SPE 107918

Design and Surveillance of Development Projects Through Specific Software Tools: Importance of Data Management in Mature and Complex Fields in the Golfo San Jorge Basin, Argentina

Ricardo Mazzola, Isabel Cano Frers, and Dario R. Baldassa, Pan American Energy LLC; Jorge Valle and Alejandro Lacivita, Interfaces SA; and Carlos A. Ponce, Alfredo F. Viola, and Miguel A. Laffitte, Pan American Energy LLC

Proposal

Cerro Dragon is a mature Area located in the Argentine Republic, 90 km to the West of Comodoro Rivadavia and 1,900 km to the South of Buenos Aires, with a surface of 3,480 km² and with 3,738 perforated wells.

Since its discovery in1958, and after a long history of production, a change of strategy on 1999 resulted in an important increase in Production and Reserves

Decision making at every level, such as people health, environment care, and strategic, organizational, structural, operative and technological planning, was key for the rebirth of this field.

The work is centered in how we handle the information, the entailment of the data bases and the use of systems we have built to contribute to maintain the production growth of the Cerro Dragón Asset.

Based on the field complexity we recognized that it was necessary to implement new tools that would allow us to make production and investments prognoses, integrating information from different sources, as well as to detect improvement opportunities.

The selected software tools allowed us to perform simulations and dynamically survey the projects. The information used came from geological, geophysical, physical production, interventions, measurements, and automation databases, among others. Some of them were developed during the 2 initial years (1999 – 2000).

The selected software tools additionally let us integrate the projects into the Long Term Plan, and Budget, taking advantage of the virtuous Circle of Plan-Do-Control-Learn.

A project simulation is solved in a period substantially shorter than the one it demands a conventional simulator, which is of great advantage at the time of analyzing different scenarios in an area where the structural complexity and the meager petrophysical information are important barriers at the time of making a study.

The control and daily pursuit of the Projects through these systems have favored substantially the fast decision making, the correct lease of resources and a better operative answer.

To complete the description of our Optimization options other tools and practices are described.

Introduction

Cerro Dragon fields are located at the Northern flank of the San Jorge Gulf Basin, in the province of Chubut and Santa Cruz, Argentina.

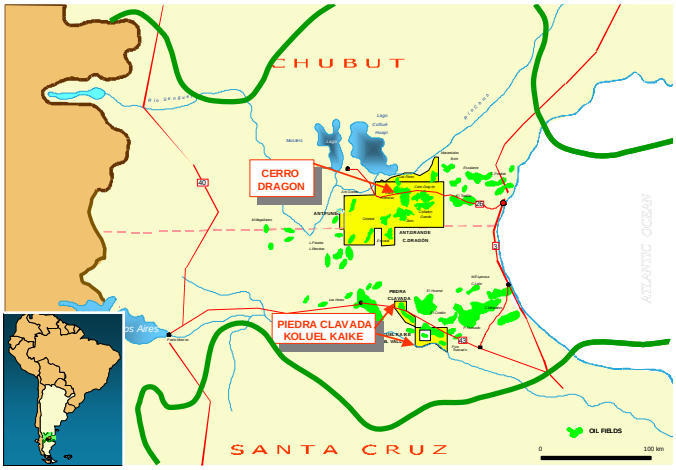
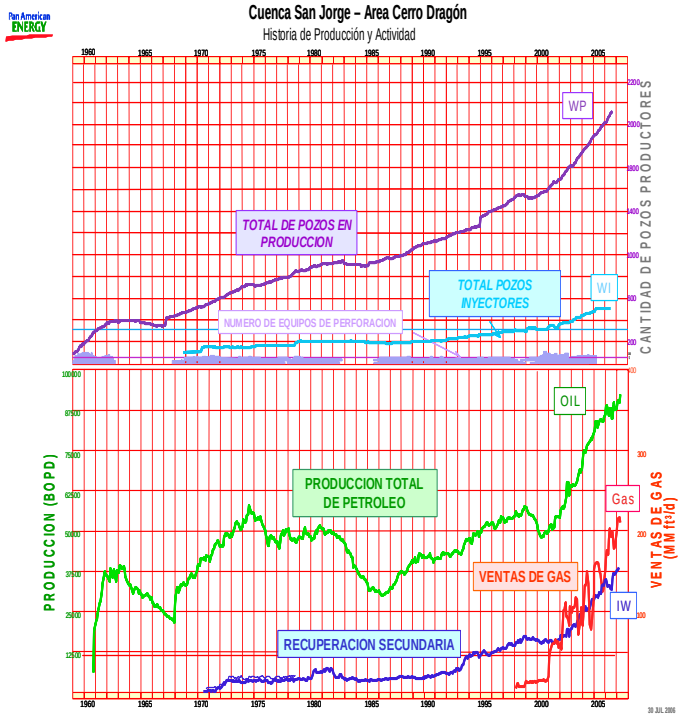


Figure 1 Cerro Dragon Areas Location Plat

The Cerro Dragón Contract Area, consists of approximately 50 fields. The area has been operated by Amoco since 1959. In 1997, Pan American Energy, become the operator following the formation of a joint venture between Amoco (now BP Amoco) and Bridas. Cerro Dragon has been under development as an oil producing area since 1959 through a combination of infill and extension drilling for additional primary oil production and Waterflooding Projects in some selected fields. Approximately 60% of the area is now under water flood. Cumulative oil recovery to date from both primary and secondary development exceeds 760 million barrels. There are currently 2410 Oil producing wells and 405 water injection wells in the area.



General Geologic Setting & Reservoir Description

The Cerro Dragon asset comprises 800,000 acres in a roughly rectangular block located on the north flank of the Golfo San Jorge Basin, a Mesozoic extensional basin filled with Jurassic lacustrian and Cretaceous fluvial deposit with Tertiary compression and wrenching superimposed on earlier extensional features.

The main reservoir consists of sandstones of the Comodoro Rivadavia Formation and altered tuffaceous sandstones and siltstones in the Mina Del Carmen Formation.

Hidrocarbons Traps consist of tilted horst blocks, faulted anticlines and structurally enhanced stratigraphic pinch outs.

Wells are produced commingled from stacked individual reservoirs 1 to 8 meters thick, each one with different initial reservoir pressure and fluid properties and contacts.

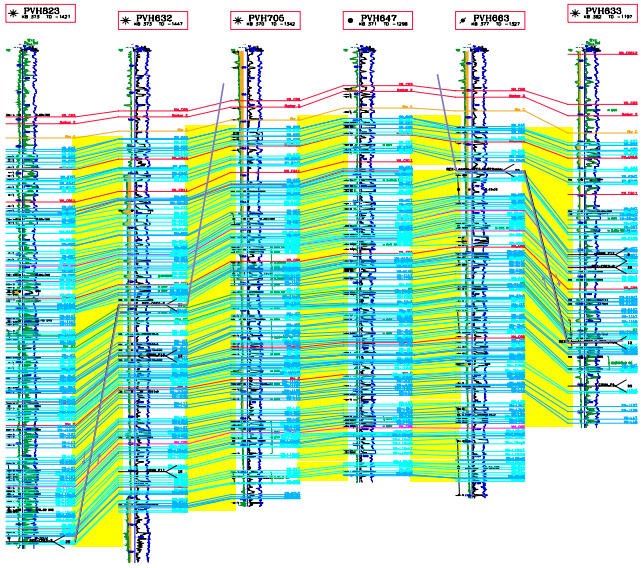


Figure 3. A schematic cross-section show the Field complexity

Some keys of the Cerro Dragon rebirth

- A Development Master Plan
- 3D Record and Processing
- An electrification plan
- Facilities expansion
- **DATA MANAGEMENT AND SOFT INTEGRATION**

In 1999 more than 90 % of the fields and wells information was available only in hard copies**, the challenge was integrate it into Databases.**

First step:

- Digitalization of old logs
- Develop and copy Wells File
- INFOPROD and BDIEP data entry (3500 wells)
- Detailed geological studies in the waterflooding blocks

Second step:

A virtuous circle “Planning , Doing, Control, Learn” was a very useful tool, associated with more friendly and empowered softwares. Sotware tools objectives goals:

1. Adjust the Production Forecast
2. Improve CAPEX and OPEX
3. Identify and Qualify the information required to share in the new Databases.

Cuenca del Golfo de San Jorge (C.G.S.J)

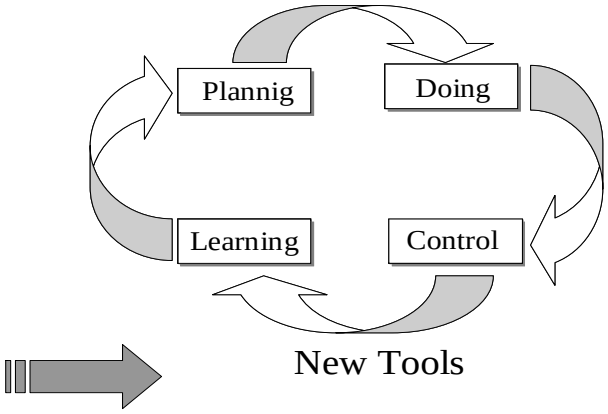


Figure 4. A virtuous circle

The core of the new way for our work was SAHARA a friendly software to history matching the production wells and forecasting. Along the years this software was empowered with new options of connectivity with our data bases and new options of calculations and simulation became available. Waterflooding Projects, Workovers and Drillings Plan were simulated block by block in each field of Cerro Dragon.

WF MANGEMENT TOOLS

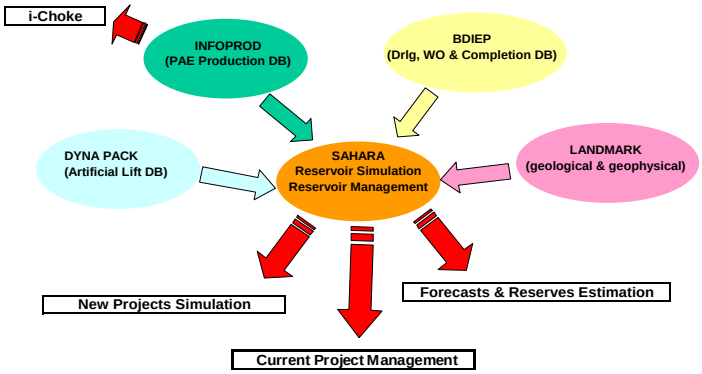


Figure 5. Inputs and outputs from SAHARA

The source of the Geological models was Landmark Software, the production and operation information source was INFOPROD , the completion and work over information including test was BDIEP SLPOS, the beam pumping information source was Dynapack . For each one of these sources data loading processes were added to SAHARA.
The simulation time in Sahara was reduced dramatically compared with conventional simulators, less information or simplification of it to simulate is very important when you have around a hundred layers in each well, with different fluid properties, only a SFT pressure by layer and completion or workover test for each one by swabbing.

TOTAL FIELD HISTORY MATCH

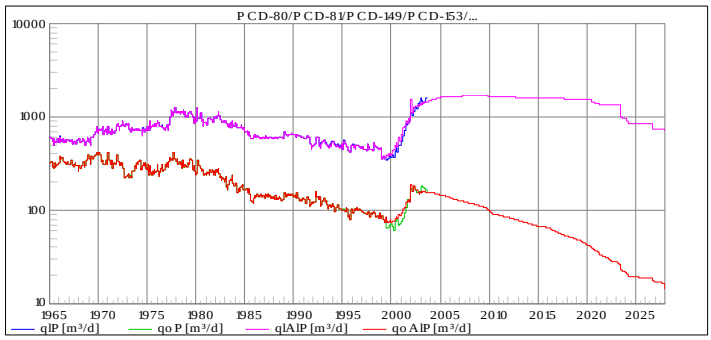


Figure 6. History Match and forecast

Sahara project expansion
Design & surveillance

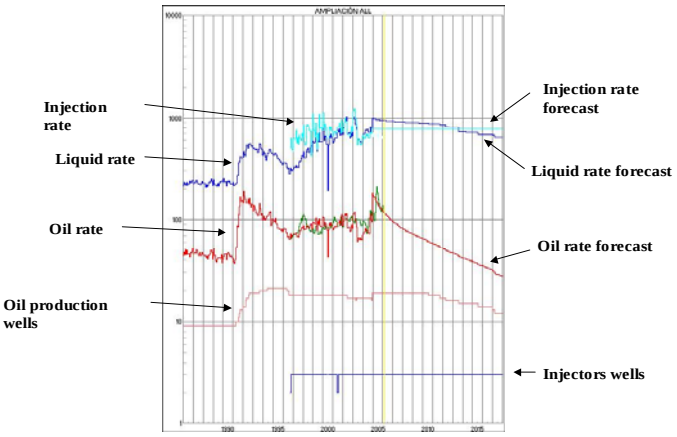


Figure 7. Some case of design

CDIII: Expansion Horizontal

The layer wf was improved with new injectors and infill well perforation

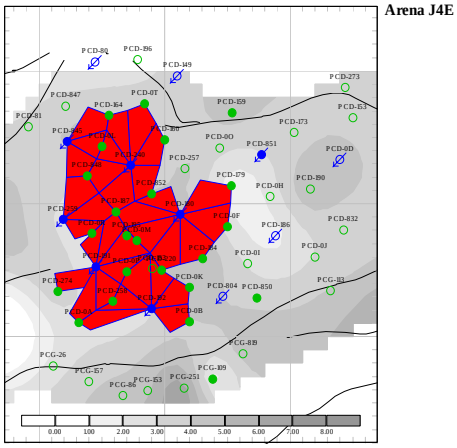


Figure 8. How you see each layer and the injection pattern

The exploitation status, dynamic and statics parameters of the wells, dinamometer studies, artificial lift system conditions, monitoring, Pulling Frequence, Production Meeting comments, references, bottomhole installation, operating conditions, changes, formation water injection by injector well and by layer can be monitored very quickly. Early detection can be achieved for taking right decisions.

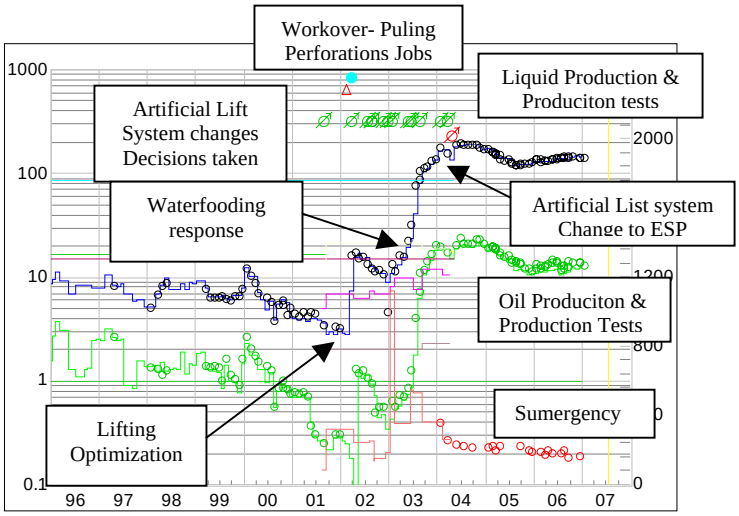


Figure 9. Well producing Chart

For Injector Wells:

In these charts it is possible to detect water distribution problems and injectivity reductions.

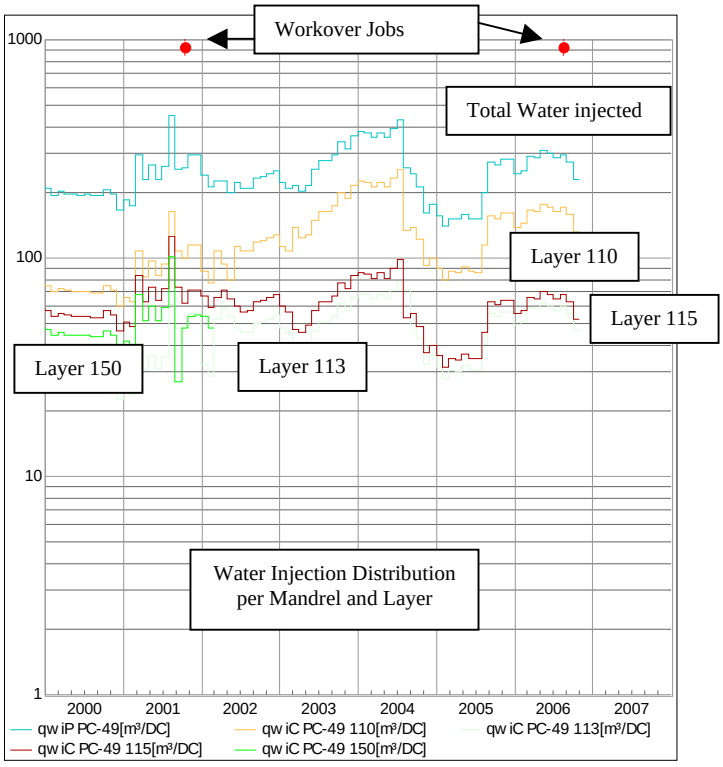


Figure 10. Well Injector Chart

Sahara surveillance - Well analysis
Well sketch

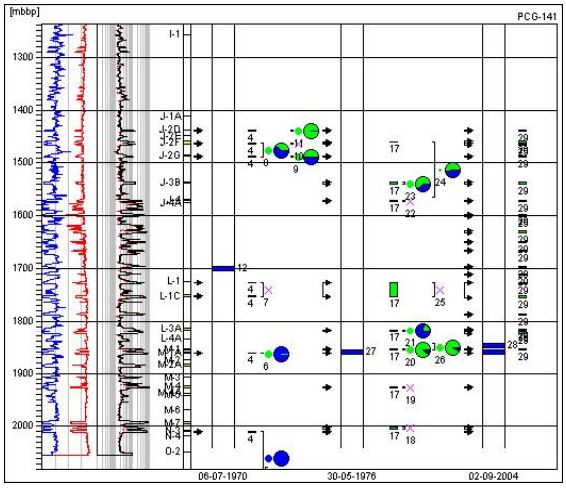


Figure 11. How look a view of a typical well sketch

Sahara surveillance
3-D visualization

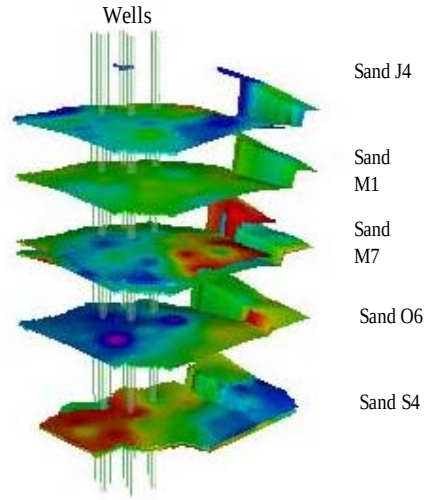


Figure 12. Layers view in a 3D Screen

The output of the SAHARA integrated data and simulation are :

1. Drilling Plans
2. Workover Plans
3. Conversion to injector Plans
4. Production and Injection forecast
5. Several Scenarios

All the SAHARA output is loaded into the P&CG system (**P**laneamiento & **C**ontrol de **G**estión system) where the analyst can manage the budget and CAPEX Expenditures to prepar the Long Term Plan.

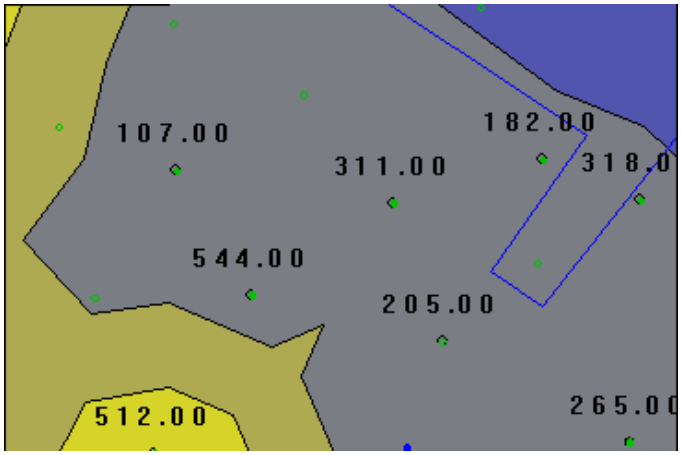


Figure 13. Sumergency Map

Drilling & WO surveillance programm

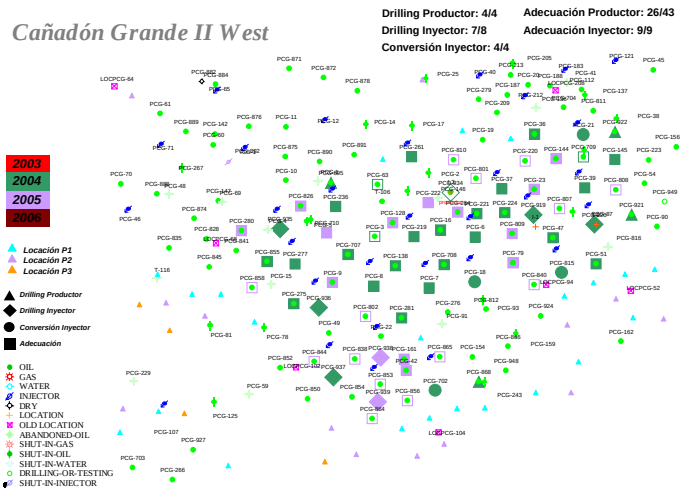


Figure 14. Quickly visualization of Drilling and WO Programs

Sahara surveillance Underdeveloped status

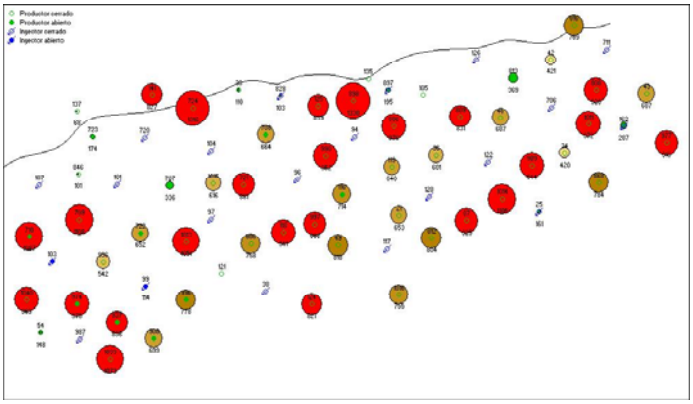


Figure 15. Underdeveloped status screen

Which tools are currently under development :

- Facilities visualization
- WETS ™ module evaluation

Which are the challenges to addres in the future:

- Export data to BDRC (Certified Reserves Data Base)
- Software utilities integration as:
  - Well type design
  - Dynamic Pressure Calculation in pipes
  - Gas material balance

Other systems and software developments support our daily work

SITU surveillance system Well following up

Figure 16. Pump off and beam pumping data visualization

SITU surveillance system Facilities following up

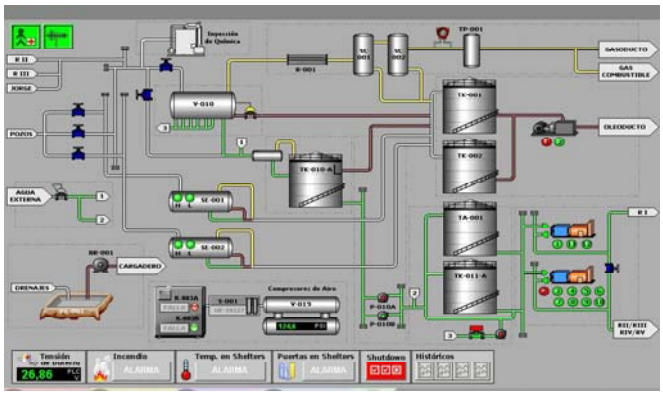


Figure 17. Facilities Control Panel

Dynapack surveillance
Well analysis

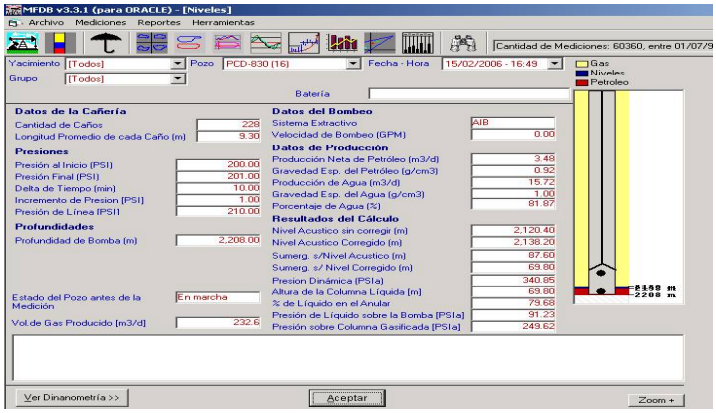


Figure 18. Beam pumping data visualization

THE PRODUCTION CYCLE AND INJECTION COMPLEXITY IN TWO FIGURES

Production Cycle

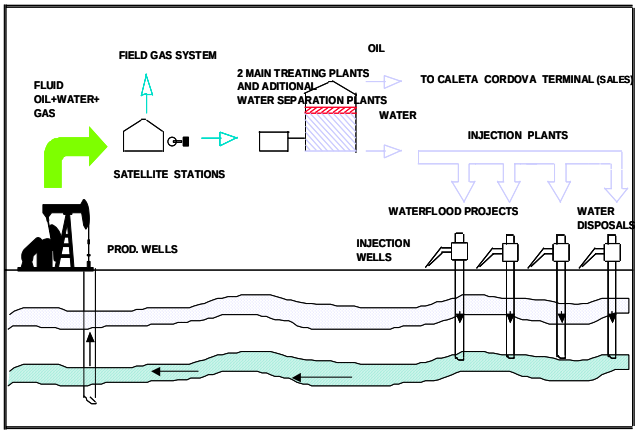


Figure 19. Cerro Dragon production cycle

- 1,850 Beam pumped wells
- 30 PCP pumped wells
- 450 ESP pumped wells
- 2 Gas production wells
- 70 Oil and gas Stations
- 2 Oil treatment Plants
- 1 Gas Treatment Plant

Subsurface injection installation
Injection histories analisys

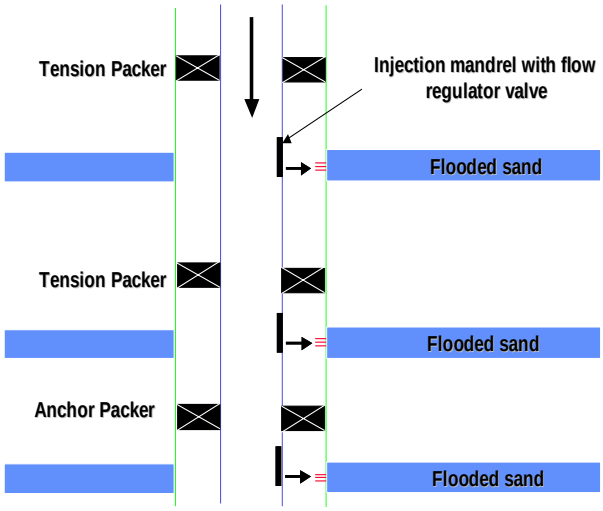


Figure 20. Subsurface injection installation

- 405 water injection wells
- 19 injection plants
- 18 water treatment plants

Conclusions

- Integrated data management is one of the keys of the Cerro Dragon rebirth.
- A flexible and friendly simulator with connection to our data bases gives us a power tool to make good decisions.
- Databases according the field complexity and needs is the best way
- The virtuous circle is the best tool of our teams to complete the targets.

Acknowledgements

Thanks are due to:

PAE Cerro Dragon Development Reserves Teams because this paper reflect their hard daily work.

The PAE facilities and automation team for improving the data loading and databases operation.

The PAE IT Team for high quality systems and communications.

INTERFACES Management and design Team because they've working along many years to improve and integrate into customized software for their and our ideas and needs.

References

1. Ezequiel Massaglia, Dario Baldassa, Carlos Ponce, Bernabé Zalazar. Injector-Well Completion Designs for Selectively Waterflooding up to 18 Zones in a Multilayered Reservoir: Experience in the Cerro Dragón Field. SPE paper 99997 presented at the 2006 SPE/DOE Symposium on Improved Oil Recovery held in Tulsa, Oklahoma, U.S.A., 20–26 April 2006.

2. J.P. Martins, SPE, J.M. MacDonald, C.G. Stewart, SPE, and C.J. Phillips, SPE, BPExploration (Alaska) Inc. The Management and Optimization of a Major Wellwork Program at Prudhoe Bay. SPE paper 30649 , 1995.