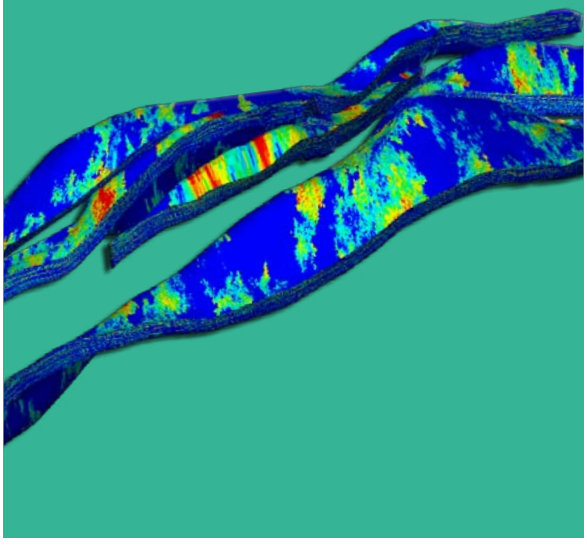
Magazine



High-pressure Condensate Gas Reservoirs

Northern Tarim Basin

China National Petroleum Corporation

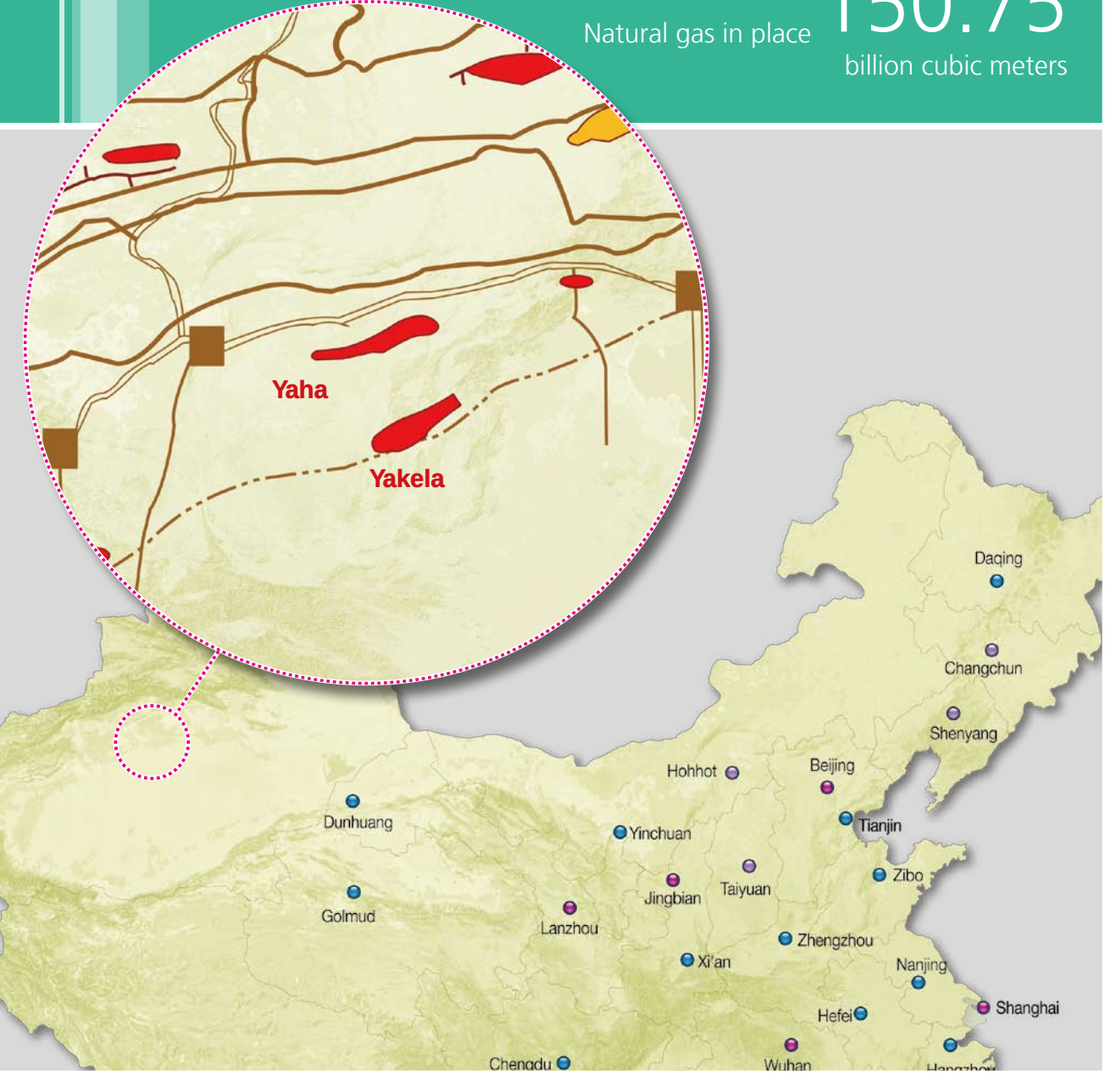
High-pressure Condensate Gas Reservoirs

Northern Tarim Basin

Several high-pressure condensate gas fields, including Jilake, Yaha, Yingmai-7, Yangtake and Yudong-2, have been proven in the northern part of the Tarim Basin since the 1990s. By the end of 2008, a total of 64.83 million tons of gas condensate in place and 150.75 billion cubic meters of natural gas in place had been proven in these fields.

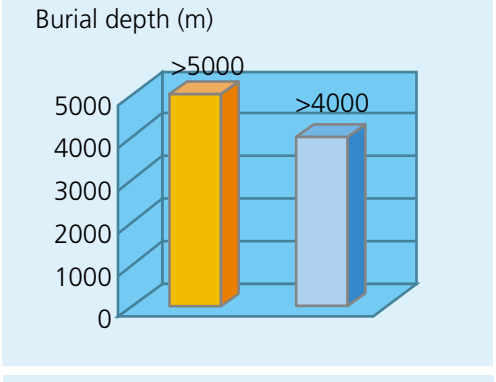
Cumulative proven gas condensate in place **64.83** million tons

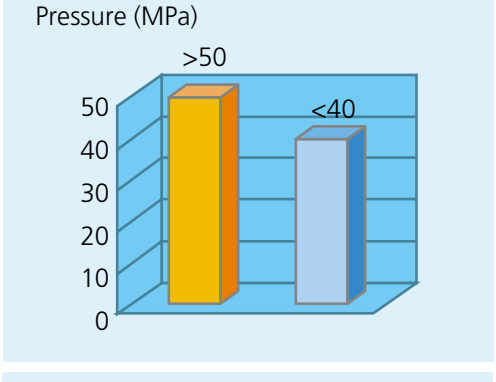
Natural gas in place **150.75** billion cubic meters

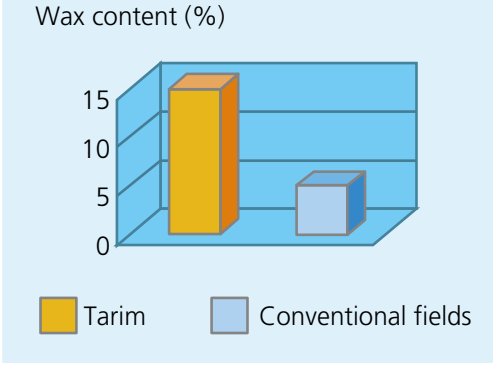


Condensate gas reservoirs are difficult to develop due to their complicated development mechanism and high technical requirements. In the northern Tarim Basin, the condensate gas reservoirs are characterized by deep burial, high formation pressure, complex constituents and phase state changes of fluid, high wax content and varied types. These have posed great technical challenges to development scheme selection, the surface process of the high pressure gas injection, high pressure well completion, and safe and efficient drilling in bad ground conditions.

Main Characteristics







- Multiple gas-bearing formations distributed from the Carboniferous System to the Neogene System, and mostly in the Jidike Formation of Neogene System, the Eogene System and the Cretaceous System
- Varied burial depth generally at 4,000-5,500 meters
- High formation pressure generally of 40-60MPa, and up to 71.5MPa in the Carboniferous System in Jilake Field
- Wide variation of gas condensate content (120-670g/m^3) and considerably varied retrograde condensation features (maximum retrograde condensation pressure of 8-25MPa and maximum percentage of retrograde condensed liquid of 4-39%)
- Low difference between formation pressure and dew point pressure of 0-26MPa and generally within 5MPa
- High wax content generally greater than 15%

January 1994
High yield was obtained during formation testing in well Yaha-3, leading to the discovery of Yaha Condensate Gas Field.

November 2000
Yaha Condensate Gas Field was put into production.

September 2004
Yaha Condensate Gas Field became the first to supply gas to the West-East Gas Pipeline.

April 2005
Jilake Condensate Gas Field was put into production.

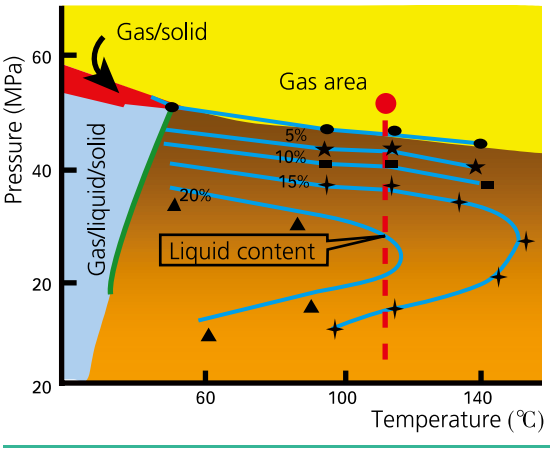
April 2007
Yingmaili Gas Field Group, including three condensate gas fields of Yingmaili, Yangtake and Yudong-2, was put into production. As a source of the West-East Gas Pipeline, it is capable of producing 2.36 billion cubic meters of natural gas annually.

Technology and Innovation

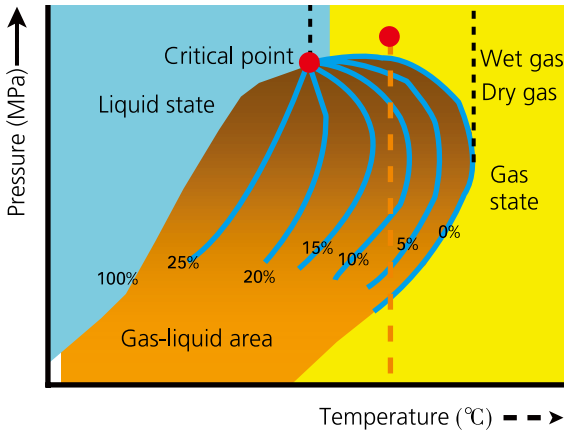
A suite of state-of-the-art development technologies for ultra-deep high-pressure condensate gas fields have been developed by addressing major challenges in developing condensate gas fields in the northern Tarim Basin.

Phase State and Seepage Theory of High-waxy Condensate Gas Reservoirs

Phase diagram of high-waxy condensate gas

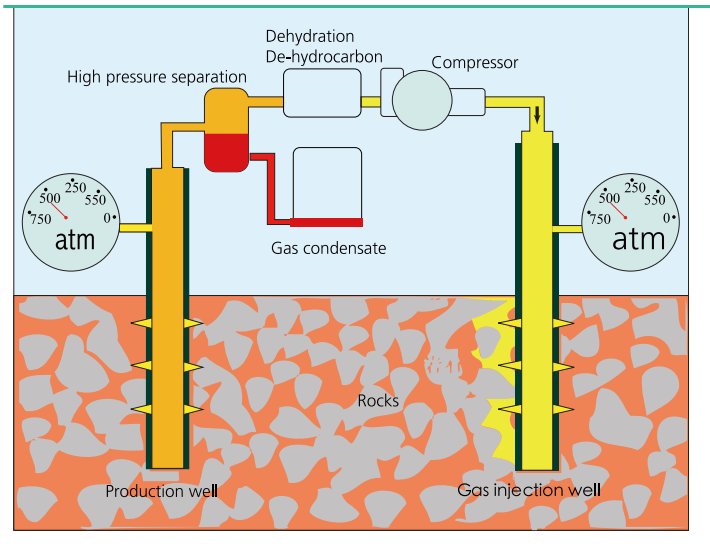


Phase diagram of conventional condensate gas



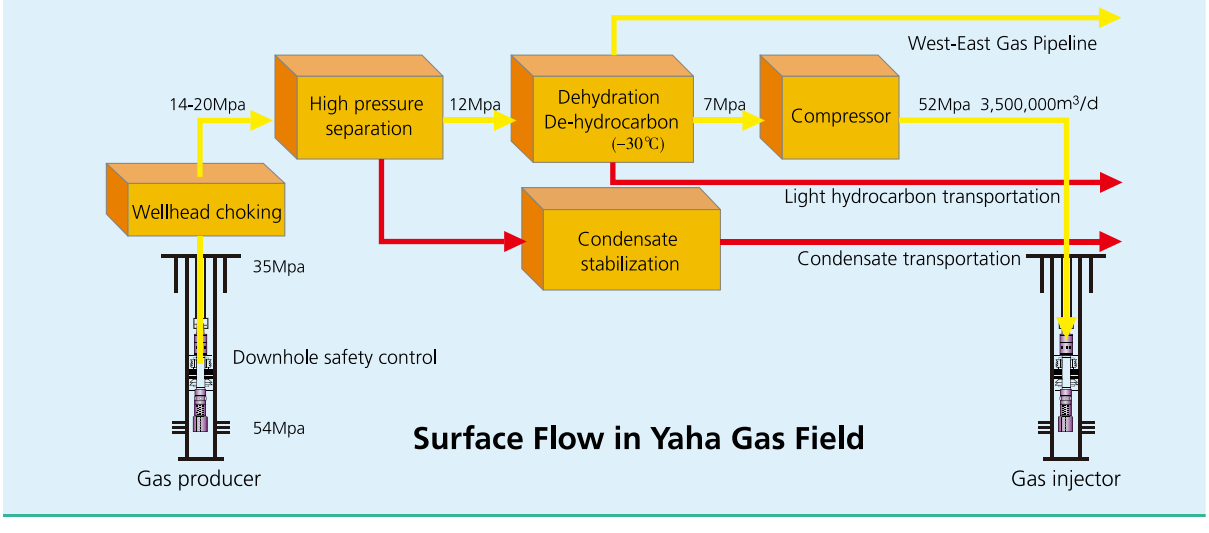
Based on experimental and thermodynamic studies on phase state, the phase state characteristic pattern and equation of high-waxy condensate gas have been obtained and reconstructed to guide the design of development plans for condensate gas reservoirs. Experimental studies on condensate gas equilibrium, gas-water relative permeability, mechanism of retrograde vaporization by gas injection, and gas injection recovery factor of long cores under simulated formation temperature and pressure have been made to search for the methods of increasing gas and condensate recovery.

EOR by Cyclic High-pressure Gas Injection



The Yaha Condensate Gas Field has been developed by cyclic gas injection at a pressure of 52MPa with a daily injection volume of 3.5 million cubic meters, achieving a recovery efficiency of 54.7%. Cyclic gas injection has also been adopted in the Kekeya Condensate Gas Field at the mid-late stage of natural depletion, increasing the field's recovery efficiency by 18.2%.

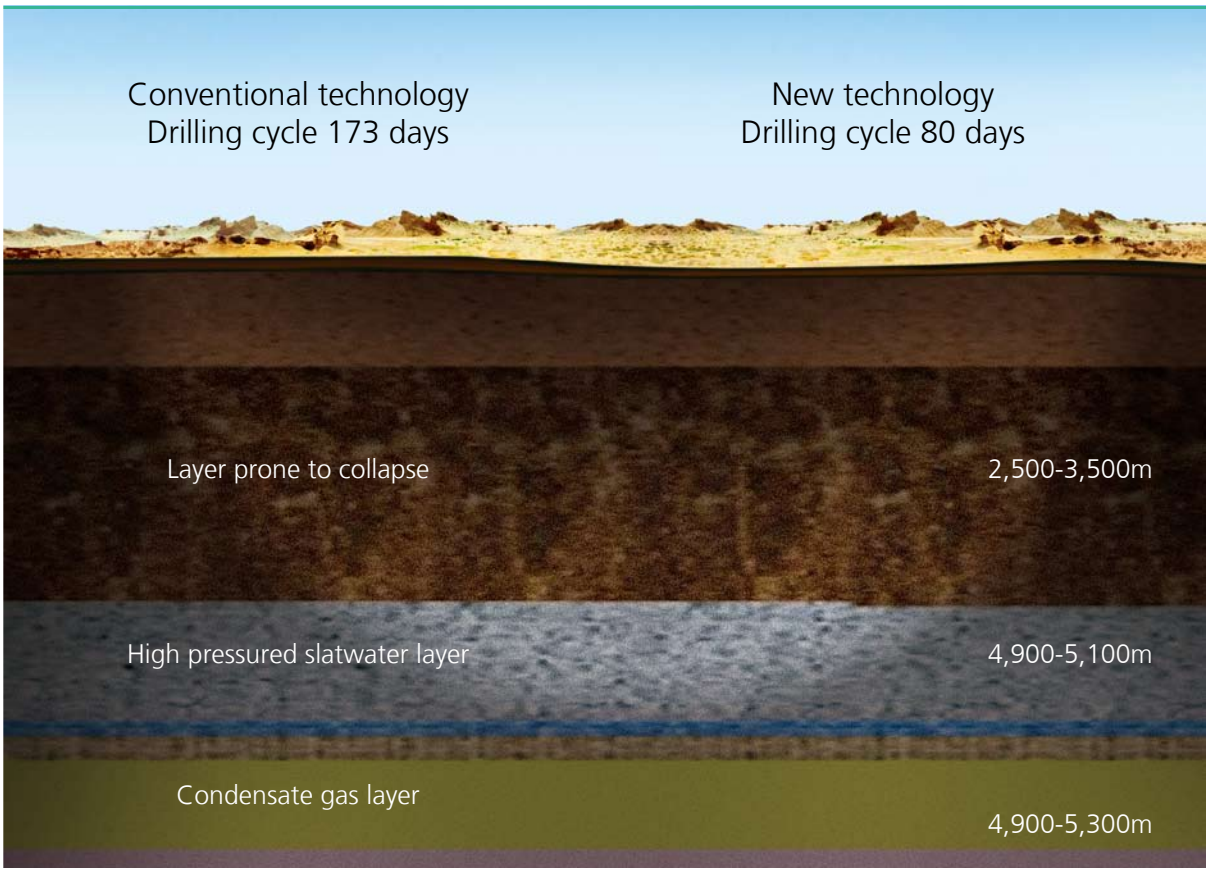
Integrated High-pressure Gas Gathering, Processing and Injection System



Surface Flow in Yaha Gas Field

The complicated surface system of a condensate gas field is integrated and mutually restricted with the subsurface system. Through multi-discipline cooperation, different systems have been optimally designed with dramatically low energy consumption and operating costs.

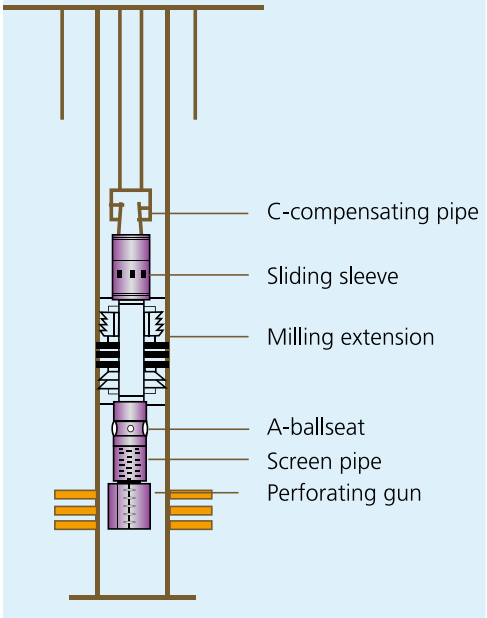
Drilling in Bad Ground Conditions



Challenges caused by the deep burial of gas reservoirs, multiple sets of pressure windows, and layers prone to collapse have been addressed by using inhibitive drilling fluid, intensified plugging drilling fluid, optimized bits, and optimized wellbore structure to effectively protect reservoirs, increase bit speed, and save drilling costs.

Single-pass Perforation and Completion of High-pressure Condensate Gas Wells

Single-pass negative-pressure perforation and completion technology for high-pressure condensate gas wells has been used to considerably shorten the completion cycle, improve operation safety, and ensure the long-term stable production of the wells.



9 Dongzhimen North Street, Dongcheng District, Beijing 100007,P.R.China
www.cnpc.com.cn