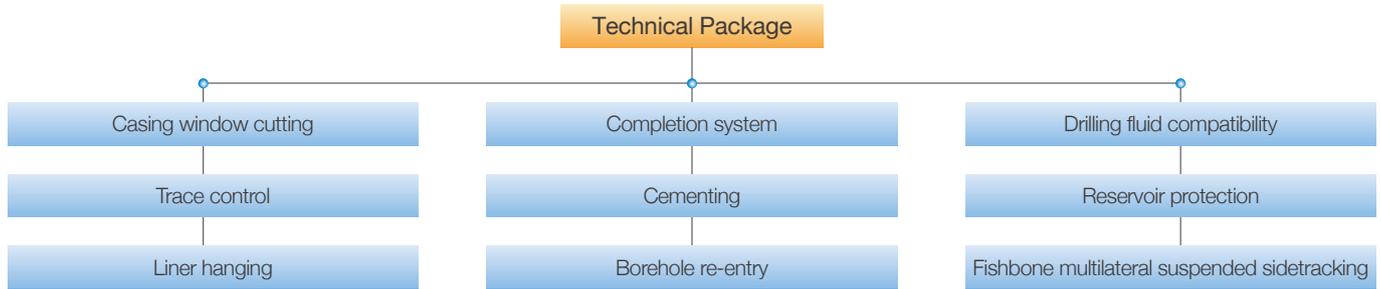




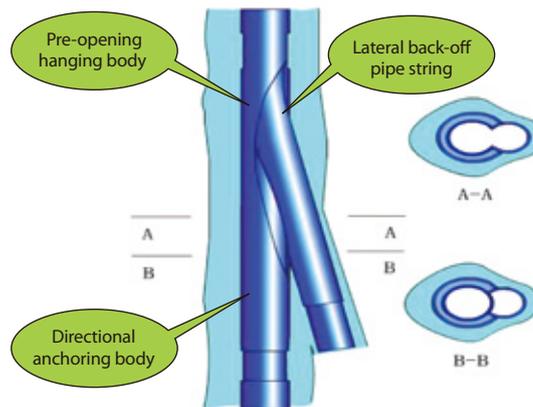
GWDC Multilateral Drilling and Completion Technology

China National Petroleum Corporation



“DF-1” System

- ✔ With embedded structure, avoiding the risks associated with traditional hanging structure during operation and ensuring mechanical stability, sealing integrity and re-entry capacity at the borehole forking point
- ✔ Two series of multilateral well drilling and completion tools and supporting techniques available for 9 5/8” and 7” casings respectively
- ✔ 16 multilateral wells and 55 fishbone multilateral wells being successfully drilled



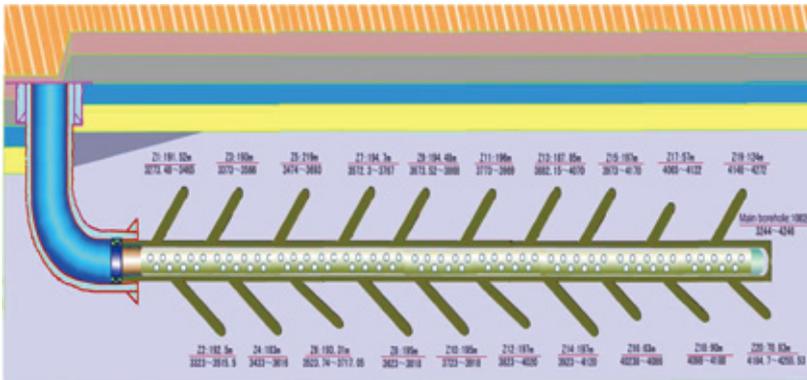
The system consists of main bore pipe strings group, branch hole pipe strings group, multi-branch window cutting tools and multi-branch well completion tools. It utilizes the special orientated junction to enable suspension of casing exit. The main borehole strings group is made up of pre-opening bodies, hanging body, and anchored unit isolating sources from the lowermost hole section. Back off facility is as part of branch hole string group that usually can be combined as per need.

Drilling and completion tools mainly include milling taper, whipstock, whipstock foundation, hollow deflector, spiral packer hanger, rotation joint, and overshot spear.

Technical Features

- ✔ Pre-opening casing and deflector fitting technology guarantee mechanical integrity and pressure integrity of the main hole/branch hole junction.
- ✔ Local close off or all close off cementing ensure reliable hydraulic sealing of the main hole/branch hole junction.
- ✔ Pre-positioning directional devices guarantee re-entry capacity of the branch hole.

- ✓ Multiple completion pipe string assemblies are available for various types of reservoirs and completion requirements.
- ✓ The system is up to TAML4 level and can be upgraded to reach TAML5 level if required.
- ✓ The system is equipped with sound contingency plans and a full range of tools for dealing with complex well situations.
- ✓ A complete set of workover techniques and workover tools that suitable for lateral re-entry is in place.



- ✓ Total depth: 4,246m
- ✓ Total footage: 7,577.19m
- ✓ Fishbone laterals: 20
- ✓ Total horizontal intervals: 4,333.19m

A completed fishbone multilateral well that records the most branches and the longest horizontal intervals in China

Applications

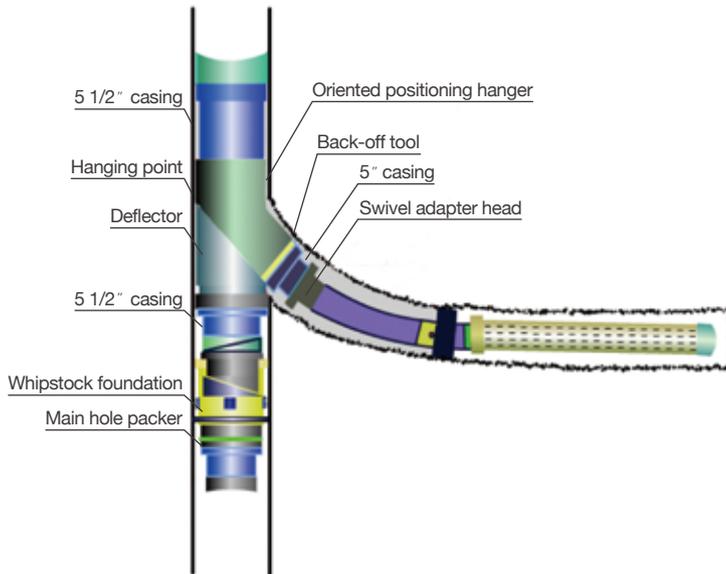
Multilateral well drilling and completion plays an irreplaceable role in increasing single-well output, tapping marginal reservoirs, enhancing oil recovery, and reducing the cost per tons of oil produced.

Currently, 71 multilateral or fishbone wells (TAML1-5) have been drilled and completed by using GWDC's technology. The average output of these wells is 2-15 times that of adjacent wells in the same block. The technology provides an edge tool to develop low permeability fractured buried-hill reservoirs, faulted edge and bottom water reservoirs, heavy or ultra-heavy oil reservoirs, deep igneous rock gas reservoirs, thin oil reservoirs and other marginal reservoirs. It has been widely applied in the Daqing, Jilin, Liaohe, Sichuan, Xinjiang and other oilfields in China. The actual casing program is selective, according to reservoir characteristics and well site conditions.



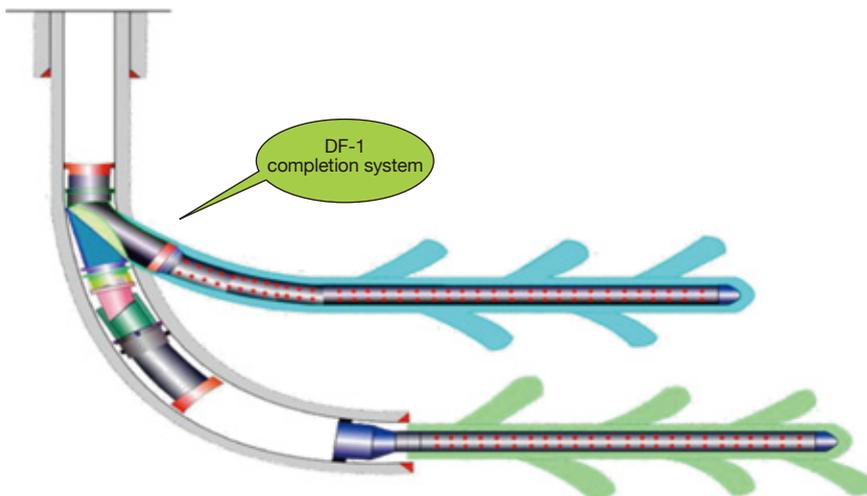
Case Studies

Well Jin 612-12-Xin22 in Liaohe Oilfield



Reservoir type: ordinary thin oil reservoir
Application mode: old well sidetracking while maintain the original borehole
Well type: multi-lateral horizontal well
Completion level: TAML 4
Completion method: half cemented half suspended-screen pipe in oil layers
Effect: produced at a rate of 30m³ per day at early stage by blowing, 7-8 times that of original borehole

Well Biantai-H3Z in Liaohe Oilfield



Lateral Z1:
 Total depth of main borehole: 3,248m
 Maximum deviation: 98.86°
 Maximum displacement: 1,320m
 Fishbone laterals: 6
 Total length of fishbone laterals: 1,212.56m
 Penetrated oil layers: 2,175.56m

Lateral Z2:
 Window cutting point: 1,798m
 Total depth: 3,110m
 Maximum deviation: 94.9°
 Maximum displacement: 1,300m
 Fishbone laterals: 5
 Total length of fishbone laterals: 888.36m
 Penetrated oil layers: 2,194.36m