



# Horizontal Wells to Minimize High Water Production In Zelten oil Field

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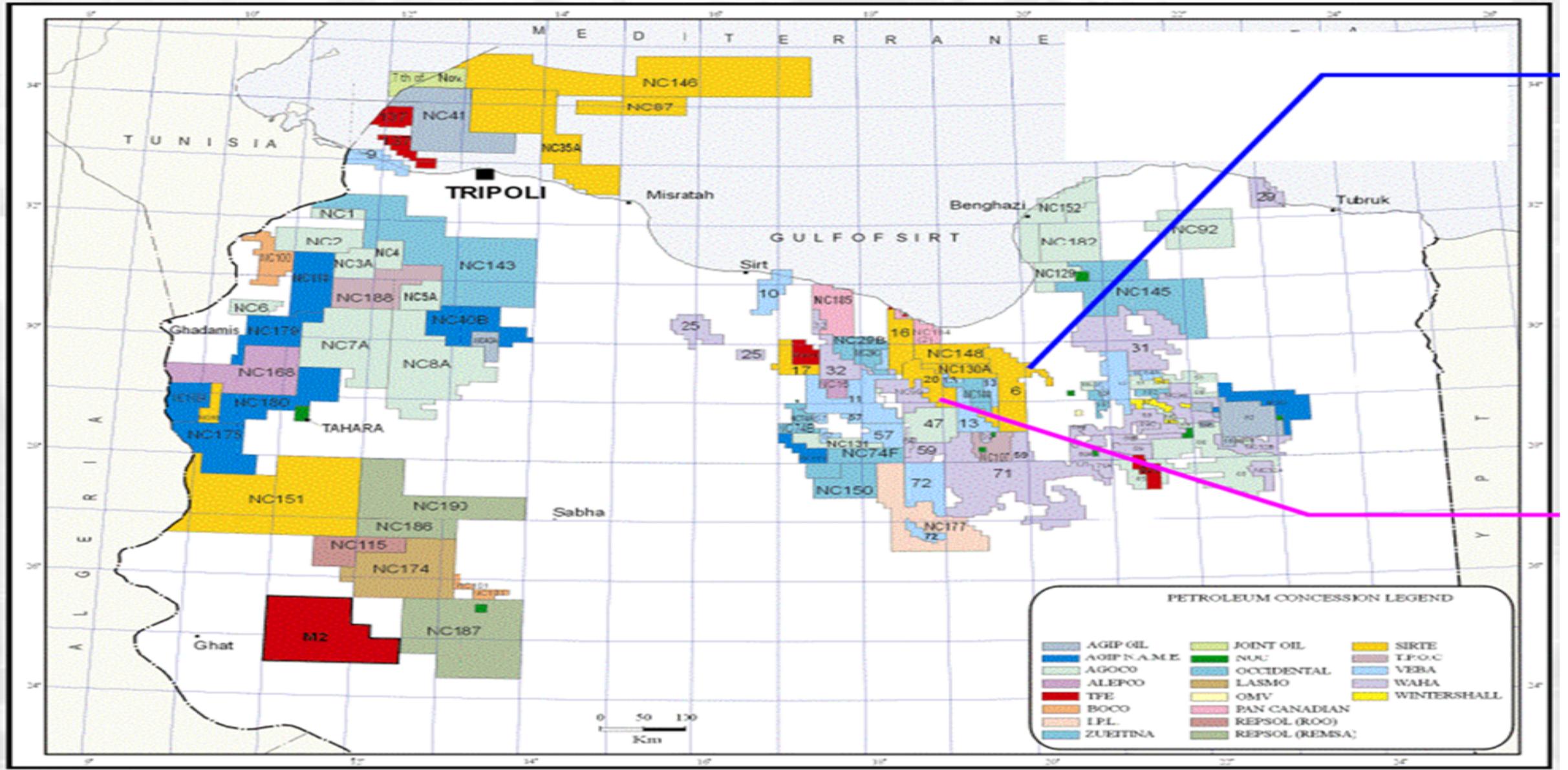
# Outlines

- Introduction
- High Water Cut In Horizontal Wells
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- ICD Completion in Horizontal Wells
- Conclusion

# Introduction

- ❑ Zelten oilfield, one of the major oilfields, is located in Sirte basin in Libya. It's a limestone reservoir with pressure support from the underlying water aquifer.
- ❑ The peak oil production from this field was around 1 million bopd in year 1968 which has gradually declined significantly in the last 50 years due to a strong water influx.
- ❑ The field has some 272 wells completed mostly open hole; all the wells in the main pay zone except 17 horizontal wells are vertical.
- ❑ For the wells currently on production, the water-oil ratio ranges from 0.58 to 7.74 with an average water cut of 76%.
- ❑ The strong water influx in the wells has been responsible in reducing the oil production.
- ❑ The current maximum water-oil ratio (WOR) in the field is 7.74; that means for every bbls of oil produced, 7.74 bbls of the water is being produced.

# Zelten Oil Field in Libya



# High Water Cut In Horizontal Wells

- ❑ Seventeen (17) horizontal wells have been drilled in the main pay in year 1994 to 2001 in Zelten field.
- ❑ The horizontal well started with the average oil rate of 663 bopd (256-1413 bopd range) with the average water cut of 31% (0-83% range) and water-oil ratio of 0.9 (0-5.2 range).
- ❑ In the average of 11.2 years of production history, the oil rate declined to the average of 88 bopd (0-530 range) with the water cut increased to the average of 77% (14-98%) and WOR increased to 9.5 (0.2-49.0 range).
- ❑ The average oil recovery per year per well of the horizontal wells has been 113 MSTB with the range of 65-208 MSTB.

- ❑ Currently, ten (10) or 59% of the horizontal wells are shut-in due to the high water cut.
- ❑ The 17 horizontal wells drilled in the main pay zone have not been successful in reducing the water reduction.
- ❑ However, the geosteering and LWD systems were not available at that time so the trajectories of the horizontal sections could not be controlled to stay in the hydrocarbon zones.
- ❑ The plan is to drill in the existing horizontal wells, the new horizontal legs utilizing the geosteering and LWD systems.

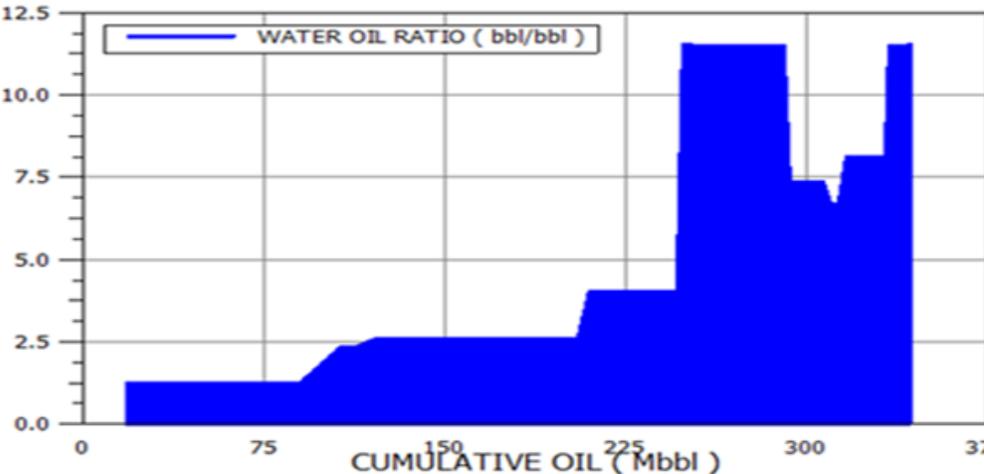
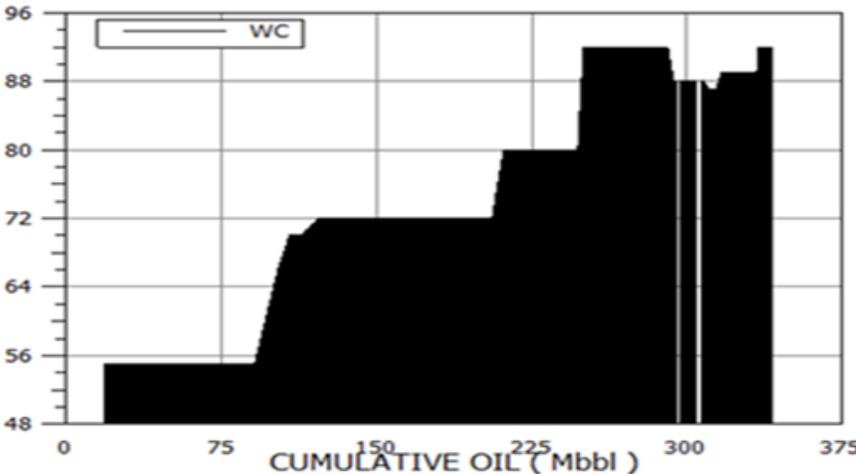
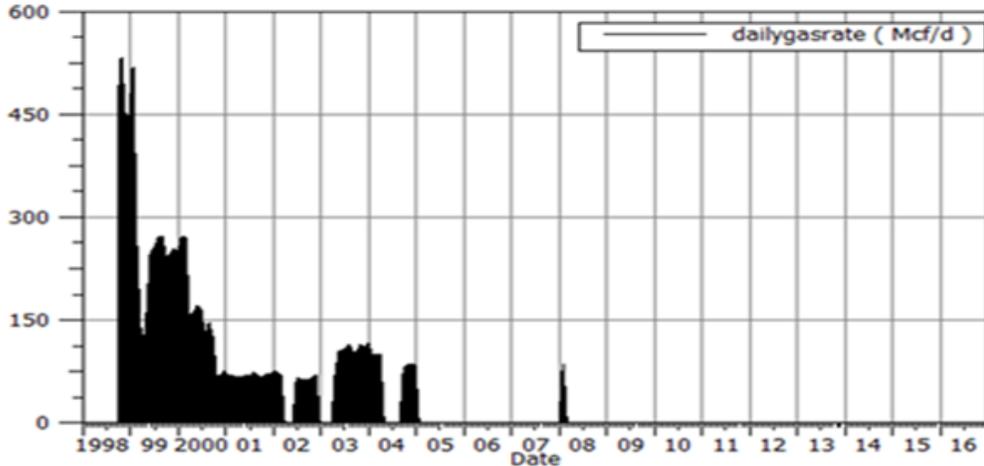
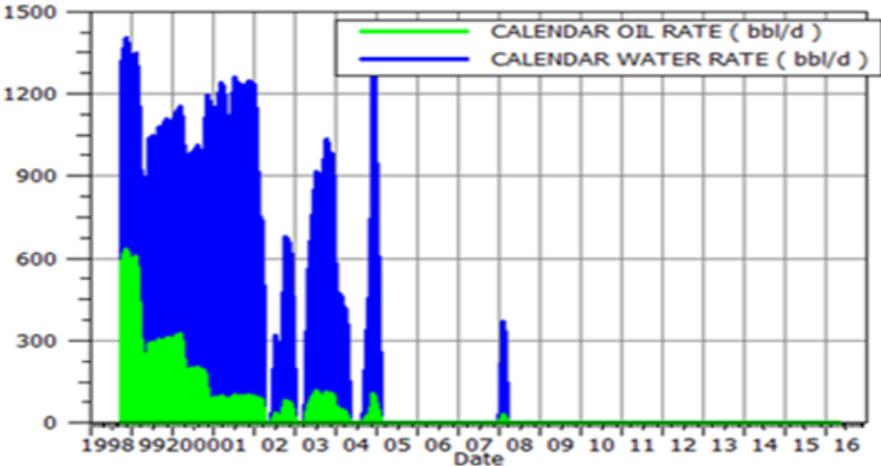
- ❑ Moreover, ICD completions will be run in the horizontal wells in order to selectively shut off the watered out zones in the horizontal sections.
  
- ❑ The ICD completions provide a mechanism to control/shut off the water production when the sections of the horizontal leg are watered out with time.
  
- ❑ In a pilot project in one of Zelden horizontal wells, ICD completion will be run to divide the horizontal leg into five segments by using 4 open hole packers and 15 ICDs . Each of the five segment will have the completion equipment to shut off the zone if and when it becomes watered out in the future.

The following is a graphical representation of the of the poorest performer horizontal well in the field

Zelten Porosity Horizontal Well: Poorest Well Performer

Summary Performance

C252



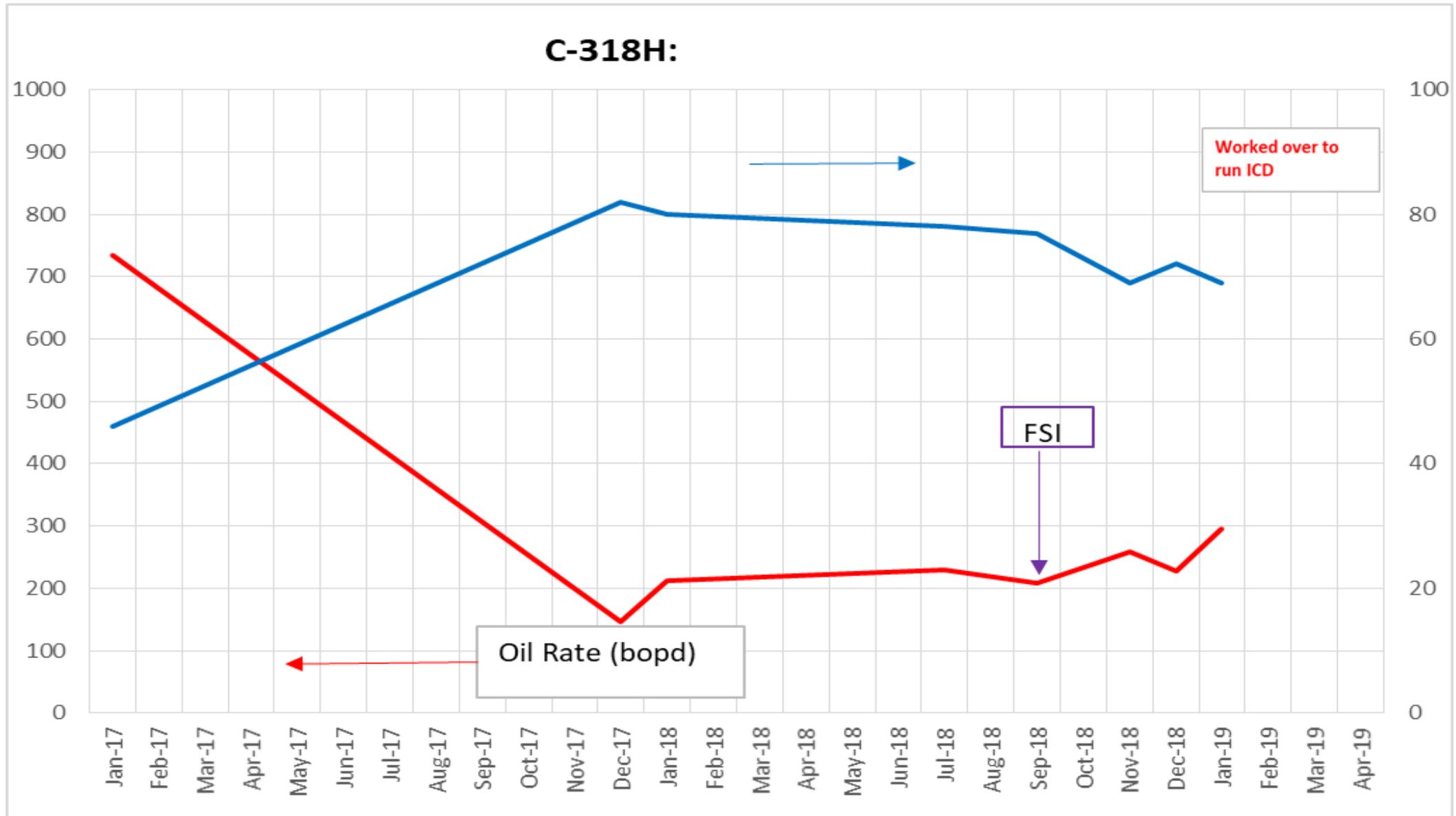
# Evaluating Horizontal Wells

- ❑ Judging by the increase in the water cut and WOR, the horizontal wells drilled have not been successful in reducing the water production.
- ❑ One of the main benefits of the horizontal wells is considered to be the lower pressure drawdown and hence lower water production and longer producing life.
- ❑ But in the case of the horizontal wells in the main pay in Zelten field, neither of the benefits materialized.

# Wells

- ❑ All the horizontal wells except C-318H were drilled without MWD/LWD due to the non-availability of these technologies in Libya at the time of drilling.
- ❑ Without the MWD/LWD, it was not possible to keep the trajectories confined in the hydrocarbon zones and, consequently, some sections of the horizontal legs ended up presumably in the watered out zones contributing to the high water production.
- ❑ The MWD/LWD technologies are currently available in Libya. Therefore, the new horizontal legs could be drilled in the existing wellbore of the shut-in horizontal wells.
- ❑ By keeping the trajectories in the hydrocarbon zones by utilizing the MWD/LWD technologies, it is expected to reduce the water cut and thus bring the shut-in wells back to production.

The following is a graphical representation of the of the C318H performer horizontal well in the field



# ICD Completion in Horizontal Wells

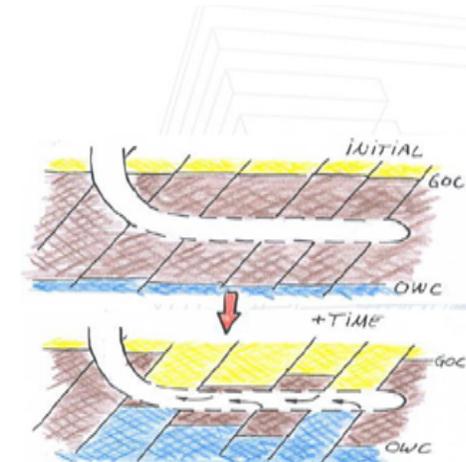
Schlumberger ICD, Inflow Control Device, completions will be used to selectively shut off of the watered out zones in the horizontal leg. The following explains the challenges faced when during the course of the production life of horizontal well, the sections become watered out and what are the objectives of remedying the problem.

## CHALLENGES

- Carbonates
- Permeability variation along the wellbores
- High water production – WC: 76%
- Long 6 1/8 " OH section, ~ 1000 ft
- Multi-fractures and/or tight reservoirs
- High water mobility rates

## OBJECTIVES

- Uniform and optimized production profile across the well length
- Control/shut-off well water production
- Completion should provide easy/cost effective water shut-off option for wet compartments

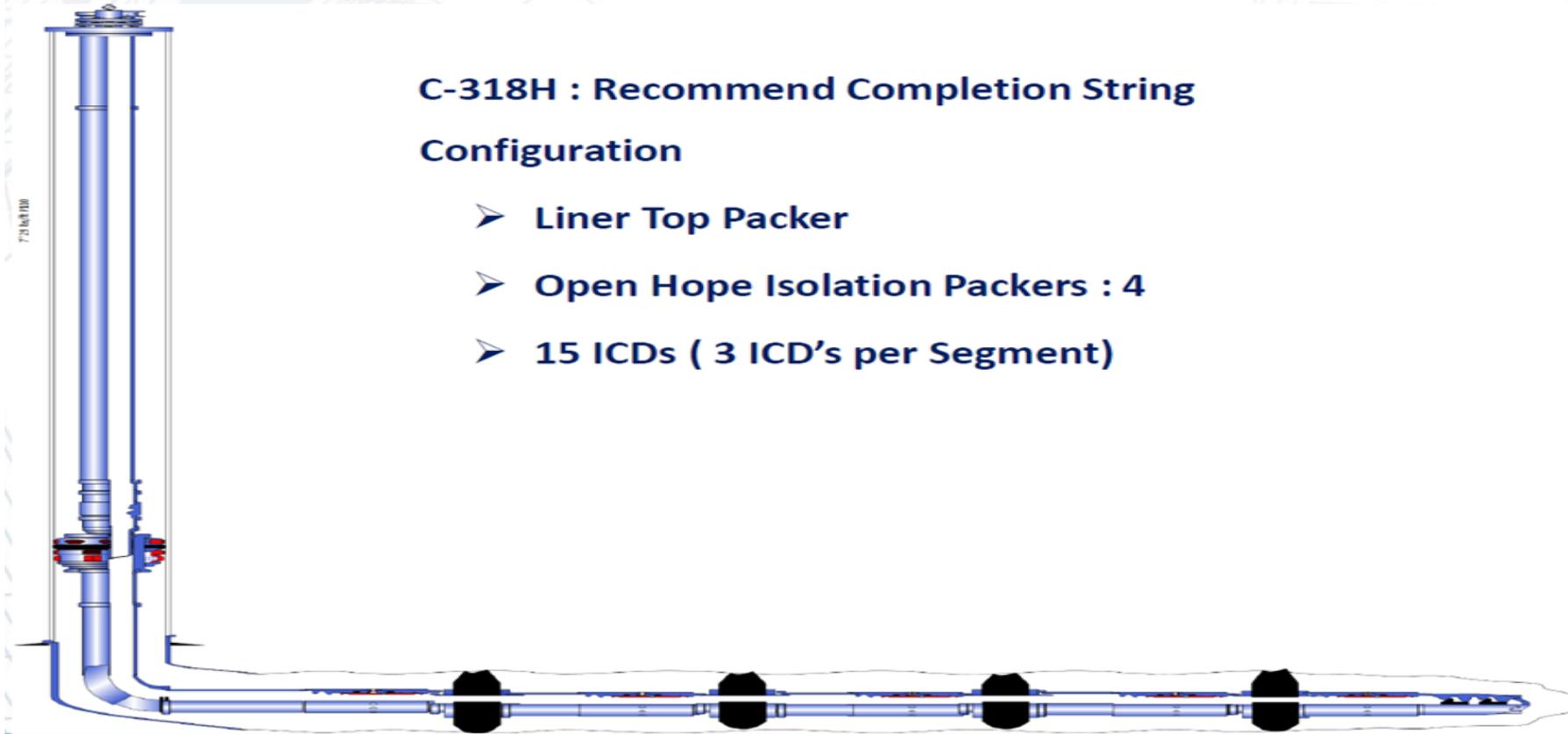


The ICD completions provide a mechanism to control/shut off the water production when the sections of the horizontal leg are watered out with time.

# Summary

## C-318H : Recommend Completion String Configuration

- Liner Top Packer
- Open Hope Isolation Packers : 4
- 15 ICDs ( 3 ICD's per Segment)



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With the help of the geosteering/LWD, the horizontal leg will have the trajectories confined to the hydrocarbon zones, and the ICD completions will provide the capability of selectively shutting off the watered out sections. The utilization of these techniques will help improve the production performance of the current and future horizontal wells in Zelten field.

# Conclusion

- ❑ The major reason for the poor production performance of the horizontal well is attributed to the fact that the geosteering and LWD systems were not available at that time so the trajectories of the horizontal sections could not be controlled to stay in the hydrocarbon zones.
- ❑ In future, in the existing horizontal wells, the new horizontal legs will be drilled utilizing the geosteering and LWD systems in order to ensure that the horizontal sections stay in the hydrocarbon zone.
- ❑ However, a mechanism (ICD) will also be required to selectively isolate the sections of the horizontal leg which could water out with time.

THANK YOU FOR YOUR  
ATTENTION