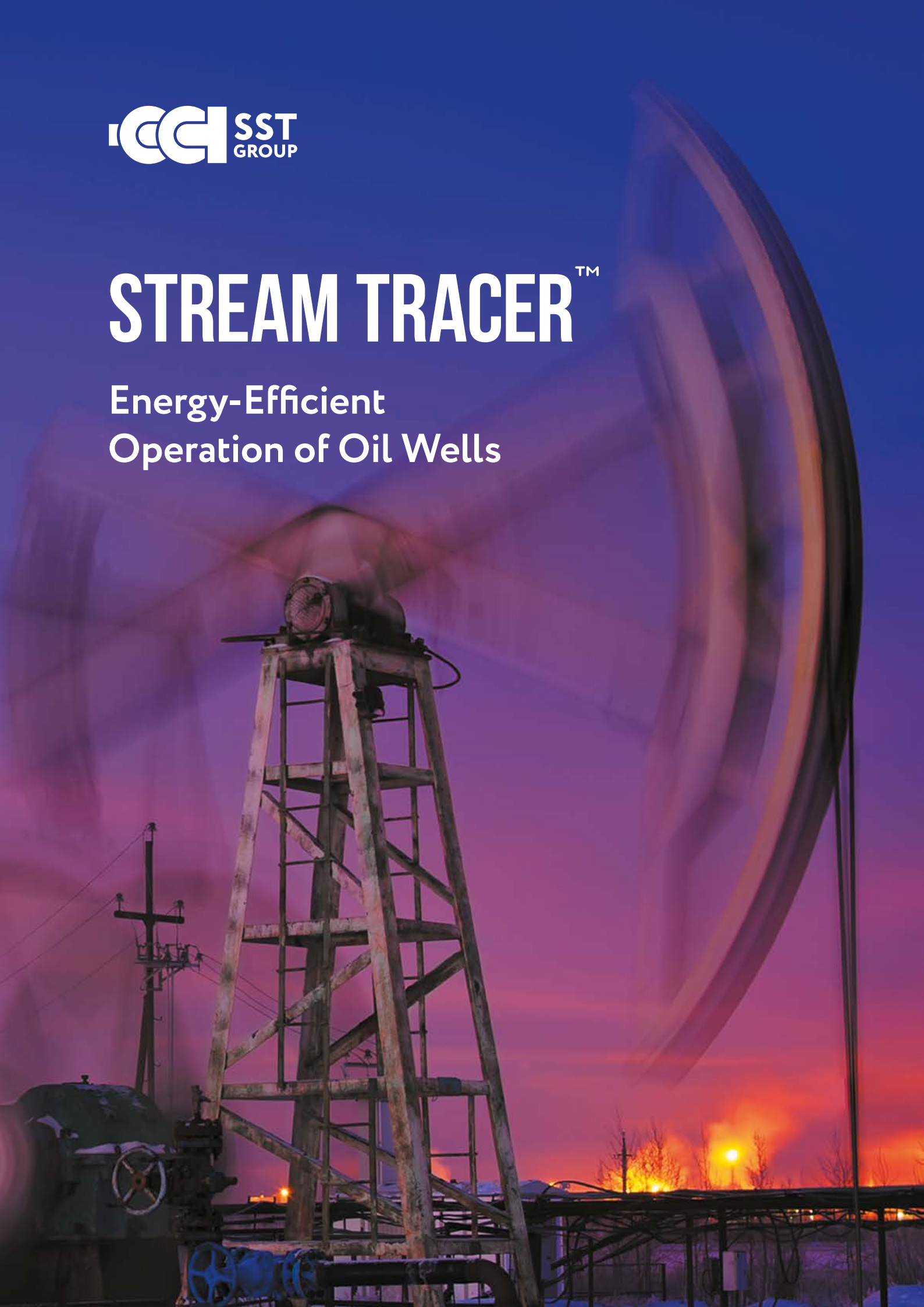




STREAM TRACER™

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/m³ 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/m³ and a viscosity above 10 000 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/m³. 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.



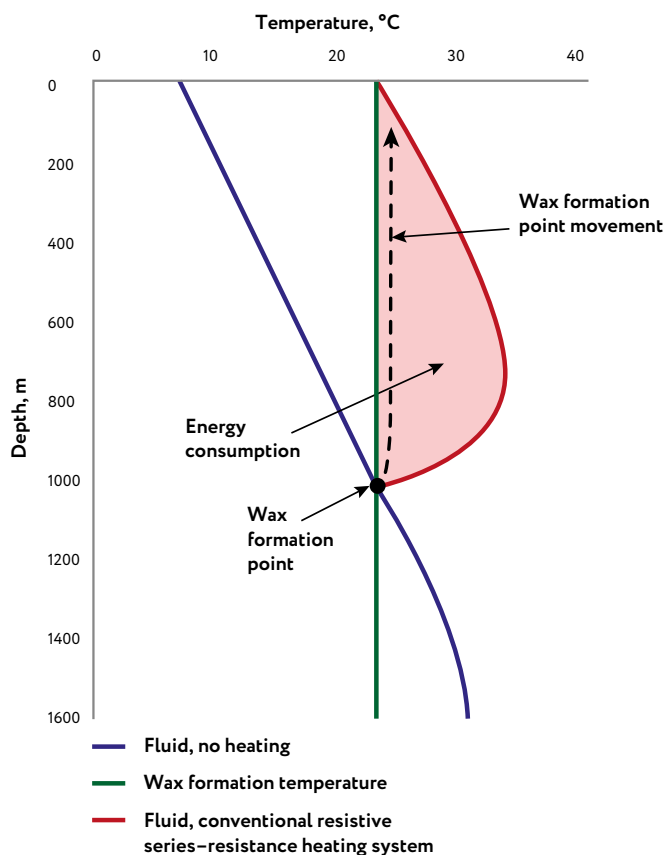
The most effective way of heat treatment is heating the borehole with an electric heater.



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 series-resistance 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.



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 kilometer. 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.

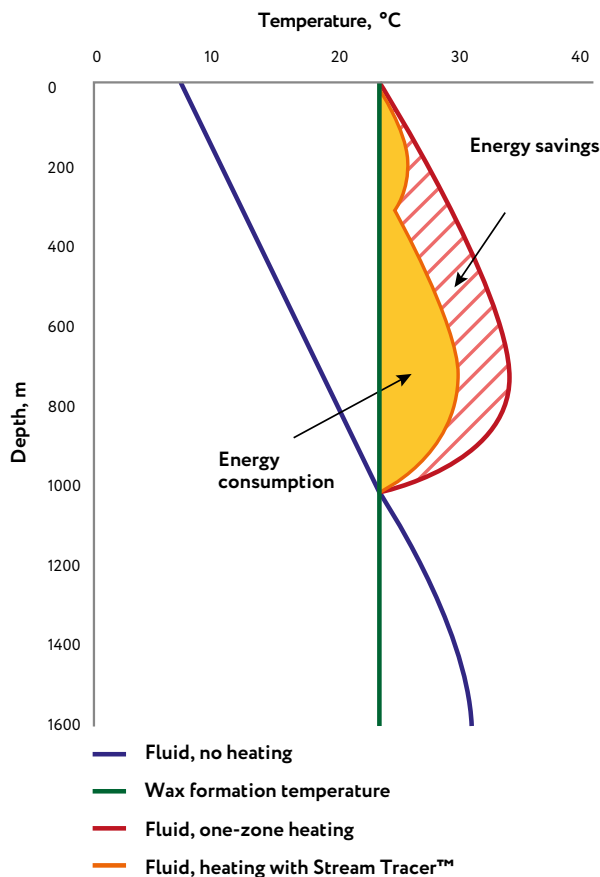
Distribution of the fluid temperature along the depth of the well during heating by resistive cable



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 series-resistance 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.

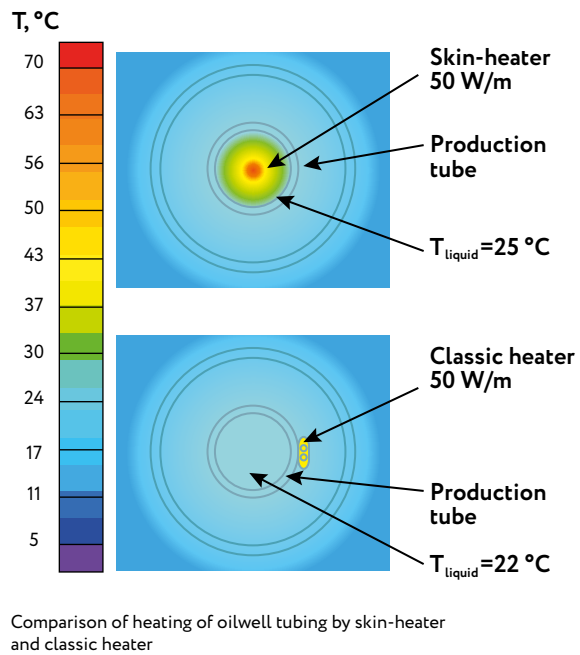
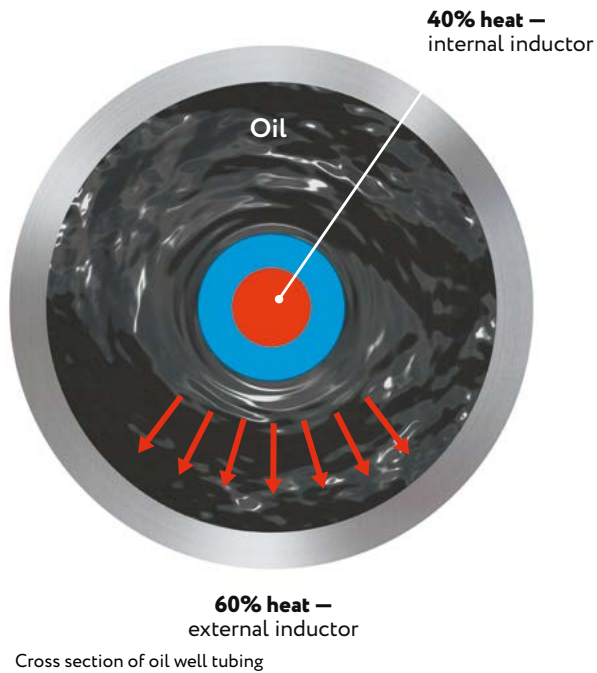
The skin-heater has coaxial design, and heat is released by current flow in the conductors, as well as through currents induced in a complex outer conductor. This solution improves the efficiency of heat transfer from the heater to the oil fluid in comparison with classical resistive electrical heating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

The well heating system Stream Tracer™ won ECO BEST AWARD 2018 in the Innovation of the Year nomination, the independent award recognizing the best products and practices in the field of environmental engineering, energy and resource saving.





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*
Minimum installation temperature	up to - 25 °C
Minimum bending radius	400 mm
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

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

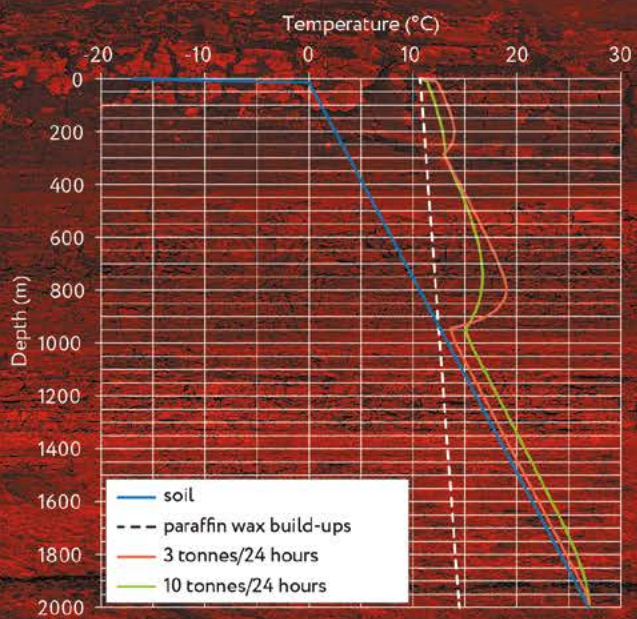
Remains in operation after 100 bends in the 400 mm radius**

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

** At positive temperatures.

Stream Tracer™

Energy-Efficient Solution for Preventing ARPDs Formation in Oil Wells



Stream Tracer™ – Energy -Efficient Operation of Oil Wells

For more than 25 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:

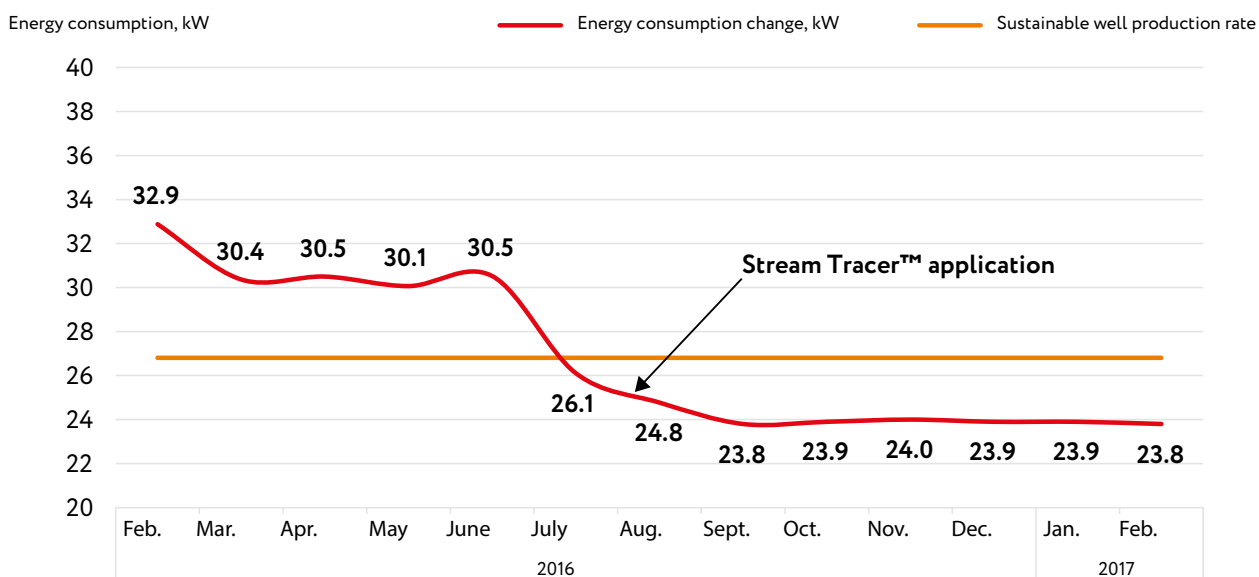
- carry out and stop the supply of the electric current to the heating element;
- control the current flowing through the heating element;
- control the voltage applied to the heating element;
- adjust the temperature of the heating element in the borehole;
- turn off the heater when disabling the control 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 oil field (LUKOIL-Perm). 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.



Oil well characteristics:

Produced fluid per day: 14.1 m³/day
 Crude oil volume per day: 13.4 t/day
 Gas volume: 113.9 m³/day
 Flowing level in well: 872 m
 Wellhead pressure: 3.3 kg/cm²

Stream Tracer™ pulling out opportunity > 10 times



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.



Actual energy usage reduction

47%



About SST Group

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 1 500 specialists. The Group encompasses four production plants, an industrial R&D center, an engineering company, several distribution companies, and an international branch network.



Nº 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**
- **1500 employees**
- **4 own plants**
- **9 branches**
- **7 subsidiaries**
- **Export to 47 countries**

45 000 m²

production facilities

10 000

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 have been certified in accordance with international standards by some of the largest European certification centres: Sira, VDE, SGS, Demko, and NANIO CCVE. The industrial electric heating systems by SST Group comply with the International Electrotechnical Commission's Standards Relating to Equipment for Use in Explosive Atmospheres (IECEx). Self-regulating electric heating cables and heat tracing system based on skin-effect (IRHS-15000) have the EU certificate ATEX. The production facilities are certified by global EPC contractors. The company also has VDE certificate.

The company's unified quality management system is certified for compliance with the standards ISO 9001:2015 and GOST R ISO 9001-2015.

For many years, SST Group design engineering department has been functioning as an industrial design-engineering institute. Our customers are able to access thousands of design and engineering solution templates to use at their own facilities. SST Group specialists act as consultants and technical experts in the design of practically every electric heating system that is developed in Russia.

Our Clients



All SST Group systems and solutions for construction and building operation are reliable and energy efficient. They are compatible with various "smart building" conceptual formats and can easily be integrated into a unified building automation system. Monolithic construction, power supply, fire suppression systems, making buildings and environments ice-resistant, creating a comfortable environment for pedestrians and vehicles – we provide you with reliable and sustainable solutions at every stage.

SST Group 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 Kazan Kremlin, the State Duma of the Russian Federation, the Moscow State Duma, the State Historical Museum, the Pushkin State Museum of Fine Arts and many others.



The Bolshoi Theatre



Moscow City business complex



Cathedral of Christ the Savior

EHP-003



HEAT TRACING

Control Panel



Input 2



CONTROL

INDICATION

ALARM

On / Off

Control ON

Heat ON

Input 1

Input 2

Common



CCCI ENERGO MONTAZH



Turn-key engineering services

SST Energomontazh (part of SST Group) is Russia's largest engineering company offering a wide variety of heat tracing solutions.

High service level, meeting international quality standards, many years of experience and industry expertise, state-of-the-art technology, and single point of responsibility enable us to carry out the most challenging projects for Russian and international customers.

Thanks to our integrated approach and project implementation control at all stages, our customers can always expect high quality and efficiency of the installed heat tracing systems.

We have the complete infrastructure required to develop and implement innovative products – from product development and manufacturing to installation, start-up & commissioning and post-guarantee service.



Complimentary scoping calculations and software

Scoping is required to estimate the investment needed to implement the project. SST Energomontazh offers complimentary scoping calculations and provides the customer with a quote containing preliminary equipment specifications and an approximate cost of the services.

At the request of the customer, we provide software that simplifies the design of the electrical heating system.

The program allows to quickly estimate the required quantities of materials, determine the installation's technical specifications, and fill out the order.



Design engineering and field supervision

An in-house R&D center and engineering teams enable SST Energomontazh to prepare high-quality design and project documentation. We design heat tracing systems, thermal insulation, and power supply systems for various applications, including explosion hazard areas. Our services include field supervision to ensure that the structural and architectural parameters match the adopted design.



Design engineering and field supervision

Being experts in the field of heat tracing systems, construction and elec installation solutions, we advise our customers on technical issues and help specify the equipment and cable heating systems for a given project. SST Energomontazh cooperates with the major design institutes and engineering companies. If the customer is responsible for installation, we offer training for the customer's staff.



Design engineering and field supervision

SST Energomontazh offers shipment in the shortest possible time because of regular replenishment of the stock and established contacts with shipping companies. We offer delivery to the door – worldwide – and we are always open to the customer's suggestions when choosing a shipping option.



Technical support and training

We offer installation and commissioning of electric heating systems, general electrical installation services, commissioning of electrical installations followed by delivery to the operator, as well as thermal insulation services. The high quality of installation is ensured by the considerable experience and high qualification of our staff who are authorized to work on electrical installations below and above 1000 V, electrical safety classes V and IV and hold safety certificates for highrise operations.



Technical support and training

Because of the exceptional reliability of the electric heating solutions and other equipment offered by SST Group, our customers have an option to extend the warranty and maintenance after the initial warranty period. Our warranty covers both the equipment and all services provided. In any phase of the project, our engineers are available to consult the customer on the operation of electric heating systems and, where appropriate, immediately make a site visit, which saves the customer's time and resources and minimizes downtime.



www.sst-international.com