

# Steam-assisted gravity drainage technology enhancement

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**Abstract.** A hydrodynamic model of a region of Yaregskoye heavy oilfield was build. The results of the simulation have shown that injection capacity along the wellbore of a horizontal well is not uniform. It is determined by the geological heterogeneity of the formation. Therefore, there is importance of enhancing SAGD technology for Yaregskoye oilfield. A new technology was created. The efficiency of the technology is proved by numerical modelling. Horizontal injector and two-wellhead production wells penetrate the formation. Horizontal sections of the wells are located one above the other in the payzone. Wells are divided into two sections. Those sections work simultaneously and independently of one another. This technology allows to increase oil recovery of the oilfield.

## 1. Introduction

Steam-assisted gravity drainage is one of the most perspective technologies for heavy oil and bitumen production from horizontal wells. In 1968 this process was initiated in Yaregskoye oilfield in thermal mine modification. In modern modification SAGD was developed by R.M.Batler in 1978. Predominantly, nowadays SAGD is used in Canada. In Russia, SAGD is implemented in Komi Republic (Yaregskoye and Usinskoye oilfield) and Republic of Tatarstan (Ashalchinskoye oilfield). [2, 3].

## 2. Study of SAGD mechanism

For the purposes of the study of SAGD mechanism, a geological model with a help of IRAP RMS of Roxar was built on the section or Yaregskoye oilfield. A sector of the following section was chosen for modelling. Calculations were conducted in hydrodynamic simulator STARS of CMG. Grid block size of the model: 10x10x0.5 m. The number of grid blocks along the horizontal axis: 119x7. The number of vertical layers: 90. Total number of grid blocks: 74970. Permeability varied between 1 and 32000 mD.

The model has 2 horizontal wells. Distance between the horizontal sections of the wells located one above the other – 5 meters. The length of horizontal sections – 1000 meters. The upper well is injector, the lower is producer respectively.

Well constrains:

- Maximum injector BHP: 2500 kPa
- Steam quality: 0.7
- Minimum producer BHP: 600 kPa
- Maximum surface liquid rate: 150 m<sup>3</sup>/day

The length of simulation was 12 years. Oil recovery coefficient reached 15.69% and cumulative steam/oil ratio composed 3.8 ton/ton. The results of the simulation have shown that injection capacity



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along the wellbore of a horizontal well is not uniform. After 5 years of injection, steam moves toward more permeable zones. Actual measurements of temperature and conducted geophysical studies of horizontal production wells have also shown uneven heating of the formation (figure 1).

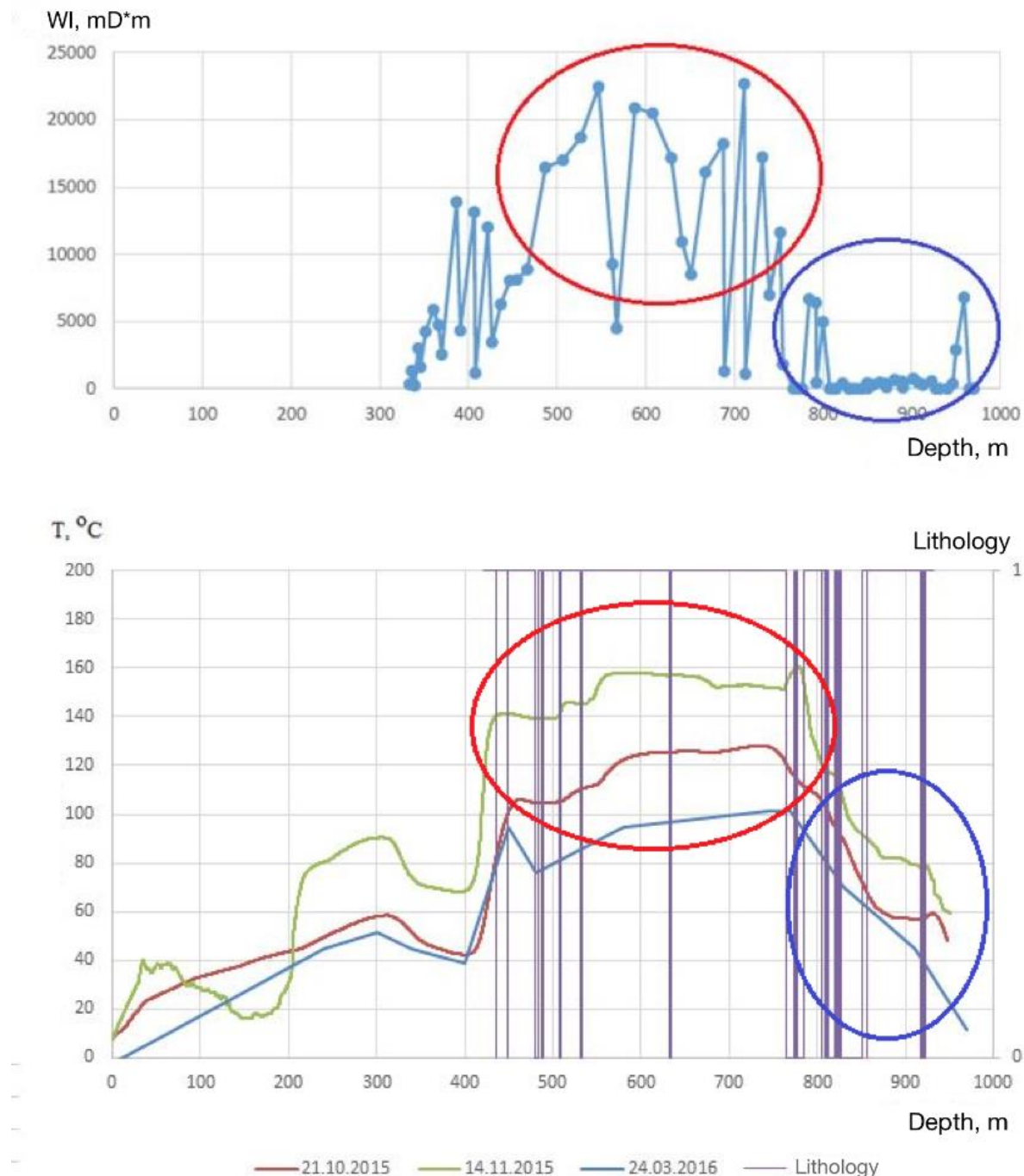


Figure 1 – Calibration of actual temperature measurements with geophysical analysis and WI index in well N.

Results of geophysical studies have shown the distribution of lithology parameter along the wellbore. Value 0 stands for non-collector, value 1 – collector respectively.

Hydrodynamic simulator CMG calculates WI index of the well automatically in every grid block that well penetrates.

Figure 1 shows that high temperature zones coincide with zones having high WI index of the well. Thus, index of the well determines inflow intervals of the reservoir fluid toward horizontal producer wells. Also, it can be noticed that in the zones of heterogeneity (layering) of the formation, development of the steam chamber zone is impeded. SAGD is a very sensitive technology for heterogeneous reservoirs. Thus, there is a high importance of pressure alteration control along the wellbore. Therefore, SAGD technology for conditions of Lyaelskaya sector needs certain optimization.

### 3. Steam-assisted gravity drainage technology enhancement

In order to enhance SAGD technic for conditions of Yaregskoye oilfield a new technology was developed. The technology is based on differential steam-assisted gravity drainage of the formation (DSAGD).

Technology includes drilling of horizontal injector and two-wellhead producer wells. Horizontal sections of the wells are located one above the other in the payzone. The upper well is injector, lower well is producer respectively. Wells are divided into two sections. Section of the injector is located right above the section of producer. Those sections work simultaneously and independently of one another.

Probable construction of injector well is depicted on figure 2.

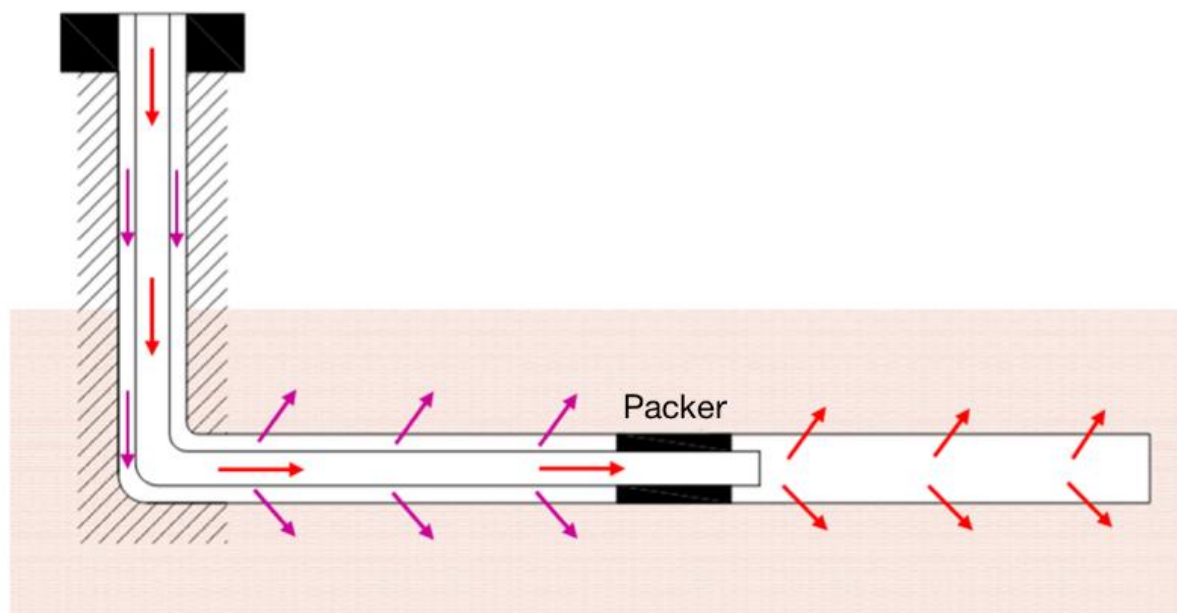


Figure 2 - Probable construction of injector well

In order to divide the sections of producer wells, an installation of a packer in the central part of the horizontal borehole is needed. Oil is produced through both wellheads (figure 3).

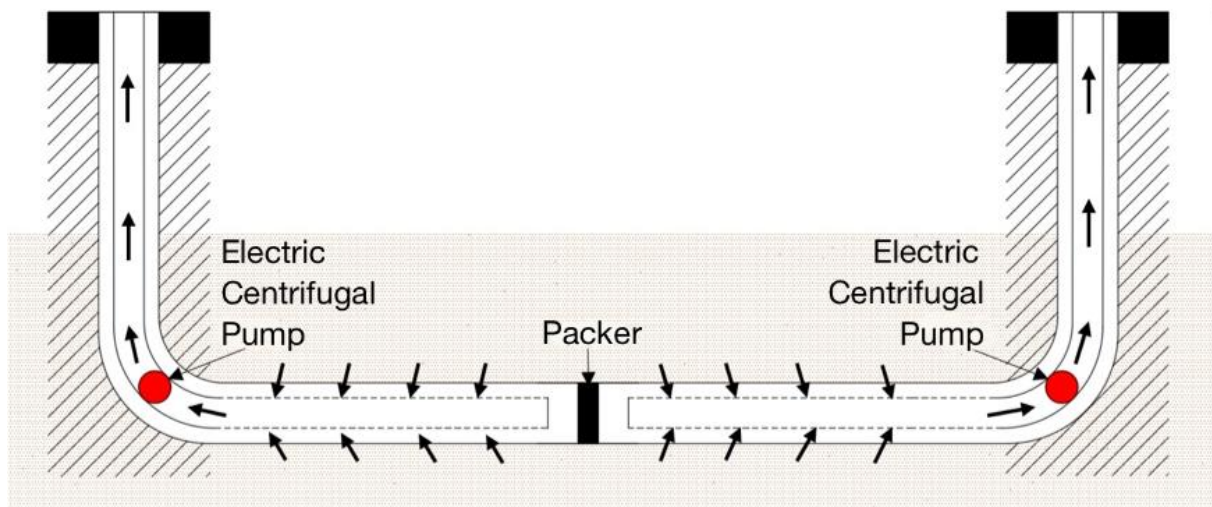


Figure 3 – probable construction of producer well

The following technology allows to increase oil production and enhance thermal sweep efficiency of the formation due to redistribution of the pressure in the formation.

The efficiency of the technology is proved by numerical modelling. For the purposes of the experiment, analogues model of the sector of Yaregskoye oilfield was created. Horizontal wells are divided into 2 sections each having 500 meters in length. The length of modelling composed 12 years as well.

Comparison of the temperature distribution in the formation using SAGD and DSAGD is depicted on figure 4.

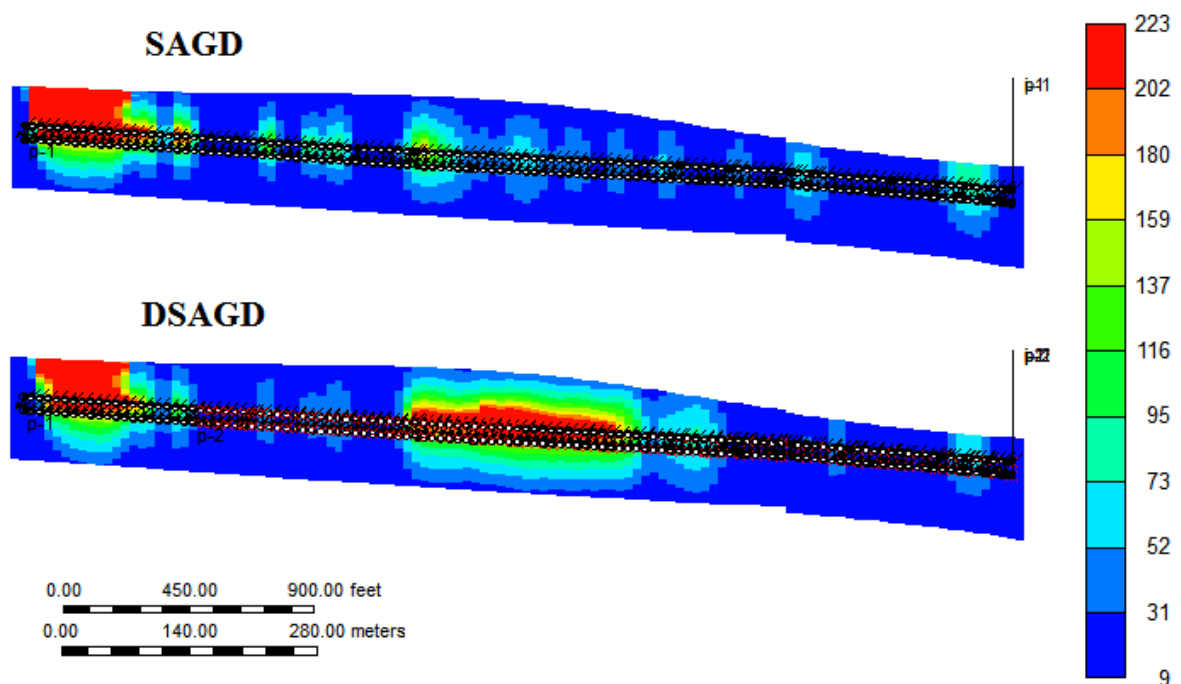


Figure 4 – Temperature distribution in the model after 2 years

Control of process of steam injection into horizontal well allows to enhance thermal sweep efficiency of the formation. Recovery factor using DSAGD reached 28.4%, steam/oil ration composed 2.82 ton/ton.

#### 4. Conclusions

Mechanism of SAGD in conditions of Yaregskoye oilfield shows that the process of steam chamber distribution will depend on geological features of the formation. Actual temperature distribution along the wellbore of production well and conducted geophysical studies also proved the above stated conclusion. In the process of steam injection, steam chamber accumulates in the zones having high WI index. Therefore, the following zones need differential approach. In order to implement this approach, DSAGD technology was developed.

The following technology allows to increase recovery factor and enhance thermal sweep efficiency of the formation due to redistribution of the pressures in the formation. For the rector of Yaregskoye oilfield, the increase of the recovery factor composed more than 12.7% in comparison with conventional technology.

Magnitude of the following increase also depends on the number of sections. Therefore, development of technologies for implementation of smart wells in Yaregskoye oilfield is actual problem.

#### References

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