

## CASE STUDY

# MARRAT PILOT WATER INJECTION PROJECT FOR KUWAIT OIL COMPANY (K.O.C)



### BACKGROUND TO PROJECT

Marrat is an over-pressurised carbonate producing reservoir deposited during the Jurassic period. Al-Khorayef Company was contracted by Kuwait Oil Company (KOC) to design, construct, commission, operate and maintain a water injection pilot to sustain reservoir pressure to prevent asphaltine deposition damage to the 11,250 feet deep reservoir. Calder Ltd working with Al-Khorayef and KOC successfully designed & installed 3 x High Pressure Injection Pump packages at the well head area where there was no provision of electrical power or water treatment facilities.

KOC regarded the output from Marrat as techno/commercially valuable in the mid to long term but had great concerns about the natural depletion of reservoir pressure causing massive asphaltine formation in the reservoir – and thus eventually blockage with the potential for long term failure of oil production. Prior to the installation of the Calder Water Injection packages, asphaltines were forming inside the production tubing and in the wellhead X-tree which required toluene to clean the production facilities.

Asphaltine formation would occur in the reservoir if the pressure falls below 6,200 psi.



*High Pressure Water Injection Pumps.*



*Hammelmann Quintuplex HDP 755 Pump.*

### OBJECTIVE OF THE PILOT WATER INJECTION PROJECT

KOC priority is to protect the reservoir against asphaltine formation and demonstrate the long term viability of the reservoir by successfully maintaining production rates at up to 10,000 bpd.

This viability of the project demanded a fully flexible and reliable water injection facility, which KOC awarded as a fixed-term contract with an EPC contractor to include 2 years operational responsibility based upon commercial terms which focus on payment per barrel of water injected with penalties for failure to meet the prescribed injection rate. The EPC contractor is also responsible for the provision of the aquifer water and all associated treatment facilities.

### CONTRACTOR SCOPE AND RESULTS

The EPC contract for all engineering, design installation and operation was awarded to Al-Khorayef, working in close association with KOC. Calder Ltd were contracted to provide the complete high pressure pump & VFD packages. Operational reliability, flexibility and compliance for the fixed two year contract period were key factors in the choice of processes and equipment.

The aquifer water is of a very corrosive nature with a high tendency for scaling. Scale and corrosion inhibitors are a fundamental part of the water treatment facilities together with oxygen scavenging. Filtration to 1 micron and total suspended solid concentration of 0.15 mg/l were agreed to be acceptable treatment parameters.

An agreed operating envelope of 1,000 BPD to 10,000 BPD at pressures ranging from 1,000 psi to 6,200 psi were reviewed, with the injection pump selection based upon operational flexibility, material selection, optimum reliability & availability taken into account. Additionally, operating costs for the injection pumps over the period of the contract were reviewed and thus total life cycle costs established and optimised. The need for electrical variable speed control of the injection pumps was clearly established as part of this review -- as was the need for hazardous area (Zone 1 ATEX) compliance of the pump packages.

# CASE STUDY: Marrat Pilot Water Injection Project for Kuwait Oil Company (K.O.C)



INNOVATION THROUGH EXPERIENCE



**Chemical Dosing & Boost Pumps.**



Calder Ltd was selected as the injection pump package supplier with three Calder pump packages together with their electric drivers and variable speed controllers being engineered, tested and delivered from their Worcester, UK facility in 7 months from order. All of the agreed key operational parameters were met by the choice of the Calder High Pressure Injection pump packages. Each pump package features a Hammelmann HDP 755 Quintuplex reciprocating plunger pump with Super Duplex steel fluid bearing assemblies.

All of the equipment; from independent diesel generation to aquifer water receipt, storage, treatment and water injection is designed into a practical site layout which is reliable, easy to use, maintain and operate.

*Variable Speed Drives.*



## SUMMARY

The plant has now achieved an operating life of 20 months. KOC has decided to maximise the injection rate at 10,000 bwpd for a period of 3 months to further investigate injection patterns and reservoir reactions. Additionally the water quality will be reviewed and mutually agreed reductions in quality of treatment and filtration will be implemented as the in-built plant flexibility will allow such changes to be quickly made.

***The pilot water injection plant is a major success, achieving:***

- ***Design and construction phase timetable adhered to.***
- ***Planned start up schedule achieved.***
- ***Successful operation within client specifications.***
- ***Full flexibility and control enabling a wide range of parameters to test the reservoir conditions.***



**Power Generation & Sub Stations.**



**HMI Control Panel.**



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