Available online www.jsaer.com

***Journal of Scientific and Engineering Research*, 2020, 7(2):299-304**

Research Article

ISSN: 2394-2630
CODEN(USA): JSERBR

Types of Smart Wells

T. Jarassova[1]*, N. Eremin[2]

[1]Akdeniz University, Science Institution, Antalya, Turkey
E-mail: t.jarassova@gmail.com
[2]Gubkin Russian State University of Oil and Gas, Moscow, Russia
E-mail: ermn@mail.ru

Abstract Recently the technology of the smart wells became one of the most compelling developments in the innovative technologies of hydrocarbon technologies. Engineers can effectively monitor and spot out the productive zones with low performance and shut them down separately without the need to shut down the whole well. The smart well technologies are being successfully applied worldwide. Currently the world watches the fast development of the application of smart wells in the fields.

Keywords smart well, snake well, dragon well, first and second generations of smart wells, multilateral wells

1. Introduction

A smart well is a well equipped with downhole sensors and telemetry systems that can receive various kinds of information about the well's work and manage its work in real time. Ground-based and downhole information-measuring systems should ensure and increase the reliability of information and operational systems for production monitoring and control of productive zones, ensure the profitability of the project and increase the oil recovery coefficient. Experience has shown that with the advent of downhole components of smart wells, it has become possible to better control and manage the formation, monitor the operation of individual layers, evaluate the skin factor, phase permeability and pressure in real time [2].

Types of Smart Wells

One of the most common varieties of smart wells are snake and dragon wells. A snake well coils like a snake from side to side and reveals only the most highly productive zones along the seam (Fig. 1). One of the snake well type is a "dragon" well, which is more complicated in terms of the structure of the intersection of the layers, it penetrates the layers both along and across their strike. Snake and dragon wells allow high production rates, equivalent to those found in many vertical wells, and to ensure the participation of each region with high productivity in development. Similar wells were used to develop Champion West, Iron Duke, in the Yellow Sea offshore Brunei. Oil production rates of snake and dragon wells exceed 2000 tons per day. These deposits were discovered 50-60 years ago, but the technology for their development for a long time was not. The technology of drilling snake and dragon wells allowed these fields to be put into development. Snake and dragon wells are drilled using directional drilling techniques such as rotary guided system (RGS). This new drilling technology allows you to create a detailed model of the borehole zone, based on the information received from the sensors of the geonavigation system of the drilling tool. Innovative drilling technologies allow drill masters to open oil and gas bearing interlayers with a thickness of 0.5 m and fall into a 2 meter target tolerance circle at a depth of several km from the earth's surface (Figure 2). Drilling of these wells allowed to reduce by 3-4 times the number of design wells in the above fields [8-10].

Snake wells first found their application in Brunei fields in 2003. The first was the Iron Duke field (Iron Duke), in which the "snake" well was drilled through the entire productive area with a capacity of 28 meters, a length of

2 km and a horizontal length of 300 meters. At the same time, it was possible to avoid getting into the nearby gas layer. Drilling a snake well contributed to an increase in oil production by 15% and water breakthrough occurred two years later than the design. Similar performance was achieved using snake wells in the Champion West field, the reservoir of which included 11 separated from each other formations. The well at this field provided oil production of 3,500 tons / day. Each snake well works like three traditional vertical wells, and helps to reduce well construction costs by more than 15% [9, 10].

The development of the Champion West field has shown how effective new technologies can affect the production of oil and gas deposits, previously recognized as economically inexpedient for development. Commodity products in the third phase of the project for the development of the field began to arrive in early 2006, with a significant lead over the work plan. The field is located at a distance of 90 km from Brunei and is the richest resource potential of countries with reserves that can satisfy the needs of the population for 20 years [9, 10].

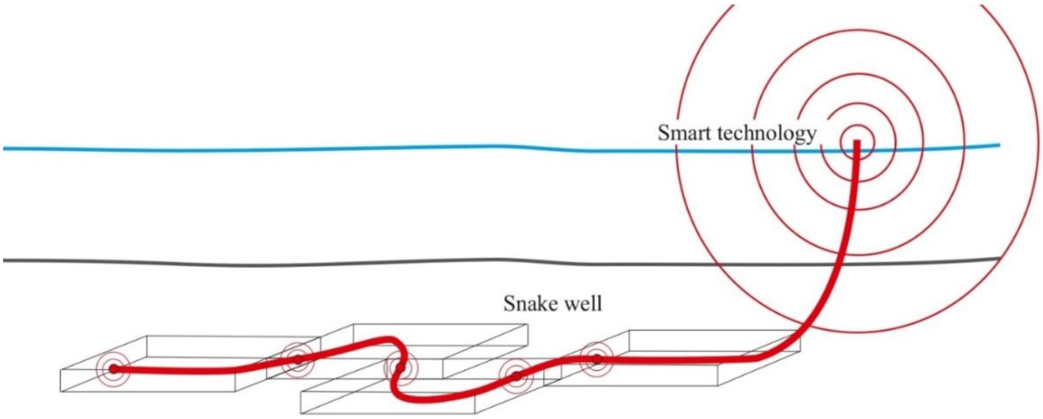


Figure 1: Snake well (modified from Eremin et al., 2012)

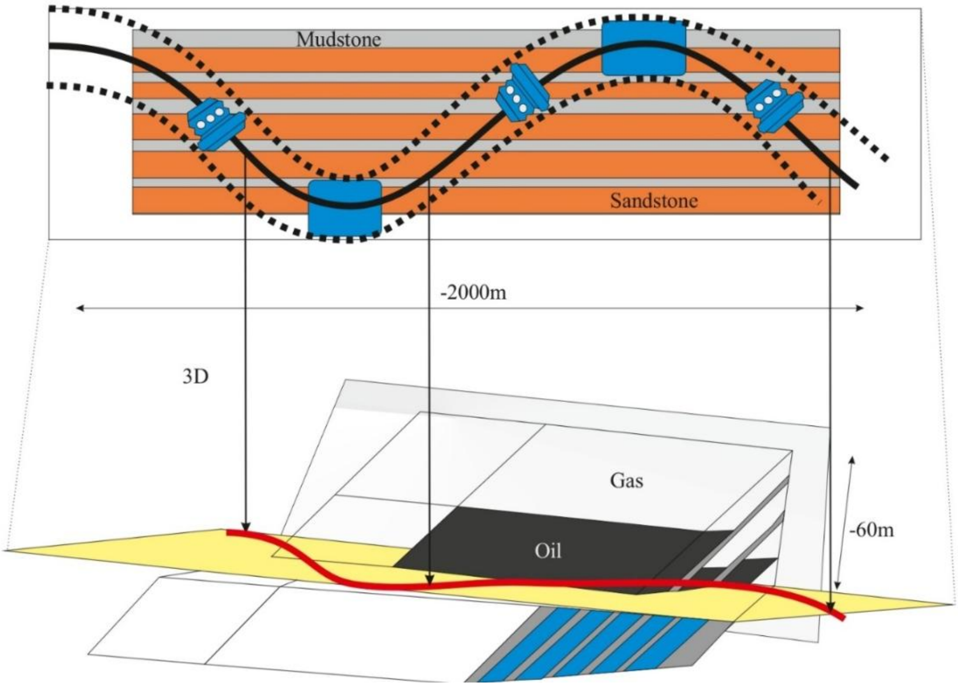


Figure 2: Schematic illustration of a snake well in the Brunei field [http://www.epmag.com]

Another type of smart well is a *bionic well*. A bionic well consists 100-150 of a smart side branches that contains an electric detector running on battery power (Fig. 3). Increasing the coverage of heterogeneous carbon layers, complex-built carbonate, is the main objective of the bionic well. Saudi Aramco has drilled 3 of these wells [7].

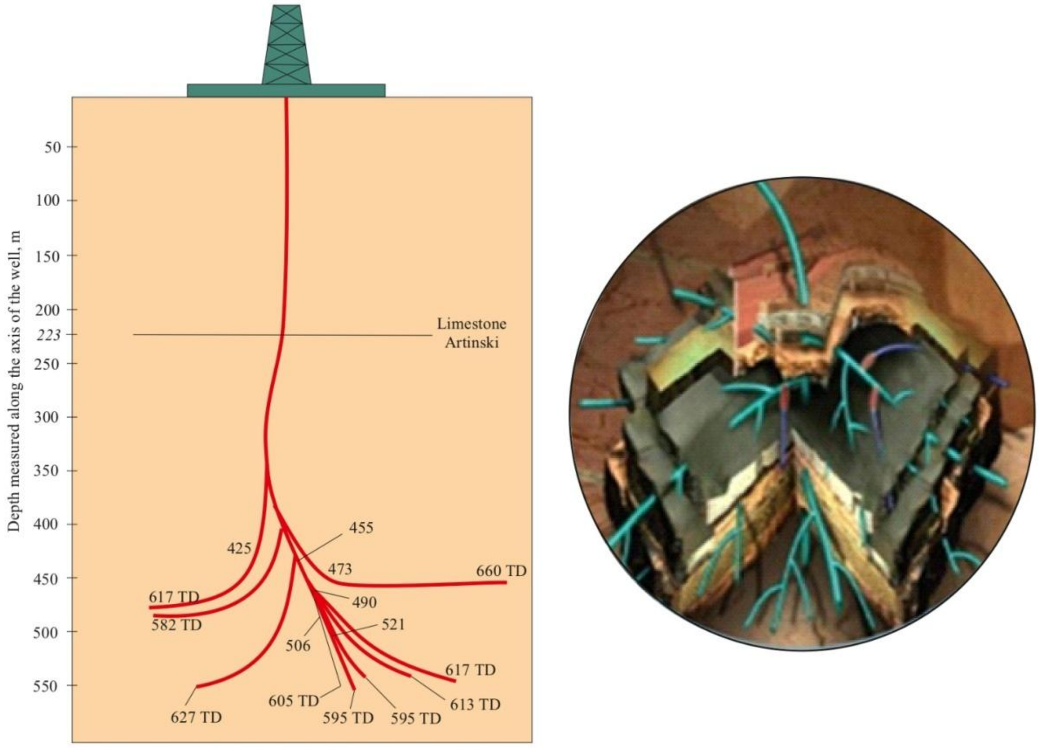
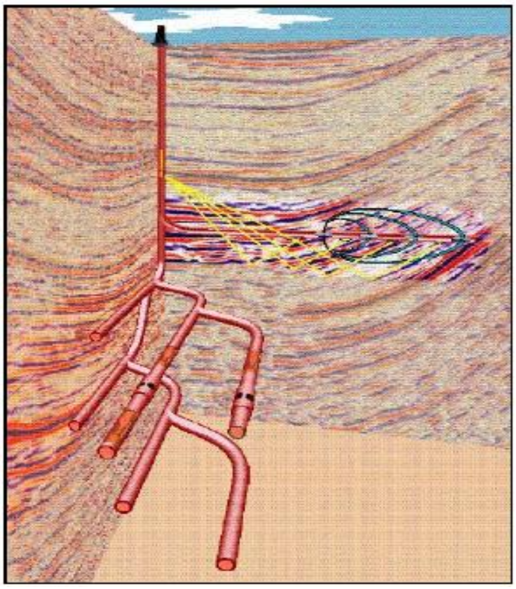


Figure 3: Bionic well (modified from Carvajal et al., 2014)

Smart multi-zone well. In each perforated area of the well, the valves are controlled from outside (see Fig. 4). Such as this management give rise to a reduction in the number of well servicing and workover for the whole life of the field, and well fixing up themselves become meaningfully effective and safe. Smart perfecting of wells makes it possible to monitor and control the bottom of the well to immediately respond to the exit from the technological design regime of reservoir development and constantly regulate the volumes of injected water and oil extraction for each zone of the reservoir (Fig. 4-5) [6].



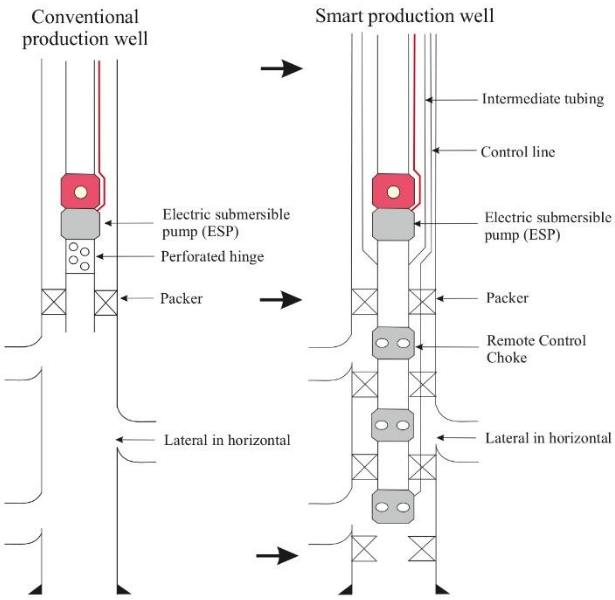


Figure 4: Smart multi-zone well [6]

Figure 5: Smart completion [6]

Smart Wells of the First and Second Generation

The first generation smart well is a well equipped with a continuous monitoring system and a manual inflow control system. The second generation smart well is equipped with a continuous monitoring system (distributed fiber optic sensors) and an inflow control system (> 24 zones) that can operate without human intervention. In table 1 shows the main differences between the wells of the first and second generations [8].

Table 1: The main differences between the wells of the first and second generations [8]

Characteristics	First generation	Second generation
Number of sensors	<45	<10 000
Type of sensors	Electric, quartz, piezoceramic,	Fiber optic
Sensor Location	Dotty	Distributed
Number of valves	<5	24<
Control	Manual control	Automated control

The second-generation smart wells are designed for continuous monitoring and control of the well throughout its life, from the cementing stage to its destruction. In general, the smart well consists of three basic elements: a fiber optic cable with tens of thousands of Bragg sensors, a ground control unit; a system for processing, modeling and analyzing the condition of the well. The second-generation of the smart well is perceptive to all kinds of distortion, such as axial compression, curve, temperature and pressure changes. The technology allows monitoring changes in casing shape continuously with a high spatial precision of up to 1 cm and a high-precision measurement of subspecies. In the first stages of field evolution, it is easy to recognize and measure geomechanical loads. The amiss of second-generation for smart wells is to increase the level of hydrocarbon production through a fast and informed decision-making process that relies on good data processing in real-time. In 2008, the first second-generation smart well was successfully tested in a gas production well to monitor good construction completion and long-term monitoring of well condition during production [8].

Additional oil production is based on the analysis of horizontal wells and devices for controlling the influx of products with a fixed number of conditions in smart wells [5].

Advantages of using smart wells are the ability to obtain information about the operation of wells and depleted reservoirs, the implementation of the principle of direct measurement, reduction of oil and gas losses. Some service companies (Schlumberger, Roxard, Baker, Weatherford, etc.) offer their solutions for deep measurement systems and remote well monitoring systems. Smart well equipment includes all point and distributed sensors (fiber optic DTS); standalone and remote (on cable or wireless). The concept of smart wells implies not only a remote way of measuring well parameters, but also feedback, which provides for the operational use of accumulated information, optimization and control of work in the field of product selection. The most commonly used in smart wells are depth sensors: temperature, pressure, water, flow rate. The range of specialized sensors consists of a fiber optic thermometer-manometer, various pressure gauges, resistance logging, gamma and neutron logging, spectral sensors, etc. [1].

Perspective areas of technology for creating smart wells include: the development of an integrated control system for reservoirs, wells and surface systems for collecting and preparing commercial products. In the near future, the emergence of systems to intensify the composition and composition of three phase liquids both in wells and in commodity production collection systems is possible [9, 10].

Expert View

The premier smart well was inducted on the Saga Snorre Tension Leg platform in the North Sea [11]. Smart well technology is used by Salym Petroleum Development. At the Salym group of fields, pilot production of smart wells began in 2006.In the next 5–7 years, an increase in the volume of annual drilling of wells with smart completion from 200 to 500-550 wells should be expected (Fig. 6-7). The introduction of second-generation smart technologies will increase the average oil recovery from the current 30-35% to 50% [7].

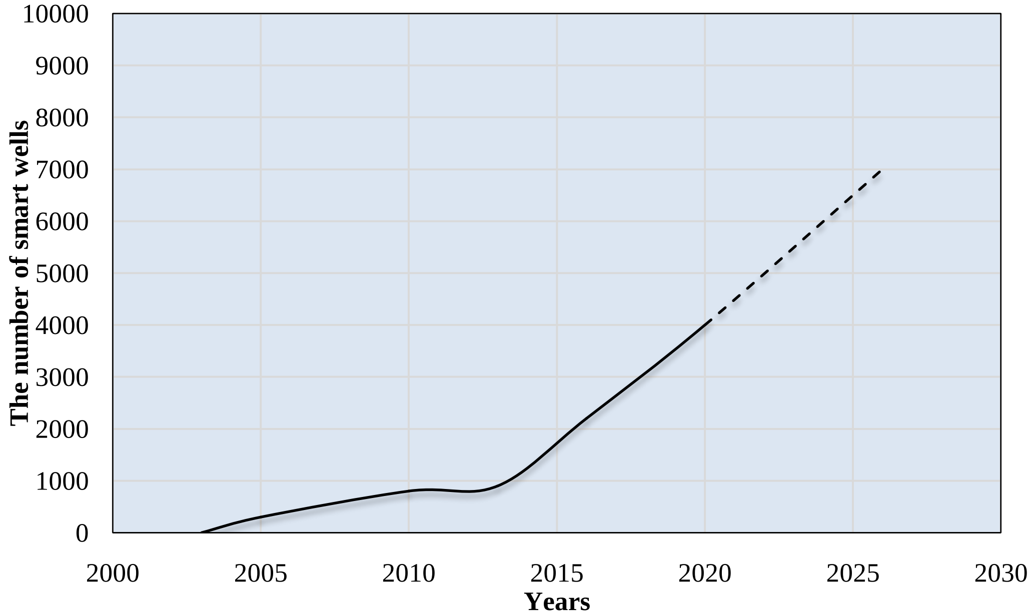


Figure 6: Number of first generation smart wells

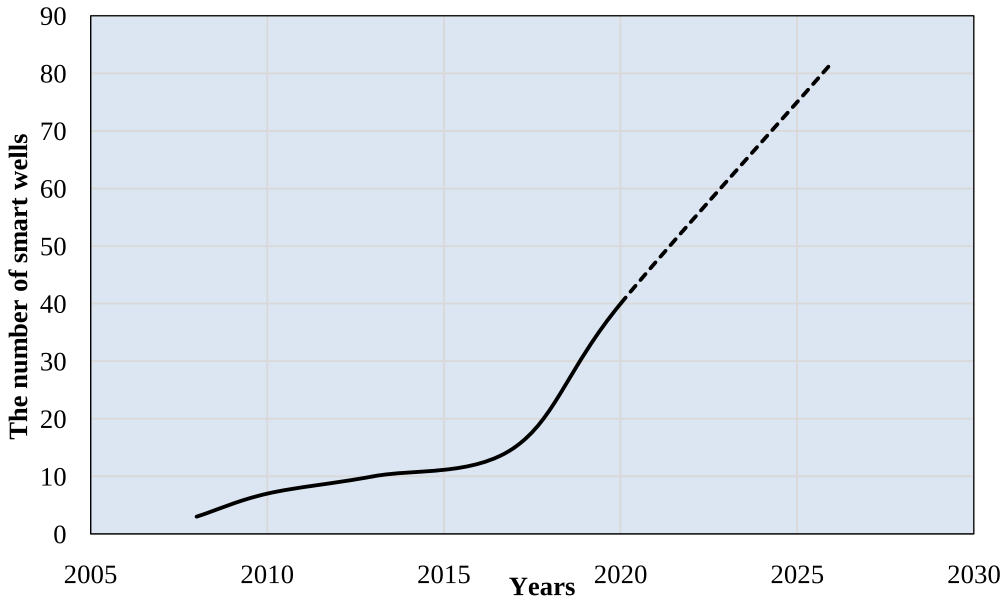


Figure 7: Number of second generation smart wells

Conclusion

Analyzing the available data, it can be assumed that in the next 5-7 years the number of smart wells of the first generation might be reach about 7-10 thousand wells, and the number of smart wells of the second generation might be 80-100 wells.

References

[1]. A. Ekebafe, A. Ogan, "Smart well Technology Application in Deepwater Field Development", *SPE Nigeria Annual International Conference and Exhibition*, Lagos, Nigeria, 2012.

[2]. A.I. Ipatov, M.I. Kremenetskiy, V.N. Chernoglazov and A. Gorodnov. Monitoring of hydrodinamic parameters of commingled oil reservoirs, *SPE Russian Oil and Gas Conference and Exhibition*, Moscow, Russia, 2010.

[3]. A.N. Eremin, A.N. Eremin, N.A. Eremin, *Smart fields and wells*, Almaty: Center of Kazakh-British

Technical University, 2013, p.320.

[4]. Al. N. Eremin, N.A. Eremin, Current state and prospects of development of intelligent wells (In Russ.), *Neft'. Gaz. Innovatsii,* 12, 2015, pp. 50–53.

[5]. D. Gulyaev, A. Ipatov, V. Krichevskiy, "Smart wells is a key to production enhancement from low permeable", *One Petro*, 2012.

[6]. J.D. Jansen, A.M. Wagenvoort, V.S. Droppert, R. Daling and C.A. Glandt, Smart Well Solutions for Thin Oil Rims: Inflow Switching and the Smart Stinger Completion. *SPE Asia Pacific Oil and Gas Conference and Exhibition*, Melbourne, Australia, 2002.

[7]. G.A. Carvajal, I. Boisvert, S. Knabe, "A Smart Flow for Smart Wells: Reactive and Proactive Modes", 2014.

[8]. N.A. Eremin, Al. N. Eremin, An. N. Eremin, *Management of the development of intellectual fields*, Moscow: Publ. of Gubkin Oil and Gas State University, Part 2, 2012, p.210.

[9]. S.N. Garichev, N.A. Eremin, *Tekhnologiya upravleniya v real'nom vremeni* (Real-time management technology), Moscow: Publ. of MPTI, 2013, Part 1, p.196.

[10]. S.N. Garichev and N.A. Eremin, *Technology of management in real time*, Moscow: Publ. of The Moscow Institute of Physics and Technology, 2015, Part 2, p.167.

[11]. Y. Shuai, C.D. White, H. Zhang and T. Sun, "Using Multiscale Regularization to Obtain Realistic Optimal Control Strategies," *One Petro* 142043-MS, Proc. SPE Reservoir Simulation Symposium, 2011.