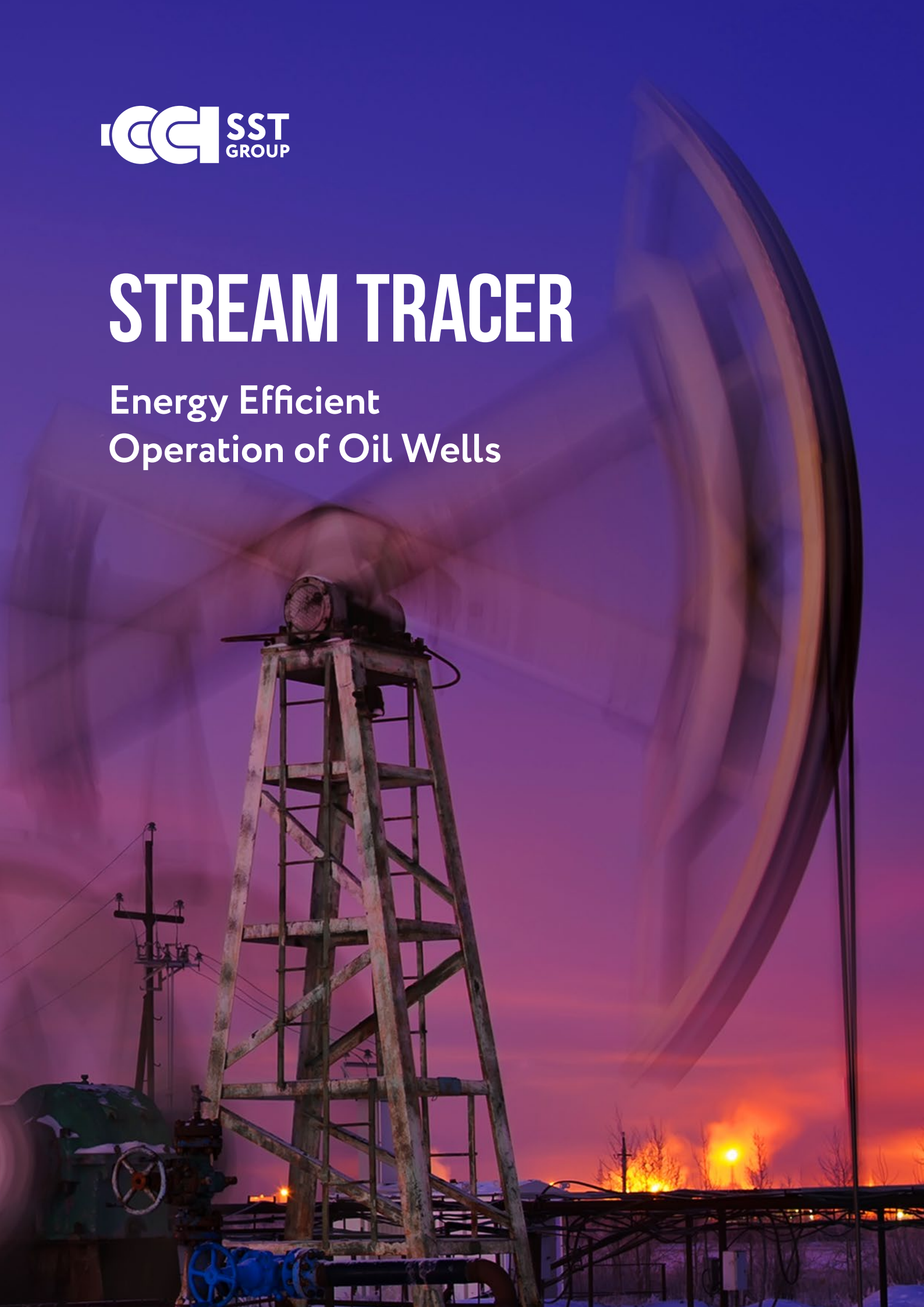
SST GROUP

STREAM TRACER

Energy Efficient Operation of Oil Wells



Growing Importance of Heavy Crude Oil Extraction

Experts predict that by 2050, global energy consumption will grow by 100%, compared to its current level. Despite the rapid development of alternative energy sources, oil remains the main source of energy.

In order to meet society's energy needs, the global oil complex is paying more attention to non-traditional costly and inaccessible sources of hydrocarbons. Heavy oil and gas hydrates in a climate of ever-depleting conventional crude oil reserves are becoming increasingly important in the global economy. Their mining is still difficult, but it has already become profitable.

According to various estimates, heavy oil and natural bitumen reserves range from 790 billion tons to 1 trillion tons, which is 5-6 times greater than the residual recoverable oil reserves of low and medium viscosity, which amount to about 162 billion tons. Proven reserves of heavy oil and natural bitumen are much smaller, but these stocks are 6% higher than the known reserves of light and medium oils.

Venezuela, Canada and Russia possess the largest reserves of heavy oil and natural bitumen. After the depletion of global reserves of conventional oil, and subject to the effective application of production methods of heavy oil and bitumen, these countries will be able to strengthen their positions in the global energy market.

The oil extraction industry is interested in technological solutions that will increase the profitability of heavy oil production. One of these solutions is Stream Tracer – a system dedicated to the protection of wells from asphaltene-resin-paraffin-deposits (ARPDs) based on a flexible self-supporting cable skin-heater.

World's reserves of heavy crude oil:

up to 1 trillion tons

Russian reserves of heavy crude oil:

55 billion tons

In the world practice, the following classification is used most often:

- Heavy hydrocarbon oils are considered those with a fluid density of 920-1000 kg/m^3 and a viscosity of 10 to 100 mPa•s.
- The natural bitumen include slow-flowing or semi-solid mixtures of predominantly hydrocarbon composition with a density of 1000 kg/m^3 and a viscosity above 10000 mPa•s.
- An intermediate group between the bitumen and heavy oils is the so-called super-heavy oil, with a viscosity of 100 to 10,000 mPa•s and a density of around or significantly greater than 1000 kg/m^3. Heavy and extra-heavy oils are often combined under the title of «heavy or highly viscous oils».

Wax Formation Prevention in Oil Wells – Critically Important Task

The problem of ARPDs in oil producing wells has long been documented. It is related to the fact that, through the lowering of the temperature and degassing of the fluid that rises up the tubing, oil loses its ability to dissolve the paraffin and resin contained in it. During the extraction of paraffin oil, the paraffin and tar deposits build up on the tubing walls in the upper portion of the borehole. Due to this, the tubing cross-section is narrowed, fluid movement resistance increases, increasing the load on the pump. The problem of ARPDs leads to negative consequences, such as:

- decline in oil production
- inefficient use of oil resources
- premature failure of expensive equipment
- reduction in equipment servicing intervals
- deterioration of technical and economic indicators of deposits

Main Factors of the Fluid Temperature Drop:

- Geothermal gradient around the oil well
- Thermal resistance of the oil well
- Well production rate
- Dynamic fluid level inside the pipe

Wax Formation Main Factors:

- Wax oil ratio
- Temperature drop inside the borehole
- Pressure drop in the borehole
- Produced gas oil ratio

Methods to Prevent ARPDs Formation

To resolve the problem of ARPDs in oil producing wells, the following methods are currently being used:

- Mechanical method with the use of dewaxing units (DU)
- Steam tracing
- Chemical method

Each of these methods has its advantages and disadvantages.

Mechanical method with the use of dewaxing units (DU)

The most common cause of oil wells shut down due to wax accumulation is dewaxing unit failure (53,6% of total number of failures). It includes failures of levelwind system to operate, DU electric engine failure, seal failure, malfunctions of control station and many more. This method has inherently low reliability.

Steam tracing

Using of steam produced by mobile steam generators of PPUA-1200/100 with output steam temperature of up to 310°C and pressure of up to 10 MPa are efficient only up to a depth of 300-400 m. Hot oiling is energy-consuming, time between treatments is normally 90 days. This procedure is efficient only with the application of chemical agents. This method shows low efficiency.

Chemical method

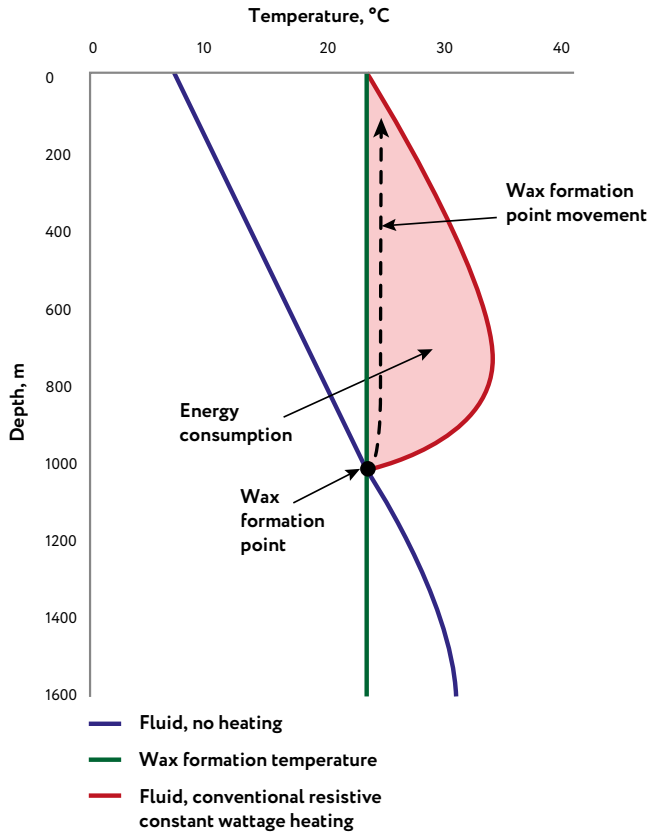
Application of cheap solvents based on raw materials used in petrochemical and oil refining production makes it possible to solve and carry to surface not more than 40% of asphaltene-resin-paraffin deposits. The rest wax remains on the well walls and on impellers of centrifugal pump unit. In view of incomplete removal of the asphaltene-resin-paraffin deposits, it may become necessary to trip the equipment out of hole for repair. This method is also not optimal.

The most effective way of heat treatment is heating the borehole with an electric heater.

Downhole Heating Systems: Conventional Solutions

Electric cable heating systems for wells have been used in oil fields in Russia since the early 2000s. The main objective of such systems is to maintain the temperature of a moving fluid above the temperature at which paraffin deposits occur.

Two- or three-core resistive constant wattage cables are usually used for heating wells. These heating cables solve the problem of heating, but are not optimal in terms of energy efficiency. The length of heating cables is selected by a wide margin. The cable heat output is often determined only by the thermal stability of the cable insulation and not the actual heat loss of the fluid in the tubing.



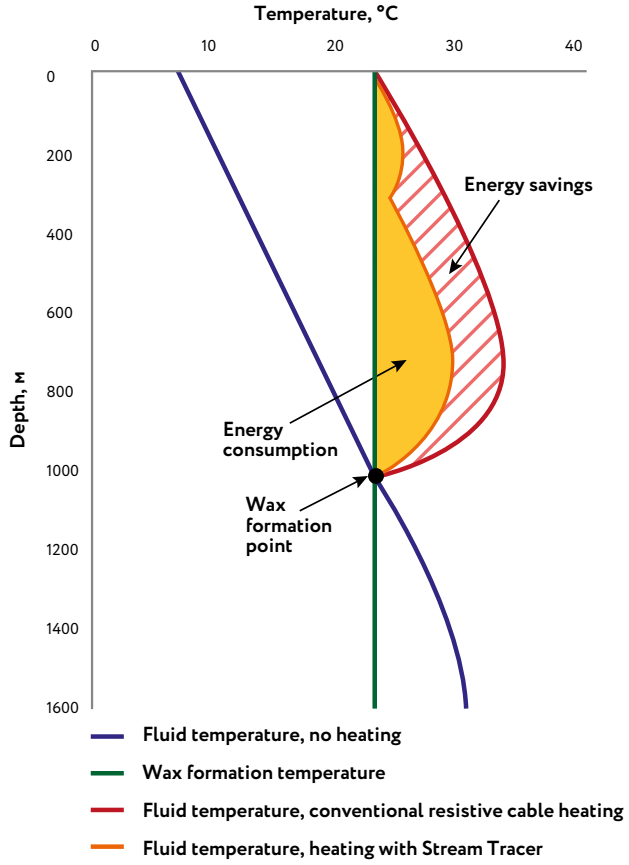
Distribution of the fluid temperature along the depth of the well during heating by resistive cable

External boundary conditions, determining tubing heat loss, vary along to the depth of the well. The geothermal curve of the ground has an incline of about 20 - 30°C per kilometre. Accordingly, heating of the well by a heating cable with constant linear output over the entire length results in excessive energy consumption of the electric heating system.

Stream Tracer: Energy-Efficient Solution

Optimal in terms of energy consumption is a solution in which the heating system operates only in the zone where the temperature of the fluid under normal conditions is below that which allows for the build up wax deposits, while the heating cable has a variable heat output along the well depth. Moreover, the heat output of such cable should vary gradually over a wide range: the linear output of the lower part of the cable should be close to zero, while near to the ground level the output of the cable can reach 70 W/m.

Development of such design of the heating cable is a highly challenging engineering task, especially taking into account the set of requirements that apply to the borehole cable. We managed to solve this problem and to develop a flexible self-supporting cable skin-heater as well as a comprehensive solution to protect wells from ARPD based on it.



Energy efficiency of using Stream Tracer in comparison with using of resistive cable

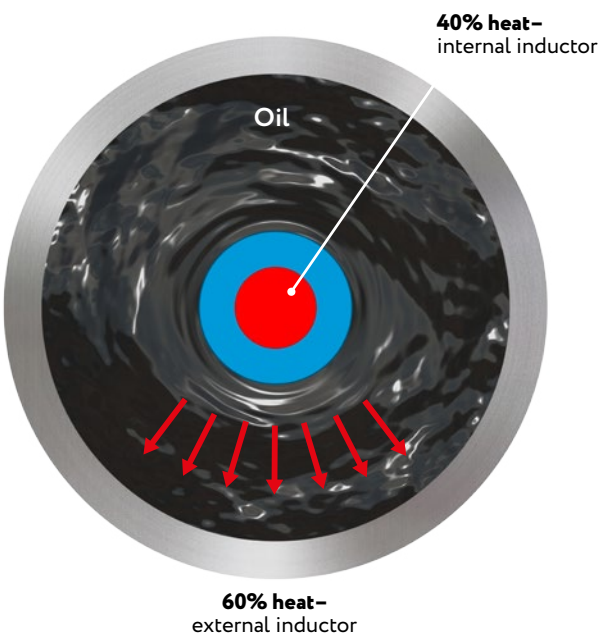
In 2015, SST Group specialists developed and presented a comprehensive solution for the protection of oil wells from ARPD.

The "heart" of the system is a special self-supporting flexible skin-heater. The heater has zones with high and low power output, which can significantly reduce the power consumption of the well heating system. SST Group experts are the first in the world to have developed and patented a solution to heating oil wells with skin-heaters.

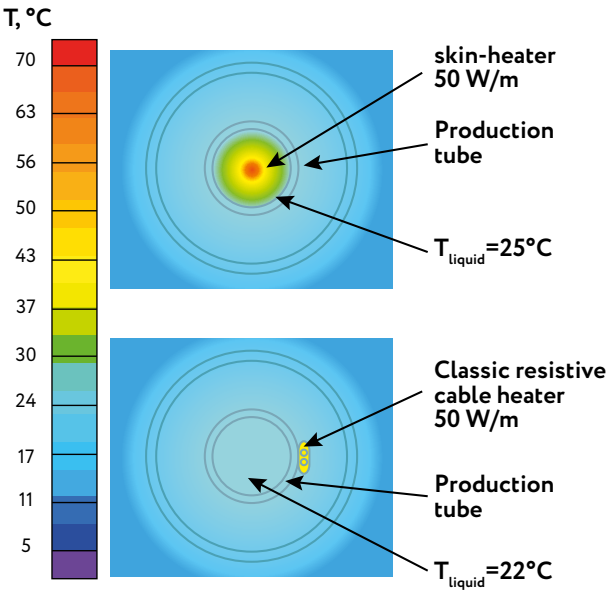
The skin-heater has coaxial design, and heat is released by current flow in the conductors, as well as through currents induced in a complex outer conductor. This solution improves the efficiency of heat transfer from the heater to the oil fluid in comparison with classical resistive electrical heating systems.

Separation of the heating cable into different power zones leads to a decrease in the level of fluid overheating and improves the technical and economic indicators of deposits. The application of the SST Group original heater with power output varying along the length allows for the reduction in electric-power consumption of the borehole heating system by almost 50%.

The heater has been developed with benefits such as increased flexibility, mechanical strength, and the possibility of adjusting the heat lengthwise that allow the use of our solution not only to prevent the formation of ARPD in oil wells, but also to prevent the formation of gas hydrates in gas wells for heating submarine pipelines and pipelines in sites across rivers.



Cross section of oil well tubing



Comparison of heating of oilwell tubing by SKIN heater and classic heater

Unlike classic electric heating, flexible skin-heater is placed inside the production tube, in direct contact with the fluid. This ensures better effectiveness of the skin-heater compared to other solutions.

- Increased flexibility
- Mechanical strength
- The possibility of adjusting the heat lengthwise
- Energy efficiency

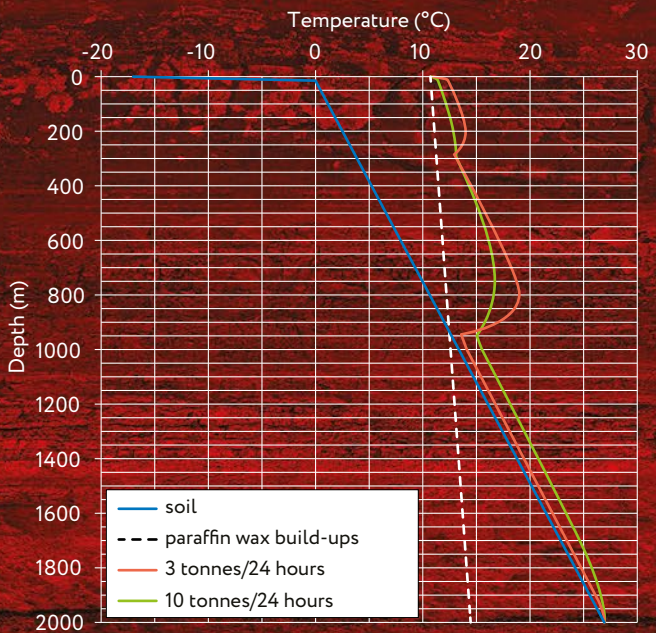
Technical characteristics of Stream Tracer

- Supply voltage: up to 1 kV
- Linear power: 50 W/m
- Heater length: 1.5 km*
- Resistance to the chemical compounds found in crude oil and fluids
- Maintains operability under external pressures of up to 150 atm and temperatures of up to 70°C
- Minimum installation temperature: up to - 25°C
- Minimum bending radius: 400 mm
- Remains in operation after 100 bends in the 400 mm radius**
- Crushing load: up to 12 kN (at the tripping speed up to 0.25 m/s)
- Tensile force: up to 28 kN
- Ingress protection rating: IP68

* A heater up to 3 km in length is currently under development.
** At positive temperatures .

Stream Tracer

Energy-Efficient Solution for Preventing APRDs Formation in Oil Wells



Stream Tracer – Energy Efficient Operation of Oil Wells

For more than 20 years, SST Group has been equipping the facilities of the largest Russian oil and gas corporations with heating systems. In most projects, we stand as an industry integrator which assumes all tasks related to the design, acquisition, logistics, installation and operation of electrical heating systems. Our wealth of expertise puts us at an advantage and represents significant value for customers.

Development of a unique heater with a power output varying along the length for heating wells is the first phase of our project. We set ourselves the task of coming up with a ready-made system that does not require the diversion of additional customer resources.

Use of this system based on a flexible self-supporting cable skin-heater increases the turnaround time of the well and improves the efficiency of energy use. Thus, our solution allows customers to reduce the cost of the well operation and reduce the negative impact on the environment.

Our solution is a mobile well heating unit based on cargo-terrain vehicles. The list of such an equipment module includes a heating cable for heating wells, power transformer, heating control station, and a mobile system for the installation, commissioning and installation of the heating cable.

Scheme layout of Stream Tracer

Heating control station controls the entire system and allows both manual and automatic modes to:

- carry out and stop the supply of the electric current to the heating element;
- control the current flowing through the heating element;
- control the voltage applied to the heating element;
- adjust the temperature of the heating element in the borehole;
- turn off the heater when disabling the control station operation of a centrifugal pump;
- measure the temperature of the produced fluid in the thermowell located in the oil-gathering collector;
- measure and regulate the temperature inside a sealed cabinet station for heat control;
- automatically disconnect the power contactor (remove voltage from the power transformer and, accordingly, the heating element) from the industrial network in the presence of current leakage, as well as to control other devices in the system.

Special heating cable, installed with the use of a mobile complex, is placed inside the production tube. The borehole oil is heated to a temperature above the paraffin crystallization temperature, which prevents the formation of ARPDs.

Stream Tracer: Efficiency and Reliability

Effectiveness of Stream Tracer solution and reliability of all elements of the system has been confirmed by pilot tests carried out at the Kazakovsky PJSC "LUKOIL-Perm" oil field. The complex has provided an increase in the temperature of the oil produced at the wellhead from 7 °C to 22.5 °C, providing a stable production rate. Furthermore, the system energy consumption for maintaining an oil optimum temperature has decreased by 47% compared to heating systems based on a heater with uniform power output along its entire length.

Energy consumption for maintaining optimum temperature of the oil decreased by

47%

compared to constant wattage heating systems

Thus, the SST Group system of heating wells solves the problem of preventing the formation of ARPDs within an energy-efficient mode, without depleting customer time and manpower resources.

About SST Group

The Special Systems and Technologies Group of Companies (SST Group), founded in 1991, is the largest in Russia and one of the largest global providers of residential and commercial heating cable solutions and industrial heat tracing systems. SST products and solutions can be found throughout Russia and are exported to over 40 countries worldwide.

SST Group is a vertically integrated holding that employs over 1,300 specialists. The Group encompasses four production plants, an industrial R&D center, an engineering company, several distribution companies, and an international branch network.

№1 electric heating manufacturer in Europe*

Own production of conductive plastics and self-regulating heating cables

1 of 4 global manufacturers of skin-effect heating systems

40% Russian market of engineering in the field of industrial electrical heating and insulation

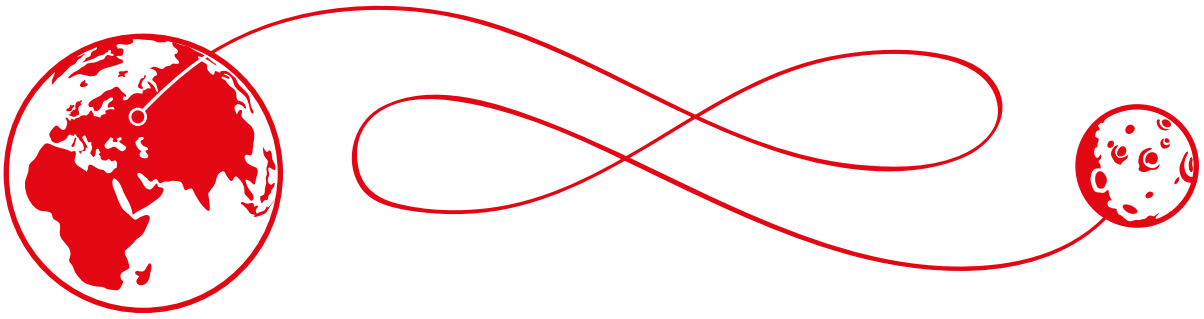
- **Founded in 1991**
- **1300 employees**
- **4 own plants**
- **9 branches**
- **7 subsidiaries**
- **Export to 47 countries**

40 000 m^2

production facilities

8 000

industrial heating systems installed



Total length of electric heating cables produced by SST Group exceeds

1 300 000 km

3 times longer than the distance from Earth to the Moon.

5 500 000 units

of temperature control equipment

* Global Electric Heating Cable Industry Market Research Report, QYResearch 2016

SST Group products are certified in accordance with international standards: VDE, SGS, Demko, NANIO CCVE. Industrial heating systems manufactured by SST Group have been certified by the International Electrotechnical Commission as suitable for use in explosive environments (IEC Ex). In 2013, the unified Quality Management System adopted by SST Group was certified in accordance with the new requirements issued as part of ISO 9001:2008 and GOST ISO 9001-2011.

SST Group is the largest Russian developer and supplier of integrated solutions in the field of electrical heating. More than 20,000 km of pipelines are heated by our systems. SST Group industrial pipeline and tank heating systems are used at the facilities of Gazprom, LUKOIL, Rosneft, Bashneft, Tatneft, Transneft, ALROSA, Total and many other companies.

Our Clients

Our systems are integrated into the majority of large cities' infrastructures. They are installed in thousands of buildings, including those of particular national significance: the Bolshoi Theatre, the State Duma of the Russian Federation, the State Historical Museum, Moscow City Business Center, Manezhnaya Square and many other sites.

SST Group is a member the Mocsow Chamber of Commerce and Industry, Academy of Electrotechnical Sciences of RF, International Association «Electrocable», Russian Association of Engineers for Heating, Ventilation, Air-Conditioning, Heat Supply and Building Thermal Physics. Our experts participate in the work of Technical committee for standardization, International Electrotechnical Commission and Committee for Standardization of the Russian Union of Industrialists and Entrepreneurs.

The Bolshoi Theatre

Moscow City business complex

Cathedral of Christ the Savior

6 Reasons to Work with Us:

1. Stable and sustainable business growth
2. Quarter century of success on the market
3. Own manufacturing, strict quality control procedures
4. Development and implementation of innovations, own R&D
5. Transparency and openness
6. Office in Europe, international team of professionals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