

## Energy Saving and Production Increase Technology and Application Prospect of Heavy Oil Reservoir based on Eddy Current Effect

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**Abstract:** With the rapid development of oil and gas technology in the world, new theories, methods, technologies, tools and materials are emerging constantly to promote the efficient development of deep, deep and unconventional oil and gas resources. Provide energy through solar energy saving system, according to the principle of the eddy current effect of physical, apply it to heavy oil reservoir in the development of mining, oil pipe, the use of tubing (this time increases the heat pipe water heater) heat transfer heat reservoir to increase production, and increase hot crude oil are used to directly wellbore cleaning adhesive in wellbore viscosity materials such as wax and asphaltene. Solar energy has been used in oil fields. As long as the temperature of water injection is higher than the temperature of oil layer and crude oil, the recovery efficiency of heavy oil wells will be improved obviously. As the world's demand for clean energy grows, more solar power will be used. Solar energy oil production principle is simple, can use local materials, and energy saving and consumption reduction is obvious. A large number of theoretical and practical basis can be drawn that the implementation of solar thermal washing nearby the establishment of solar hot water station, storage power station and supply power station, can effectively use resources, reduce waste, achieve sustainable development at the same time can also reduce tons of oil consumption and electricity, and improve efficiency.

### 1. Introduction

Heavy oil also weighs heavy crude oil or high viscosity crude oil. According to viscosity classification, crude oil with viscosity higher than 100mps and degassed at reservoir temperature is called heavy oil. It is estimated that the total conventional oil reserves in the world are 300 billion t, in addition to unconventional oil resources such as heavy oil, oil sands and oil shale, their reserves are equivalent to about 8.9 trillion tons of conventional oil, which will become an important source of oil in the future. With the gradual decrease of light crude oil resources, some difficult heavy oil has to be exploited, so the share of heavy oil in the world oil production is gradually increasing. According to the viscosity of heavy oil and the different structures of each reservoir, different oil recovery technologies can be adopted, which are mainly divided into two categories: heavy oil water drive recovery and heavy oil thermal recovery. At present, heavy oil and high condensate oil are generally produced by thermal method at home and abroad, and electric heating technology and steam heating technology are commonly used. Electric heating technology is to put a cable through the hollow sucker rod. One end of the cable is connected to the bottom of the hollow sucker rod. AC power is applied on the loop composed of cable and hollow sucker rod. Compared with other technologies, this technology has higher efficiency, and the operation is relatively simple, the cost is lower, so it has obvious advantages, many oil fields in China have been widely used.

The application of the heat generated by solar energy in the heating ground pipelines of crude oil and fuel oil transportation can effectively reduce the viscosity of the fluid, speed up the flow of the fluid and reduce the loss by preventing the waxing phenomenon in the flow process. Solar power generation is mainly divided into solar photovoltaic power generation and solar thermal power generation. In 2011, the installed capacity of global solar power generation was about 28 gig watts.

The total installed capacity reached 69 gigawatts, and the global output of solar energy in that year was 93 billion us dollars. In the process of oil production and production increase, the general power should reach 20KW, at least 10KW. Now, monocrystalline silicon solar cells have a conversion rate of about 17% which is about 170 watts per square meter. So 1,000 watts is about 6 square meters, and amorphous conversion efficiency is about 7%. That's about 14 square meters. Polycrystalline cells are about 13%.

## **2. Development status of heavy oil reservoir**

Heavy oil exploitation is a common topic faced by the world oil industry. At present, the exploitation methods are simply summarized as cold exploitation of heavy oil and hot exploitation of heavy oil, in which the viscosity of oil layer is less than 100mPa•s and the cold exploitation technology of heavy oil can be used for exploitation. If the cold exploitation technology cannot achieve the desired effect, the hot exploitation technology of heavy oil can be used for effective exploitation. At present, the recovery rate of heavy oil is not high, generally only 8% ~ 30%. Cold as part of the thick oil field to develop some of the problems, such as injection water channeling in serious, serious water coning, oil pollution, oil well sand production, etc., the serious influence developed oilfield crude oil output stability, oil production decline rate increased year by year, produced liquid water cut rising speed, causing the design production and recovery factor cannot achieve. How to increase the recovery rate and make full use of recoverable reserves is an urgent problem to be solved. Through the practice has proved that viscosity than I level 2 kinds of crude oil in oil layer under the high temperature steam heating distilling, make the light fraction of crude oil increased, the viscosity reduced. There are many factors such as high development cost and limited space in oil field development. At present, the existing space can be effectively utilized to increase the continuous high-quality and low-cost steam supply through multiple thermal flow thermal production technology, so as to "activate" the liquidity of heavy oil and improve the recovery rate of heavy oil.

Heavy oil resources are very valuable underground resources. Because of their high asphaltene and gum content and viscosity, it is difficult to exploit them. Steam drive is the main process of heavy oil and ultra heavy oil reservoir exploitation method, this method usually USES the natural gas production of high temperature and high pressure steam boiler, and put it in the injection well, by lowering the underground crude oil viscosity, increase the thermal expansion of crude and liquidity, in order to achieve the purpose of mining and improve the recovery efficiency, burning down the "gas" for "oil". Most of the countries in the world adopt steam heat displacement technology to exploit underground heavy oil reservoirs, which are all steam production based on natural gas. Oman in the Middle East needs to import natural gas due to the shortage of natural gas. According to the data, natural gas accounts for about 50% of the cost of hot steam production per barrel of crude oil.

Solar energy is an important field for the development and utilization of renewable energy at present. It is clean, extensive and easy to obtain. Heavy oil exploitation by solar energy not only reduces gas consumption, but also meets the requirements of low-carbon and environmental protection development.

## **3. Eddy current energy supply system**

In the process of oil fire drive ignition and exploitation, the general power should reach 20KW, at least 10KW. General solar radiation on earth every square metre is probably in 1000 watts of power to solar panels of gallium arsenide battery now, high efficiency, the efficiency is greater than 37%, one square metre is 370 watts of power, an hour is 0.37 KWH (f), 13-22% of ordinary commercial solar battery, the power of one square metre is 130-220 watts, an hour of power that is 0.13-0.22 KWH (c). Combined with the power generated by solar energy in the above Table, the series and parallel transformation of solar silicon plate and the increase of solar silicon plate area to a certain extent can meet the power required by volcanic oil layer in the oil field. Solar energy can

be widely used in the oil field, and the heating and heat tracing mode can be optimized in the thermal production of heavy oil field to increase production.

The precipitates (wax-forming blocks) produced in the production process of oil Wells are usually solid or semi-solid, and the color is dark brown or dark brown. The components are mainly paraffin wax, and the colloids are mixed with asphaltenes and sand particles carried by drilling fluids. These precipitates make the crude oil viscosity is very high, and the rheological characteristics of high waxy crude oil vary greatly with the temperature, showing different characteristics at different temperatures. When the oil temperature is higher than the waxing point of crude oil, the wax crystals are basically dissolved in crude oil. The dissolved paraffin can be considered as a uniform medium with interaction between paraffin and the molecules of petroleum solvent. Its viscosity is a single value function of oil temperature, which is shown as the characteristics of Newtonian fluid. When the temperature of crude oil is lower than the abnormal point, the wax precipitated from the crude oil causes the physical structure (such as particle orientation, shape and arrangement) inside the system to change qualitatively. The viscosity of crude oil is no longer a single value function of temperature, but is also related to the shear rate, showing pseudo plastic fluid characteristics and accompanied by thixotropy. When the oil temperature drops below the point of loss of flow or solidification, the precipitation amount of wax crystal increases greatly, and the concentration of dispersed particles in the system also increases correspondingly. The particles start to connect into a network, and the continuous phase and dispersed phase in the system gradually turn to each other. At this time, the crude oil has the fluid characteristics of thixotropy and yield. Temperature is the most important factor that affects the viscosity of heavy oil, and the development and design of heavy oil reservoir are mainly aimed at the viscosity of heavy oil.

#### **4. Solar energy saving system**

Solar energy and heat energy into electrical energy by the ground device used for heavy oil reservoir development, but in the for solar heat collection, conversion, storage is important, so is especially important for structure design of energy saving system device, the main material through a lap glass tank for solar energy and heat energy conversion and storage, in turn, its into the underground, improve the efficiency of heavy oil reservoir development and production, reduce the cost of heavy oil reservoir development, improve the efficiency of the oilfield development.

Solar energy saving system consists of receiving device, conversion device, transmission device, control device and monitoring device. The receiver is polished and coated to maximize the absorption of solar radiation energy. Tubular glass shielding technology reduces heat loss in convection. The receiver is suspended in the greenhouse through the steel rod. The steel rod is in the stretching state, which ADAPTS to the daily thermal expansion and cold contraction, and maintains the alignment accuracy of the optical system. There are several parabolic mirrors hanging in the greenhouse, which are light aluminum honeycomb structure. The total weight of the mirror and frame is only 4kg/m<sup>2</sup>. Compared with the conventional solar panel, the optical accuracy is very high and the cost is greatly reduced. ABB automatic cleaning system is installed on the roof of the heat-collecting greenhouse, which can automatically clean the roof surface every night, and 90% of the cleaning water can be recycled; The air treatment unit can filter the dust and provide dry air for the strong dust climate. Both devices can greatly improve energy efficiency and reduce the adverse effects of dust and wind. Combination of desert area and better accept the area of solar energy and a better climate characteristics, designed the fold type slot type condenser field, with the traditional thermal power generation, compared with open groove type condenser field have made a great breakthrough technology: the design of the biggest highlights of the condenser field is solar energy condenser is placed in a glass house structure, glass room kept higher than the outside air temperature and pressure, can prevent the dust into, can resist external wind erosion damage of condenser, etc.

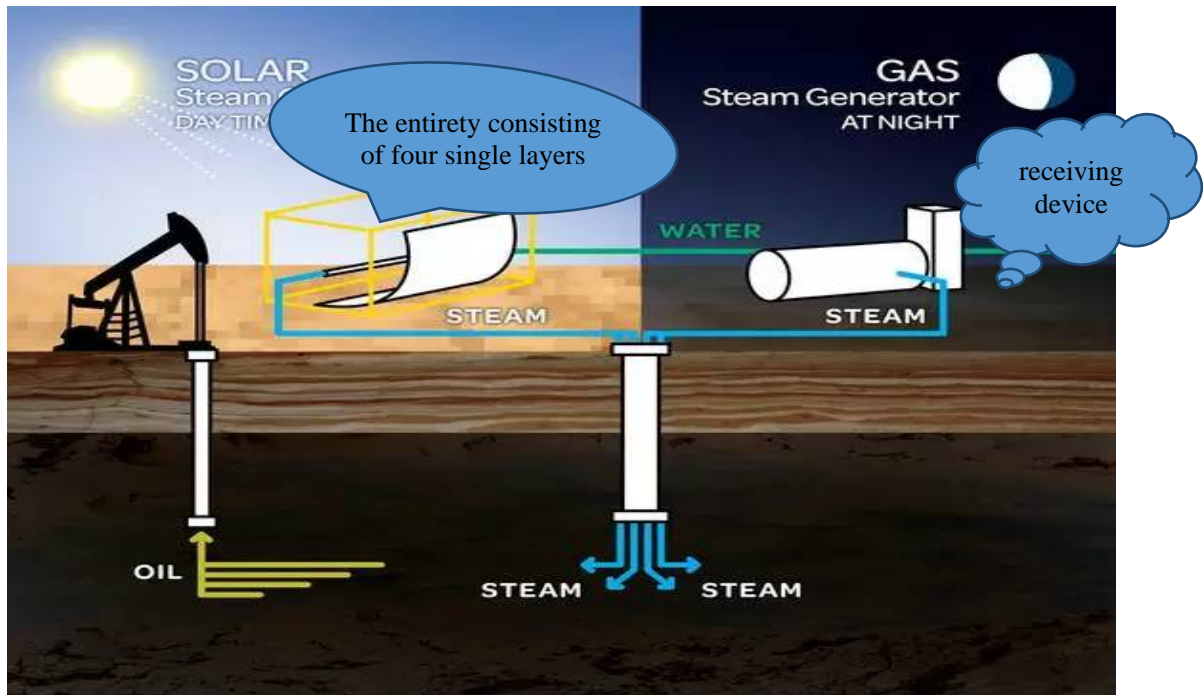


Fig.1 Solar energy saving system

The increasing demand for primary petroleum energy and its limited reserves make the world face a serious oil crisis. Solar energy resources is one of the largest green renewable energy reserves, as an aid in the energy of oil field exploitation, fold glass trough type solar energy saving system technology applied in heavy oil thermal recovery, can reduce the thermal recovery of heavy oil field of conventional electricity and natural gas consumption, save resources, enhance oil recovery efficiency, increase oil production, improve the national strategic petroleum reserve, to promote the healthy development of national economy, has the significance of both defense and national economy. Solar energy resources is one of the largest green renewable energy reserves, as an aid in the energy of oil field exploitation, the glass house groove solar-thermal EOR technology applied in the thermal recovery of heavy oil, can reduce the thermal recovery of heavy oil field of conventional electricity and natural gas consumption, save resources, enhance oil recovery efficiency, increase oil production, improve the national strategic petroleum reserve, to promote the healthy development of national economy.



Fig. 2 The core technology of solar energy heavy oil energy saving system

The core technology of solar energy heavy oil energy saving system -- cascade heat and solar energy conversion technology is studied. The closed structure is similar to a four-page glass greenhouse, which is composed of multi-layer glass and steel structure. Abb robot is adopted for automatic cleaning and 90% water can be reused. The glass greenhouse covers an area of 17,280

square meters and consists of 12 rows of trough collectors. Solar power up to 7 mw steam generating system, every day can produce 50 tons of steam temperature is 312 °C. The annual steam output is nearly 13,000 tons, and the annual operating efficiency is 98.6%. Compared with the traditional technology of burning natural gas to generate steam, this technology can reduce the consumption of natural gas by more than 80%, save more than 1.3 million cubic meters of gas consumption per year, reduce carbon dioxide emissions, and provide steam at a stable price over a 30-year service life.

Solar thermal recovery technology of heavy oil has the advantages of low cost, safety and environmental protection. It not only meets the social requirements of green and sustainable development, but also can improve the operating value of heavy oil assets, which is worth learning from.

## **5. Application advantage**

Change the traditional heavy oil stimulation mode, and apply the solar energy saving system to the development and stimulation of heavy oil reservoir by eddy current effect. To create a more efficient and environmentally friendly way of energy saving and production increase, reduce the production cost of the oilfield, reduce the formation and environmental pollution, effectively protect the reservoir structure, reduce damage to the reservoir, prevent the formation of the pore throat, permeability, porosity, fluid properties of large changes. Keep the fluid in tubing and formation at a high temperature, increase the fluid fluidity and flow efficiency, prevent wax and asphaltene crystallization, improve well washing efficiency, improve reservoir fluid temperature, reduce viscosity, effectively combine the energy saving system with heavy oil field production, and increase revenue. Change the traditional way of energy supply and use solar energy, which is inexhaustible and clean. Keep up with international steps, respond to the call of green environmental protection, protect the environment, Lower fuel costs.

(1) In traditional heavy oil projects, the purchase price of natural gas for steam production accounts for 60% of the project cost. Solar energy saving system solutions do not require the burning of large amounts of natural gas to operate. In sunny areas, solar steam production equipment can reduce gas consumption by 80%.

(2) Maximize the value of natural gas. The natural gas resources saved through the solar energy saving system can be used for high-value applications, such as power generation, transportation, LNG export, etc., which will have a huge impact on local economic development, especially in the gulf region where natural gas supply is relatively scarce.

(3) Producing more crude oil. Because of the lower cost of steam production, operators can drill Wells for better and longer periods of time, extend the economic life of the field, produce more crude oil, and improve ultimate recovery.

China's heavy oil reserves are huge, but there is a large waste of resources for its exploitation, so solar energy saving and production increase technology may become a new trend of China's heavy oil development in the future. Combined with China's actual situation, this technology has certain application and promotion space in xinjiang region and maritime region. Located in the hinterland of the Asian continent, far from the ocean, xinjiang has a broad surface of the gobi desert, and has a specific geographical location and climatic conditions, such as a dry atmosphere, good sunshine permeability and sunny days. At the same time, xinjiang's dense heavy oil resources, combined with two kinds of rich energy resources, comprehensive application, the adoption of solar energy exploitation of oil, xinjiang has a unique advantage. It is suggested that relevant departments cooperate with bodian company, learn from and introduce closed groove heat collecting system, and establish relevant pilot projects in xinjiang heavy oil blocks, so as to provide new development direction for heavy oil exploitation in China. We will create cheaper energy supply methods, form our own unique features and technologies, and enhance our position in the international oil industry. It can expand the application prospect of solar energy and provide new technology for the development of oil industry. Can carry on the new pattern well washing, the heating fluid, enhances the recovery rate greatly, proposes the feasibility plan for the solution our country petroleum

demand big country's difficult problem. Set up under the conventional mode of production, simplifying the wash well equipment, reduce the cost of flushing, directly using the crude oil washing Wells in the wellbore, establishing fluid production technology in the heating pipeline, heavy oil reservoir with conventional technology and laws, and the tension between optimizing mining thick oil reservoir and simplify the operating personnel to the complexity of the instrument, make its operability and more scientific, high efficiency, energy saving, environmental protection of new technology to increase production.

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