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The fight with hydrate formation during the operation of wells at the Tagulsky field

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Abstract

At the moment, during the operation of wells in a mechanized way at the Tagulskoye field, there are formation's problems of hydrates, solid deposits that block the passage. Hydrate deposits form in the Christmas tree check valve, blocking the annulus gas passage. In the case of a closed annular space, the gas flowing through the annular space accumulates and squeezes out the dynamic level before accepting the installation of an electric centrifugal pump (ECP), which in turn leads to the ingress of gas into the ECP, disruption of the supply and shutdown of the pump. In turn, this leads to a possible failure of the installation, because due to a possible shutdown, the pump can jam and no longer start, which in turn will lead to additional costs for well servicing and workover. (WSW) and a decrease in current oil production. The fight against hydrate formation in the check valve of the Christmas tree is carried out using heating cables, valve induction heaters (IVH), as well as injection of a hydrate formation inhibitor - Dehydrate 4010.
The methods were adopted as the situation with hydrate formation became more complicated, that is, at the initial stage of well operation, to avoid complications, there was enough heating cable used in the upper well piping to increase the temperature of the pipeline and prevent water freezing in the metering branch, while the well was not being measured But as the water cut of the well production increased, it was necessary to install the VIH, and soon install the dehydrate-4010 inhibition units. As you can see, to reduce the equipment located on the Christmas tree, it is necessary to come up with another way to avoid the formation of hydrates.

Keywords: Hydrate formation, complications in oil and gas condensate production, collection and transportation, induction heating, temperature fields;

1. Introduction

Let us consider what hydrates are, hydrates - solid crystalline compounds formed under certain thermobaric conditions from water (aqueous solution, ice, water vapor) and low molecular weight gases. Outwardly they resemble ice or snow (Figure 1a) [2, 6]. Figure 1b shows the equilibrium hydrate formation, it can be seen that at an increased pressure, hydrate formation is possible at a positive temperature, which in turn poses the problem of maintaining an elevated temperature inside the pipeline. The main places of formation of hydrates are places of narrowing of the passages of the gas mixture (Figure 2) [7].

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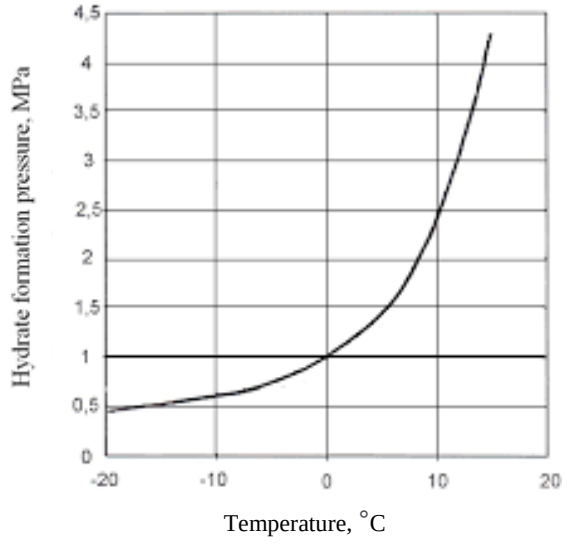

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Fig. 1. a- hydrates in the pipeline; b- equilibrium curve of hydrate formation

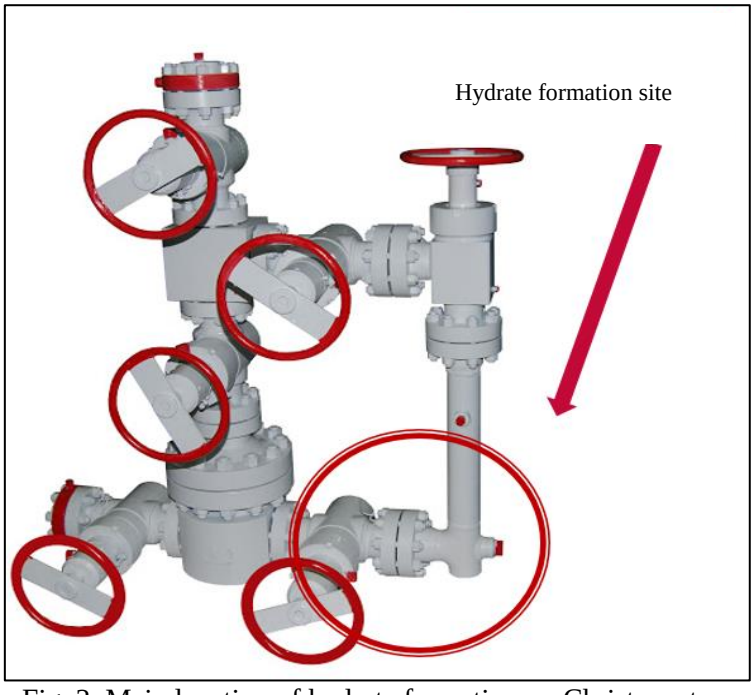

Fig. 2. Main location of hydrate formation on Christmas tree

2. Disadvantages of using technologies to combat hydrate formation

At the moment, the use of the methods both separately and in a complex manner has a number of disadvantages. Let's consider the disadvantages of each method.

2.1. Using a heating cable

The heating cable is used in all wells of the Tagulskoye field, so the heating cable is laid along the lower part of the pipeline and when it is turned on, only the lower part of the pipeline is heated, Figure 3 shows the temperature field obtained with this cable laying scheme, it can be seen that at the upper point, liquid has the lowest temperature leading to the formation of deposits. When using a heating cable, there is also a restriction on the use of special equipment due to possible damage to the cable section and the need to re-lay the entire line, including the insulation layer. The use of a heating cable implies the use of a large number of equipment such as heating cable, heating cable connection box, terminal box and lead wires from the transformer (Figure 3) [5]. The temperature of the liquid with a permanently operating cable reaches 7 ºC. It has been experimentally found that the heating of the liquid in the pipeline and further circulation occurs within 24 hours after the cable is turned on.

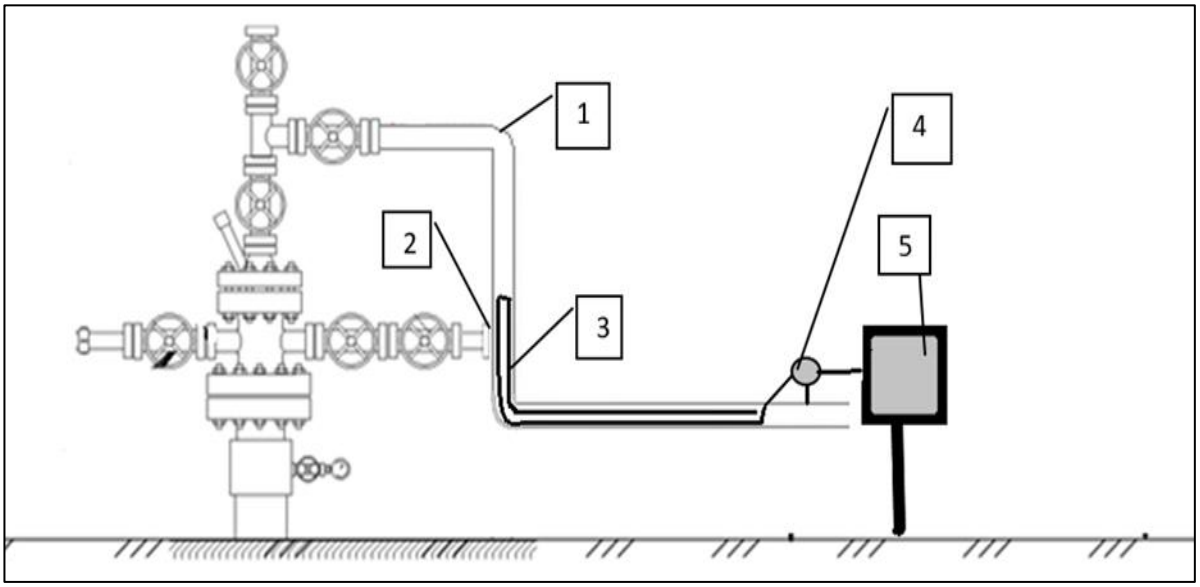

Fig. 3. Heating cable laying diagram
1 - Christmas tree, 2 - check valve, 3 - heating cable, 4 - heating cable connection box, 5 - terminal box.

2.2. Application of induction valve heater

The induction valve heater (Figure 4) has a concave shape and due to the design feature, tight installation is not possible on some of the wells. Due to the small area of the heater, only a small part of the check valve heats up and the formation of hydrate is possible in the lowest heating zone (Figure 5) [8]. The disadvantages of IVH are:

1. The INK complex includes: a heating module, power supply and grounding cables.
2. The need to supply power to the electric cable and grounding, which creates an additional load on the well equipment during servicing;
3. In the course of the well insulation, a problem is created to check the operability of the IVH, since it is wrapped in a layer of insulation;
4. Impossibility of using a mobile steam generating unit (MSGU) to warm up the equipment;
5. The coverage area is approximately 20-30 cm.

Fig. 4. Valve induction heater

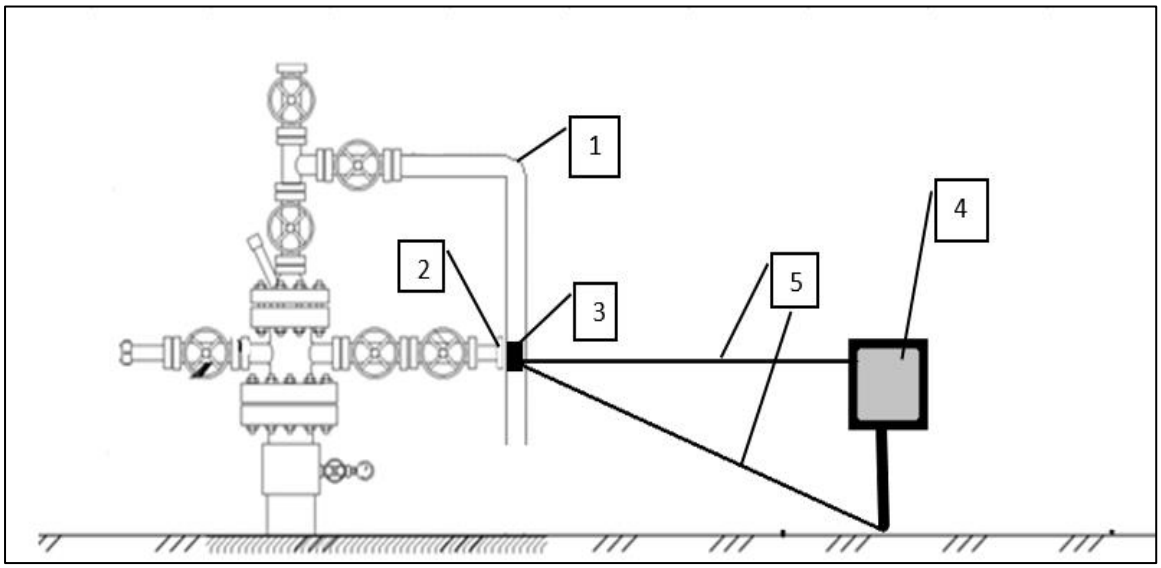

Fig. 5. Installation diagram of the valve induction heater
1 is a Christmas tree, 2 is a check valve, 3 is an induction heater for a valve, 4 is a terminal box, 5 is a power cable and ground

2.3. Installation of reagent dosing.

The most effective method used to reduce the likelihood of hydrate formation is the use of a reagent dosing unit (IRD). The reagent dosing unit located near the well (Figure 6) requires constant refueling of the inhibitor and control of the liquid level; during the operation of the IRD, constant leaks of chemistry occur, causing soil contamination, which requires constant monitoring by the maintenance personnel, the supply of barrels with the inhibitor and an increase in labor costs staff [1]. The IRD also requires electrical cables and grounding and reagent impulse tubing. Also, the complex design of the reagent dosing unit itself causes frequent breakdowns of individual units.

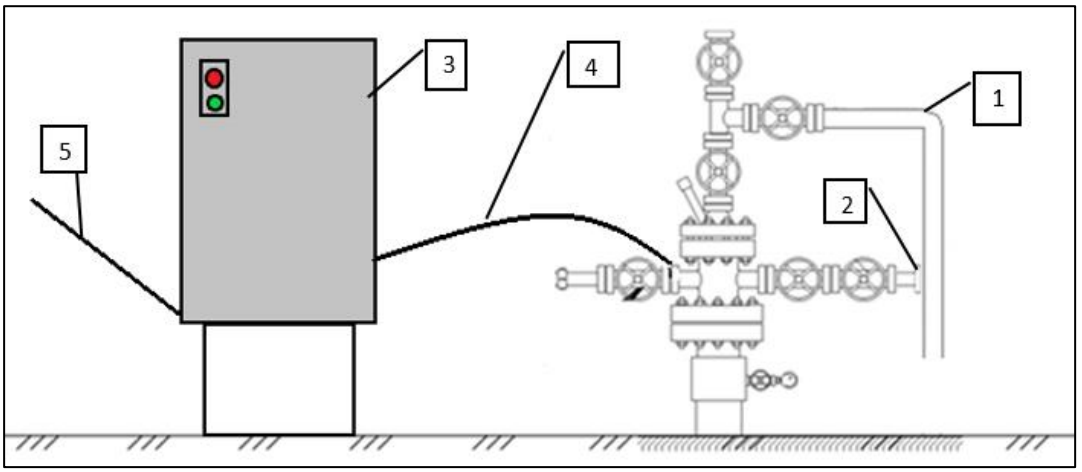

Fig. 6. Setting the reagent dosing
1 - Christmas tree, 2 - non-return valve, 3 - UDR, 4 - impulse tube, 5 - supply cable and ground.

2.4. Proposed way to solve the problem

To solve the problem of eliminating hydrate formation in the Christmas tree check valve, it is possible to increase the heating temperature of the Christmas tree by replacing the used heating cable with an induction-type Warm Stream system, when the heating cable is completely replaced with an induction pipeline heating system [4, 9].

The Warm Stream technology refers to the field of electrothermics and is used to maintain the temperature of the fluid flow in pipelines, as well as to protect the transported fluid from freezing in pipelines and heat the flow to the required set temperature.

The induction heating method consists of the transfer of electromagnetic energy from the energy source to the heated object without contact between them (for example, an inductor laid on a metal wall of a pipeline through a heat-insulating layer). The energy source is a semiconductor frequency converter, which generates current pulses of a given power in the inductor. Due to electromagnetic induction, eddy currents arise in the heated object, which cause heating of the metal [10, 12].

Advantages of thermoelectric unit Warm stream

• quickness of heating;
• low energy consumption;
• automatic control of the heating process;
• the possibility of contactless transmission of energy to the heated object allows the use of heating in fire and explosion hazard areas.

Functionality

• switching on and off heating;
• control of the current in the circuit;
• voltage control;
• automatic maintenance of the set fluid temperature;
• automatic maintenance of the set current level;
• automatic disconnection of the supply voltage from the network when a leakage current appears;
• decrease in heating power when the liquid supply is stopped;
• automatic restarting of the unit in case of power outages;

• metering of electricity consumption by a built-in electricity meter of accuracy class 1.0.

Installation kit

1. Inductor winding cable
2. Terminal box
3. Fiberglass
4. Covering material
5. Temperature sensor

To reduce the equipment used and optimize the technology for excluding hydrate formation, the Warm Stream technology is proposed. Warm Stream technology uses Christmas tree and pipeline as a magnetic core, inside of which an alternating magnetic field is created using inductor windings. The alternating field inside the core induces Foucault eddy currents, which heats up the core (pipeline), while the inductor winding practically does not emit heat. Figure 7 shows the very basis of the process, Figure 8 shows the process of the actually occurring process, as a result of which the fluid in the pipeline is heated

Fig. 7. The physical process of the formation of currents

Fig. 8. The process of formation of currents in the pipeline

To understand the location of the Warm Stream system on the well, we will show Figure 9.

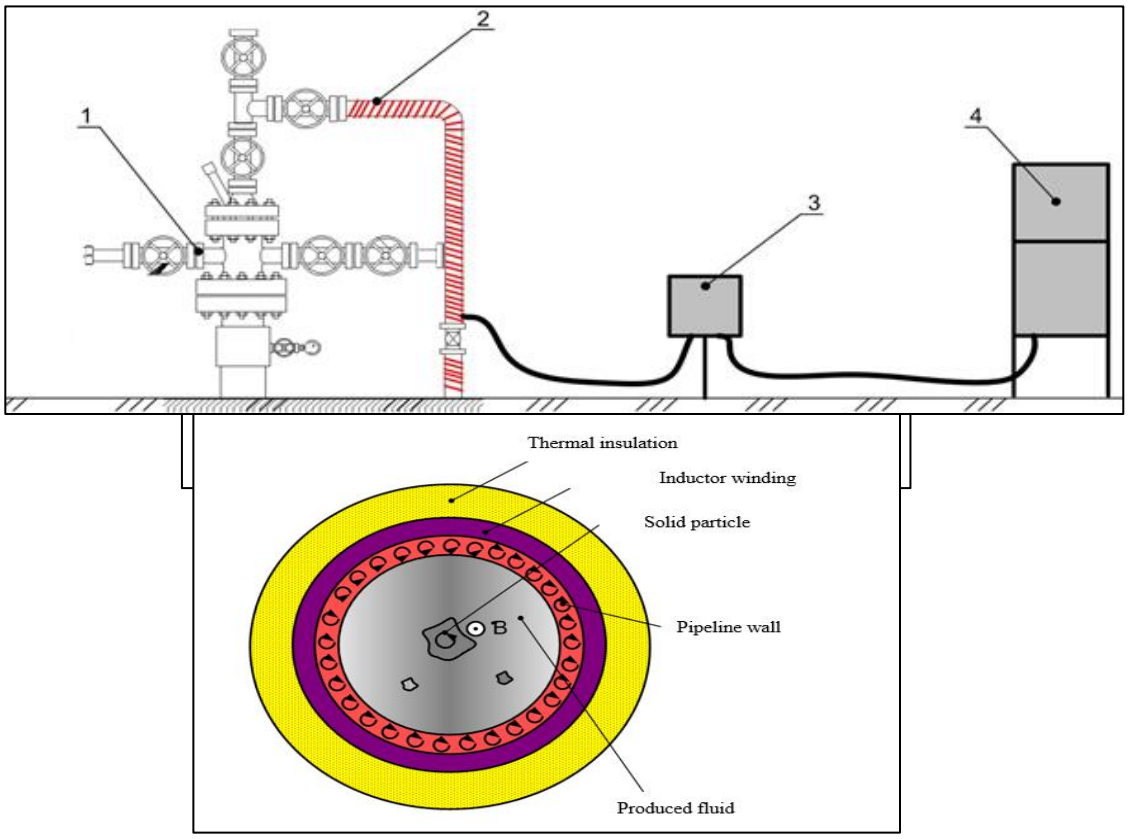

Fig. 9. Fountain fittings with induction cable

1 - Christmas tree, 2 - induction heater winding, 3 - terminal box, 4 - control station.

The use of Warm Stream technology allows using different types of cable installation for various types of complications (Figure 10) [3] and allows heating the entire diameter of the pipeline (Figure 11), which leads to conditions in which water freezing and the formation of deposits are impossible [11]. After starting the installation in 40 minutes, the liquid temperature was +33 ºC. So the use of Warm Stream is possible on periodically used pipelines without constant power consumption due to the rapid heating of the product.

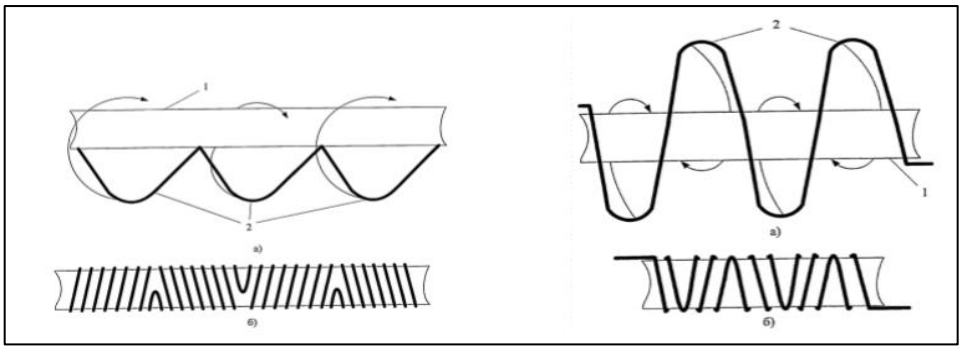

Fig. 10. Installation options for induction cable

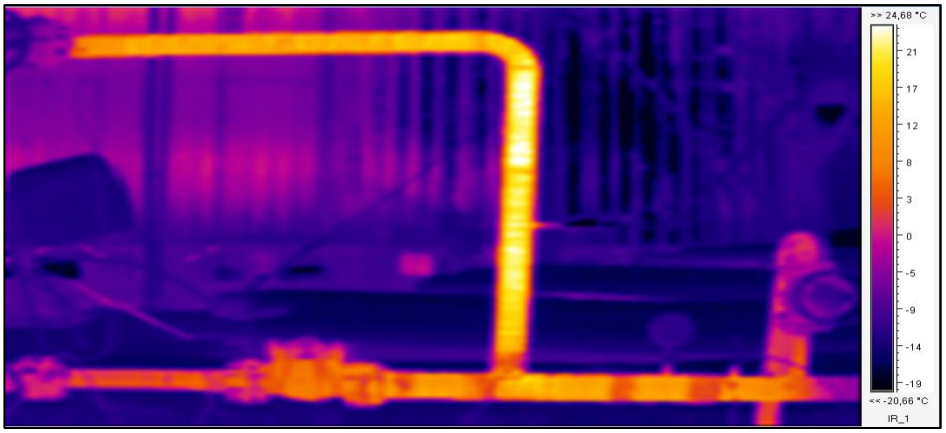

Fig. 11. Thermal field during operation of an induction cable

Conclusion

Replacing the complex method of combating hydrate formation with the Warm Stream and CNG unit will allow:

1. Saves 6 858 thousand rubles / year;
2. Reduce the number of power consumers, reduce the number of current supply wires;
3. Elimination of hydrate inhibitor injection;
4. Increase additional oil production by reducing the downtime of wells due to a decrease in intraday downtime by 6,000 tons / year.

With the successful application of the Warm Stream technology, its further development is possible due to its application to combat formation in the tubing.

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