

A Long-term Inhibitor Released Technology for Low Permeability Oilfield

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ABSTRACT

During the low permeability oilfield development, it's a challenge for operation company to balance the OPEX and the large quantity of oil wells with low output of single well, especially for the daily inhibitor injection and related management. It is necessary to prolong the continuous production period and mitigate the corrosion and scaling of the tubular caused by complex production medium. A long-term inhibitor released technology has been designed which combines encapsulated corrosion/scale inhibitors and soluble alloy baffle chamber without extra energy or mechanical controlling system. Therefore, the long-effective prevention would be achieved by slow release of corrosion and scale inhibitors just as bamboo joint in sequence.

As the key materials of this technology, a magnesium-aluminum alloy as the soluble baffle for the bamboo chambers and encapsulated inhibitor have been developed. Through chemical component design, the alloy reaches high strength under 10MPa pressure and below 80°C. The relationship between structure and strength relationship have been tested according to the requirements of produced brine and periodic soluble reaction. The released characterization of encapsulated inhibitor stored in the dissolvable baffle chambers has been researched to adapt the release requirement.

The following problems of the segmental dissolution-release controlling process have been discussed: (1) density and release controlling of corrosion/scale inhibitors; (2) pressure resistance of structure; (3) blocking effect of evolved gas.

Compared with the capillary line mechanical injection or wellhead manual injection methods, this technology possesses effective releasing, simple structure, and low investment at the same time. The cost of a single well using this technology is about \$5,000/a, achieving a theoretically two-year lifespan. It is a novel production flow assurance technology suitable for low permeability oil wells.

Keywords: inhibitor, downhole, soluble alloy, release control, bamboo chamber

INTRODUCTION

With the development of low permeability oilfields, it's a general situation that production ability of each well is low, which requires much more construction wells than the medium to high permeability oilfields. Moreover, multi-stratums have been developed at the same time, factors such as the mixture of incompatible brines, unstable dissolved corrosive gas content and degassing in downhole would cause complex scaling and corrosion problems. Thus, the production process need inject different kinds of inhibitor are usually injected during production, leading lots of manpower and management cost. Intermittent production regulations of oil wells put forward higher requirements to dynamic adjustment the regulation of downhole inhibitor.

Downhole injection technologies of inhibitor

In order to achieve best production and prevent scale or corrosion issues in the tubing and pump, it is essential to detect the onset of scale deposition as soon as possible or consider the option of chemical injection. The commonly used techniques include continuous capillary injection, intermittent injection of the encapsulated inhibitors or regular inhibitors from wellhead, and chemically infused porous multi-function proppant in fracturing process. Encapsulated or solid inhibitors are also used in low-production offshore oil wells. Downhole electrical controlling system will suffer from the disadvantage that valves are prone to fouling due to produced solids accumulation and scale deposition upon contact with water and this can prevent them from opening or closing properly.

The essence of those above techniques is that formation or surface medicine are regarded as storage systems, downhole piping acts as inhibitor container, which suitable for the liquid production volume, the content of scale or corrosion medium, and then by using diverse injection control devices to prolong the validity period and reduce the operation cost, keeping the concentration above minimum effective concentration (MEC). The advantages and disadvantages of these methods are highlighted below in Table 1.

TECHNICAL PROCESS AND EXPERIMENT

The problem of scaling or corrosion wellbore is gradually increased after water cut is more than 30%, due to the change of emulsion state in produced liquid and the directly contacting of metal surface with scaling/corrosive medium. The whole idea is to control the release speed of inhibitor along with the increase of water cut. The tubing is used as the storage container and the water soluble alloy as the partition to form the pressure isolation chamber. A number of chambers and storage tubing segments are sequentially

combined to form a "Bamboo Release Tool" (BRT), which soluble materials could be dissolved during oil and water production. The high gravity chemicals in the segments slowly dissolved, and sufficient minimum effective concentration is maintained before the next segment dissolved. Such a long-term effect can achieve the long-term purpose of mitigation scale or corrosion. The advantage of this technology is that it does not need manual management or other mechanical power, and can theoretically retain 2-year validity.

Table 1: The comparison of different inhibitor injection methods

methods	Injection controlling			Inhibitor shaping		
Releasing technology	Downhole continue injection ¹⁻⁴	Wellhead batch injection	Downhole electric controlling	Multi-function proppant ⁵⁻¹⁷	Wellhead encapsulated or solid inhibitors ¹⁸⁻²⁰	Downhole solid state inhibitors
pros	1.inhibitor content accurate; 2.same lifetime with well	1.flexible,easy to adjust; 2.without downhole apparatus	1.tubing used as storage container; 2.electric valve opening on schedule	1.compound with fracturing, without daily management; 2.protection reservoir, downhole at the same time.	1.flexible,easy to adjust; 2.life span about; 3 months	1.no daily management; 2.life span 8-10 months
cons	complex accessories; inhibitor blocking	SHE requirements; risk of temporary lost oil	Battery life span and valve stability effected by T、P;can't adjust intervention frequency	1-2% of total proppant, large consumption; potential formation damage	Enough rat hole volume; horizontal wells can be challenging	Limited effective load; replacement during workover
CAPEX	high	medium	medium	high	no	Low
OPEX	medium	medium	low	no	medium	no

According to the characteristics of soluble alloys and the release characteristics of encapsulated chemicals, the advantages of the two methods are combined to solve the problems of wellbore corrosion or scaling.

Inhibitor release ratio experiment

1. Weight the certain amount of solid inhibitor (W_0), and separately add into 6 parallel glass tubes with the distilled water.
2. Transfer the tubes into the thermostat box with 60 °C set conditions.
3. 5 days later, take out the solid residue form inhibitor resolution of the first tube. Dry the residue in vacuum at 80 °C for 5h, weight it as W_1 .
4. Extract the liquid form the 4 residual tubes, and add fresh distilled water.
5. Circle the process 4 after 25 days, get W_2 to W_5 .
6. Test effective concentration of inhibitor in water solution by ICP.
7. The release amount of inhibitor in different release time was calculated.

$$W_n = W_{n+1} + C_{n+1} \cdot V_{n+1}$$

C---the effective concentration of the inhibitor.

V---the volume of liquid.