Norman Wells Field – a long history of oil production in the Central Mackenzie Valley

Ron Babiy, Imperial Oil Resources, 237 – 4th Ave. SW, Calgary, Alberta
ron.j.babiy@exxonmobil.com

Summary

The Norman Wells Field has been a producing entity from its discovery in 1920 to present day. Throughout its history it has been an example of a multi-disciplinary integrated approach to producing hydrocarbons in a remote, geographically and climatically challenging part of Canada.

Introduction

The Norman Wells field is located in the Northwest Territories approximately 145 kilometers south of the Arctic Circle. The majority of the field lies beneath the Mackenzie River which is ~ 5 kilometers wide at Norman Wells. In 1789 Sir Alexander Mackenzie noted in his journal that he had seen oil seeping from the river's banks. The Geological Survey of Canada later confirmed these seeps in 1888 (Stewart, 1948). In 1920 Imperial Oil drilled the discovery well and early production of the light crude supplied local needs such as mining operations and fishing boats. Early production was intermittent and seasonal. The field underwent a major development during World War II to supply fuel in support of North American forces. The development project, named Canol (Canadian Oil), included 67 new drill wells and a pipeline from Norman Wells to a purpose built refinery at Whitehorse, Yukon. The Whitehorse refinery was shut down after the war and up until1985 production was to a refinery on site which supplied only local markets. In 1982 a major expansion of the field was undertaken by Imperial Oil, which included the construction of 6 artificial islands on the Mackenzie River, the drilling of 253 wells and the construction of an 870 km pipeline from Norman Wells to Zama, Alberta where the line connected with the Rainbow Pipeline. In the 1990s and 2000s an additional 37 wells were drilled in the field.

Reservoir, Production and Logistics

The Norman Wells reservoir is a Middle to Late Devonian carbonate reef complex. The top of the reservoir varies in depth from ~ 320 meters to ~ 650 meters. The reservoir is a re-crystallized limestone with a variety of pore types present with microporosity in the matrix and / or intraparticle microporosity being the dominate pore system. Porosity ranges from 3% in the reef interior to 18% in the reef margin, with a field average of 8%. Matrix permeability in the field ranges from 0.5 millidarcies to 20 millidarcies with a field average of ~ 2 millidarcies. Although the reservoir is naturally fractured, there is evidence that the field is generally behaving as a conventional reservoir with a limited number of effective fractures. The reservoir is oil wet with a connate water saturation < 10%.

During the 1982 to 1984 expansion the field was developed on a 6.7 ha (16 acre) / well spacing and a five spot pattern waterflood was implemented. Currently there are ~330 active wells which includes 166 producers and 163 injectors. The producers are all on artificial lift with approximately 50% gas lift, 40% rod pump and 10% electrical submersible pump. Current production rates are ~2250 m3/d (14 kbd) oil and ~7500 m3/d (47 kbd) water.

As a result of a fully integrated multi-disciplinary approach to managing the reservoir the team has had a significant impact on reducing the oil production decline rate of the field. The team comprised of a geologist, reservoir engineers, subsurface engineers, operation technologists and field operators, identify, plan and execute an effective and efficient program of injector / producer stimulations, completions and recompletions, and waterflood pattern reconfigurations.

Field operations are faced with a number of logistical challenges. First is the remote location of the field. The nearest supply center is Edmonton, Alberta, which is 1500 km south. Transportation of supplies is limited seasonally to either the winter ice road from Fort Simpson, N.W.T., or the summer river barge from Hay River, N.W.T. An alternate option is airfreight from Edmonton which is expensive and load size limited. The second challenge is that the majority of wells are on the artificial and natural islands in the Mackenzie River. Movement of large equipment to the islands is seasonally limited to an ice road in the winter and a company operated barge in the summer. The third challenge is the extreme cold operating conditions that can be experienced during the winter.

Conclusions

Imperial Oil Resources continues to operate the Norman Wells field in an effective and responsible manner. As a result of past and present efforts more than a quarter of a billion barrels of oil has been produced from the Norman Wells oil field.

Acknowledgements

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References

Stewart, J.S., 1948. Norman Wells Oil Field, Northwest Territories, Canada. Structure of Typical American Oil Fields, Volume III, American Association of Petroleum Geologists, Special Volumes, p 88.