ISSN: 2319-6505

Available Online at http://journalijcar.org

International Journal of Current Advanced Research
Vol 4, Issue 3, pp 25-28, March, 2015

International Journal of Current Advanced Research

ISSN: 2319 - 6475

RESEARCH ARTICLE

WATER QUALITY FOR SECONDARY OIL RECOVERY

[1]Udeagbara, S.G, [2]Anusiobi, O.J.

[1]Department of Petroleum Engineering, Afe Babalola University Ado-Ekiti, Ekiti State, Nigeria
[2]Geomatics Department, SPDC Port Harcourt, Rivers State, Nigeria.

A R T I C L E I N F O

Article History:

Received12th, February, 2015
Received in revised form26th, February, 2015
Accepted8th, March, 2015
Published online 28th, March, 2015

Key words:

Water, subsurface injection, Contaminants.

A B S T R A C T

The use of any source of water for subsurface injection without proper analysis and treatment could be disastrous to the whole system. Subsurface injection entails the injection of water into an oil reservoir to recovery some appreciable quantity of oil left behind after the natural energy might have died down. The water meant for the injection should be properly treated and cleaned otherwise the aim of the project would be defected.

Discussed in this write up are the processes involved in the treatment of water meant for subsurface injection. The processes which are oil removal, solid contents removal, dissolve gases and oxygen removal must be properly carried out as outlined in this work to ensure a hitch free oil recovery operation. Proper adherence to the processes would ensure quality water that would meet the standard of the regulatory bodies.

INTRODUCTION

Historical Background of Water Injection

The total oil accumulation in the reservoir does not really get to the surface during production using natural energy, some substantial volume of the accumulation still remain in the reservoir when the natural energy most have died down. With the discovery of this, the need for secondary oil recovery and enhanced oil recovery comes into play.

One of the most widely used methods of secondary oil recovery is water flooding. Gas injection is also another method. Water flooding involves the injection of quality water at certain determined pressure into the reservoir to harness a meaningful volume of the remaining accumulation to the surface. The water been injected into the reservoir should be of high quality, such that will not defect the aim of the purpose.Quality water means well treated water that could be injected into the subsurface formation at the desired injection rate without prohibiting pressures and at a minimum cost. A measure of water quality is defined as the ratio of the concentration of suspended solids to the permeability of the filter cake formed by those solids. Desirable water for injection should be available in sufficient quantity, readily accessible, cheap, and chemically compatible with other make up water. The qualities are not always readily available but most waters can be made to work if problems are recognized and fully understood.

Sources of Water Injection

Practical experience is very crucial in selecting a water source for subsurface injection. There are two sources for water injection

1. Fresh water source
2. Salt water source.

Fresh water sources

1. These are waters held in rivers and lakes; they have the undesirable qualities of containing large amount of oxygen, a high level of suspended solids (sand, animal and vegetable products and bacteria)..
2. Alluvial water tapped by shallow wells in the vicinity of surface water accumulations. This water have the advantage of been naturally filtered but are still subject to surface contaminants and anaerobic bacteria may develop.
3. Permeable shallow reservoirs are also very often rich in fresh water bearing. However, their use is subject to restrictions to the provision of portable water in many areas.

Salt Water Sources

1. In the vicinity of oil reservoirs there are often deep, salt water bearing formations. The water may be pumped to the surface in specially drilled pump water supply wells, and in general requires the least extensive treatment. This type of water often contains anaerobic bacteria, particularly the sulphate reducing variety which must be eliminated. Moreover it should also be protected from contact with atmosphere once it is confirmed to be free of hydrogen sulphide and carbon dioxide.
2. Sea water may as well be used. It is usually corrosive and requires treatment to reduce its attack on metal equipment.

Water injection suitability means that the desired volume of water can be forced into the formation at economical pressures. Rising of injection pressures may be caused by one or more of the following conditions

- Fill-up of the formation (filling up of void spaces)
- Swelling for formation clays, resulting in decrease permeability. The degree of swelling of a clay mineral is a function of some factors like the pH of the water, the specific cations present, the presence of polar organic compounds, the total ionic strength of the water, etc.
- Increase in oil saturation around the wellbore in a water injection well is far more common than realized. This additional oil may have one or more of the following origins: oil suspended in water used in water flooding, plunger lubrication oil, oil carrier used in treating chemical, formation oil from backflow during down period, and oil used as oil blanket to exclude air.
- Formation and deposition of insoluble material in the formation.

There are two mechanisms by which insoluble material may be formed and deposited within the formation: the reaction of injected water with formation water to form precipitates and a time-dependent reaction within the injection water, which result in formation of insoluble material after the water, has entered the formation. These mechanisms are not important when there is a reasonable permeability in the formation. The precipitates will be deposited sufficiently far from the well bore and so will have a negligible effect on the injectivity. A low permeability formation may be damaged by these mechanisms because the deposition will take place at or near the well bore face.

Corrosion Control

Corrosion is a common occurrence in water flood systems. Due to its destructive nature, a lot of care must be taken to prevent and control it. Corrosion mechanism in water flooding is caused by the dissolved gases, bacteria action, hydrogen sulphide, oxygen, carbon dioxide, stray currents and galvanic action etc.

Carbon dioxide

Carbon dioxide dissolved in water gives rise to bicarbonate with higher pH value. The action of this product upon metal is acidic attack.

Hydrogen Sulphide

Corrosion caused by hydrogen sulphide has been a puzzle for many years due to several mechanisms at play. Hydrogen sulphide causes depolarization of the cathode owing to precipitation of ferrous sulphide.

Oxygen

Oxygen is a prevalent, most serious cause of water flood corrosion. The sources of air contamination are as follows: when wells pump are off and the casing annulus is opened, particularly critical in wells with high water production, air is drawn into pumps through packing glands, also through the production tank batteries.

Most produced waters and primary source waters from deeper aquifers are acidic and corrosive, if they can be maintained oxygen free, the type of attack will be easy to control by chemical inhibition.

Bacterial mechanisms

Bacterial growth may be responsible for accelerating oxygen corrosion by the establishment of differential aeration cells. In the absence of dissolved oxygen, bacterial corrosion proceeds whenever environmental conditions are favourable and an infection has been established.

MATERIALS AND METHODS

Preparation and Treatment of Water for Subsurface Injection

The major treatment processes as carried out for water injection are as follows:

Oil Removal

The ease of removing oil from water is greatly influenced by chemical treatment or the physical handling of the oil-water mixture before it reaches the injection water system. The method mostly applied in this work to eliminate oil from water is by gravity separation.

The oil and water mixture should be discharged into a gravity separator, and allowed to stand for 30 minutes to an hour. At the end of the period, the mixture would be separated into distinct phases owing to the difference in density between the oil and water. The water is then run off through a valve connected at the bottom end of the separator for further treatment. This process is highly effective with low specific gravity oil (high API), but becomes less effective or even impossible with high specific gravity oils (low API).

Solids removal (Filtration)

The water free from oil above undergoes solid removal treatment. This could be done by filtration method using a slow sand filter. The water is be passed through a slow sand filter to remove the solid particles. The particles would be collected as residue and the clean water passed through the filter as the filtrate. The residue should be subjected for further analysis why the filtrate (water) collected for further treatment.

Removal of dissolve gas

The commonly encountered acid gases in produced water are hydrogen sulphide and carbon dioxide. The gases need to be removed from the water before injection because of their negative effect on the surface and subsurface equipment. There are toxic, poisonous and can cause corrosion of the pipelines and other equipment.

No economical chemical treatment has been established for the removal of hydrogen sulphide except for small concentrations in which a sodium and calcium hypochloride oxidizing agents are used. Chemical treatment has not proved feasible and so mechanical scrubbing has been attempted by several means.

Hydrogen sulphide removal is carried out by aeration or some other methods, this simply involve passing of air through the system containing the water (the filtrate above), and the dissolve gas would be eliminated out of the water by absorption; though it's only successful for small quantity of hydrogen sulphide. The more sulphide content in water, the less effective the aeration method because it rises the pH which in turn changes hydrogen sulphide to soluble sulphide which cannot be removed by aeration.

Carbon dioxide removal is done alone side hydrogen sulpide, it is practically observed that a system that is able to eliminate hydrogen sulphide from water also takes care of carbon dioxide.

Oxygen Removal

Oxygen removal from the resulting water above is followed after hydrogen sulphide and carbon dioxide removal. This could be done by counter current stripping using natural gas. The water when passed counter currently with natural gas in a packed tower or column. The natural gas is able to absorb the oxygen content of the water.

DISCUSSION AND CONCLUSION

The use of any source of water for subsurface injection without proper analysis and treatment could be disastrous to the whole system. The forms of harm normally encountered are formation of scales on surfaces, plugging of formation which leads to rising injection pressures, and most especially corrosion of pipelines and metal surfaces.

According to Charles w. wright, " it is relatively easy to protect a new, clean system, whereas it may be very difficult , if not impossible to protect a corroded , dirty system, as protective chemicals seldom can penetrate deposit or enter deep pits filled with corrosion products".

In terms of economic, it's worth saying that it's a whole lot cheaper to have injection water properly treated than trying to repair or protect an already damaged or corroded system.

Presently, there is no alternative to water treatment prior to injection which makes the analysis and treatment of injection water highly inevitable if there is to be high quality water for subsurface injection during water flooding.

The steps discussed above for produced water treatment should be followed assuming a good and meaningful work is to be done. The methods applied for the water purification were all very effective. Gravity separator would be able to separate the two phase region- oil/water an each phase would successfully be separated from the other. Analysis shows that 90% of the oil content is separated from the water thereby Meeting the discharge regulation.

The filtration process according to research is able to handle the solid contents of the water effectively using a slow sand filter. The solids are collected as residual and analyzed. The analysis carried out on the water shows that the solid contents are drastically reduced as required by the regulatory bodies.
Dissolved gases especially hydrogen sulphide and Carbon dioxide are among the composition of produce water and other sources of water. They cause serious harm in water used for subsurface injection if not treated before use; they are toxic and can cause corrosion of the valves, fittings and pipelines used for injection. Aeration is actually one of the methods used to eliminate hydrogen sulphide from the water. Aeration is very effective in handling the dissolve gas, not just hydrogen sulphide but also carbon dioxide. It has been established that any process that can handle hydrogen sulphide can as well remove carbon dioxide from the system. Aeration process is able to bring down the concentrations of the dissolved gases to the accepted limits.

The high concentration of oxygen in water does not favour subsurface injection because it can create some problems alone the line. The concentration needs to be brought down to the required level. This is carried out by counter current stripping using natural gas in a packed tower. The natural gas according to research is able to absorb the oxygen content of the water. Analysis shows that the concentration of oxygen is able to go down to the required limit as specified by the regulatory bodies.

The steps as written and discussed above, if followed properly and effectively should be able to produce quality water for subsurface injection.

Acknowledgement

The support of my friends and colleagues in the department of petroleum Engineering, Afe Babalola University Ado-Ekiti, Ekiti State, Nigeria is highly appreciated. My special thanks goes to Engr Okechukwu Anusiobi of Geomatics Department, SPDC Port Harcourt, River State, Nigeria.

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