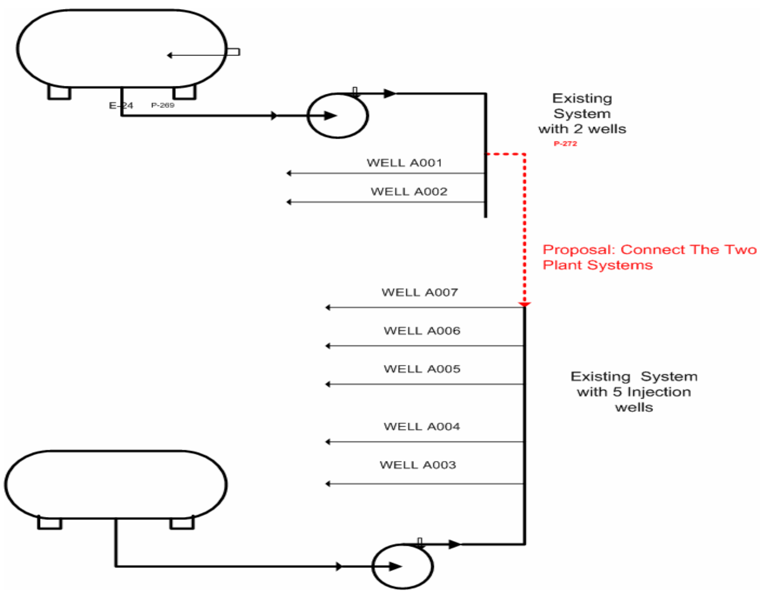
Case B Plant AX002: Here is was shown that a problem due to limitation in the pump is looming as the forecast showed that the produced water rate was significantly increasing beyond the existing pump capacity and the injection wells intake, while the flowlines showed no limitations. It was proposed here to install a new pump and a new well.



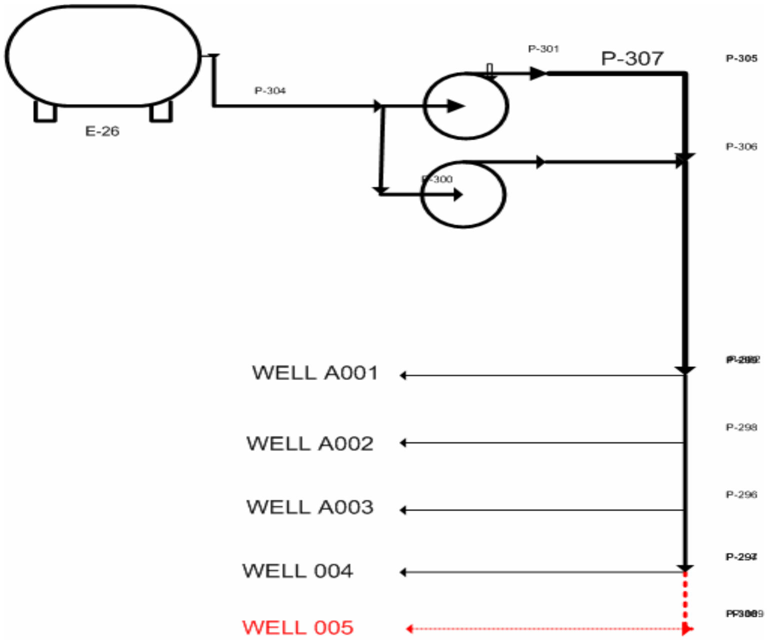
Case C Plant AX003: The new injection strategy called for abandoning some injection wells and moving in the field, a distance away from the plant, utilizing watered-out oil wells. Simulation runs showed as the new distant wells were added and old wells close-by were mothballed, severe back pressure would be sustained. The proposed solution was to tie-in to the new wells directly to the system with a dedicated large size diameter .



Case D Plant AX004: In this unique case, the two close-by systems were operating inefficiently due to the limited system capacity of one system and excess capacity of the other. The investigation showed that by integrating them, we would be able to utilize the excess well potential of one system for the other one. This was possible for the systems' close proximity from each other. It was proposed here to resolve by connecting the two systems at closest points at the flowlines, with an adequate line segment.



Case Plant AX006: It was determined in this case that the high back pressure is caused by well potential limitation requiring operating the pump at a very low efficiency point. The analysis showed that by adding a new injection well, the back pressure would drop, improving the pump efficiency. The well location was selected by reservoir engineers. The addition of the new injection well allowed reducing the back pressure and de-staging the existing pumps from 8 stages to 6 stages. This measure significantly reduced the energy consumption.



Conclusions

Water reinjection operation is a dynamic world, as all elements considered in the initial design basis change and no longer the optimum. Therefore periodic evaluations are urged to ensure implementing an effective water flooding program and efficient water reinjection operations.

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