DETERMINATION OF TOTAL BACTERIA COUNT AND SELECTION OF INJECTION WATER QUALITY RATING CHART FOR WATER FLOOD NEEDS IN SUMATRA OIL FIELDS

by
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ABSTRACT

An important factor affecting the success of a water flood project for secondary recovery is the quality of the water being injected. In this research, the water quality tests were focused on determination of total bacteria counts of the analyzed injection water sample using ASTM D 5465-93 and selections of injection water quality rating chart for water flood needs in Sumatra oil fields. The results of microbiological laboratory tests of all analyzed injection water samples showed three parts. An injection water sample of N - 82 containing type of bacteria Bacillus sp with the total bacteria counts 5.02 x 10^0 colonies/cc was categorized as no. 1 water quality rating chart. Subsequently, G – GS injection water sample indicated Bacillus sp with total bacteria counts 4.28 x 10^1 colonies/cc and Bacillus Laterosporous with total bacteria count 3.31 x 10^1 colonies/cc for G – 90 water sample. Two samples mentioned above were classified as no. 2 water quality rating chart. Next, Bacillus Alvei was found in T – 21 injection water sample with total bacteria count 1.85 x 10^2 colonies/cc and Bacillus Pathothenticus in T – GS injection water samples with total bacteria count 2.61 x 10^2 colonies/cc. Position of water quality rating chart for both last samples were no. 3. These results gave valuable and useful information before implementation of water flood in the oilfield.

Key words: Total bacteria count, bacteria type and injection water quality rating chart

I. INTRODUCTION

Microbiology is one branch of biology which concentrates on microscopic forms of life known as microorganism. Primary concern in oilfield operations is the behavior of microscopic, single-celled organism which are capable of living under all sorts of conditions and multiply with incredible speeds. Water flooding is a secondary recovery method in which water is injected into a reservoir to obtain additional oil recovery by movement of reservoir oil to a producing well *after* the reservoir has approached its economic productive limit by primary-recovery methods. It is expected that by using water injection method, productivity and oil recovery in old fields can be improved. Significant factor in the success of waterflood project is the quality of the water required for injection into the reservoir. The water quality is greatly affected by several contaminants, such as corrosions products/suspended solids, scale and bacteria [1,2,3,4,5]. If injection water which is used in water flood process contains total bacteria count more than 100,000 colonies/cc, this case will result in the worst injection water quality rating chart and can plug pore media or reservoir or production facilities. Therefore, bacteria analysis is highly required and very important to be carried out. The main points of this paper consist of three parts; firstly, identification of bacteria type. Secondly, determination of total bacteria counts with using ASTM D 5465-93 and Microscope Olympus CX41. Thirdly, selection of injection water quality rating chart. Laboratory tests for the analyzed water samples were performed, based on standard operational procedure (SOP). The results gave precious and helpful information before implementation of water flooding method in Sumatra oilfields.

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II. SCOPE OF WORKS

Lists of injection water samples that were analyzed in this research as follows :

1. N – 82
2. G – 90
3. G – GS
4. T – 21
5. T - GS

which scope of works involve :

- Identification of bacteria type.
- Determination of total bacteria count.
- Selection of water quality rating chart.

III. THEORY OF BACTERIA

This Section explains theory of bacteria briefly, especially related to oilfield water that will be used for water flood needs.

A. *Type of Bacteria*

Type of bacteria which is present in injection water, has enormous influence on quality of injection water. For example : Source of textbook Elementary Petroleum Microbiology (by. J.M Sharpley) and Applied Water Technology (by Patton Charles) explains that Subtilis bacteria is a dangerous type of bacteria that indicates incredible speeds of bacteria growth with large amount of bacteria in colonies. This case can cause the occurrence of plugging in media pore and the reduction of rock permeability around 80 % in water flooding process. Bacteria are extremely small (about 0.5 ìm in diameter) and exist in literally thousands of species. Bacteria can live at temperature (14 - 210^{o}F), pH value (0 - 10.5) and oxygen concentrations (0 - 100%) conditions. True bacteria are shaped like spheres, straight rods, or curved rods [2,3,6,7,8].

B. *Total Bacteria Count*

Determination of total bacteria count play important role in injection water quality test. The results of total bacteria count in injection water determinate injection water quality rating chart. The chart consists of several rating number as follows :

1. None (0 colonies /cc).
2. Very low (1 - 99 colonies/cc).
3. Low (100 - 999 colonies/cc).
4. Large enough (1000 - 9999 colonies/cc).
5. Large (10,000 – 99,999 colonies/cc).
6. Very large (> 100,000 colonies/cc).

Data above are from a textbook Introduction to Oilfield Water Technology (by.Ostroff A.G).

IV. METHODOLOGY

This section explains stages of bacteria type identification that are described briefly and schematically and can be seen in Figure 1 below. Identification of bacteria type exists in injection water samples took longer time around one to two months because needed by bacteria growth [3,7,8,9]. Then the other tests; total bacteria counts laboratory tests were determined by using ASTM D 5465-93 and Microscope Olympus CX41 (Please see in Figure 2).

V. RESULTS AND DISCUSSION

In water flood application planning, sources of water that will be used as displacement fluid in water flooding process, are from some wells and gathering stations :

a. N – 82.
b. G – 45.
c. G – GS.
d. T – 21.
e. T – GS.

For all analyzed water samples were mentioned above, the results of identification of bacteria types were tabulated in Table 3 and performance of bacteria growth, colonies, pure isolate and types of bacteria can be seen from Figures 3 to 7 on the next pages, namely:

- Figure 3 for N - 82 sample.
- Figure 4 for G - GS sample.
- Figure 5 for G - 90 sample.

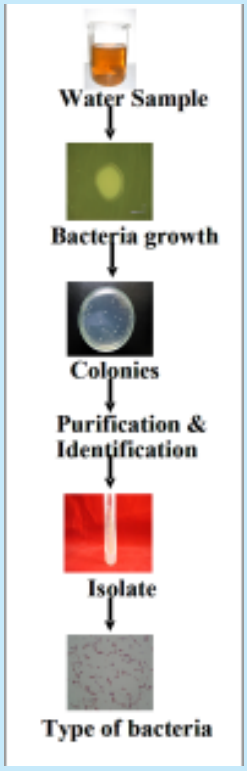

Figure 1
Stages of bacteria type identification

- Figure 6 for T - 21 sample.
- Figure 7 for T - GS sample.

Based on the results of bacteria analysis, N – 82 water sample had water quality rating chart no. 1 (none bacteria) because the water contained 5.02 x 10^{o} colonies/cc total bacteria count with type of bacteria *bacillus* sp. For the other water samples, total bacteria count for both G – GS and G – 90 water samples were larger compared with N – 82 sample.

So, both the water samples can be categorized as water quality rating chart no. 2 or very low with total bacteria count 4.28 x 10^{1} colonies/cc and bacillus sp type of bacteria for G – GS water sample, and 3.31 x 10^{1} colonies/cc with bacillus lateros porous for G – 90 water sample. Among of all analyzed water samples, total bacteria counts were found bigger in T – 21 (1.85 x 10^{2} colonies/cc) and T – GS (2.61 x 10^{2} colonies/cc) water samples with position of water quality rating chart no. 3 or very low. Both sample

Figure 2
Olympus CX41 Microscope

Table 5.1
The results of bacteria type Identification
For Injection Water Samples

No.	Water Samples	Type of Bacteria
1	N - 82	*Bacillus* sp.
2	G - 90	*Bacillus* Laterousporous
3	G - GS	*Bacillus* sp.
4	T - 21	*Bacillus Alvei*
5	T - GS	*Bacillus* Pathothenticus

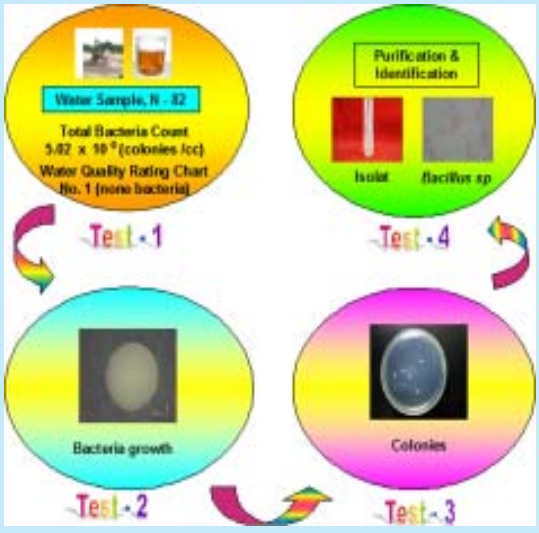

Figure 3
The results of Bacteria analysis of
N – 82 water sample

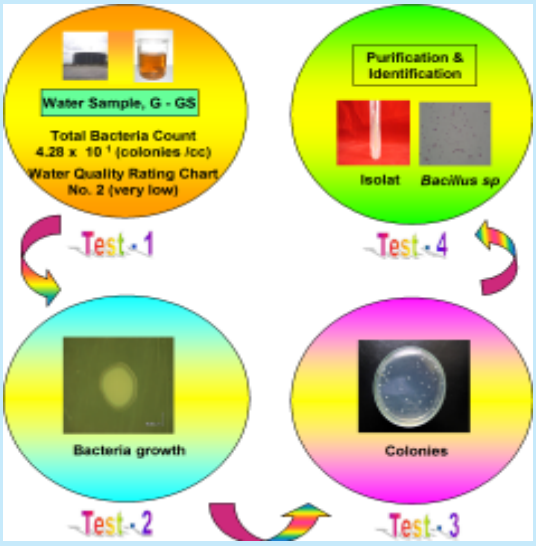

Figure 4
The Results of Bacteria analysis of
G - GS water sample

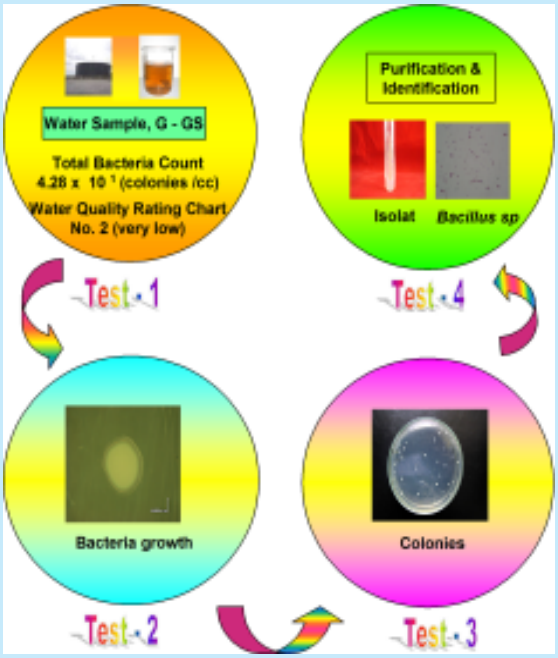

Figure 5
The results of bacteria analysis of G – 90 water sample

mentioned above had type of bacteria, namely bacillus alvei and bacillus Pathothenticus repectively.

VI. CONCLUSIONS

The obtained results of laboratory tests can be concluded as follows:

1. Water quality rating chart of the analyzed injection water samples were:
   - no. 1 is N – 82 water sample.
   - no. 2 is G – GS and G – 90 water samples.
   - No. 3 is T – 21 and T – GS water samples.
2. Total bacteria counts (colonies/cc) of the analyzed injection water samples were:
   - 5.02 x 10^0 for N - 82 sample.
   - 4.28 x 10^1 for G - GS sample.
   - 3.31 x 10^1 for G - 90 sample.
   - 1.85 x 10^2 for T - 21 sample.
   - 2.61 x 10^2 for T - GS sample.
3. The types of bacteria were found in the analyzed injection water samples were:
   - *Bacillus* sp. in N - 82 sample.
   - *Bacillus* sp. in G - GS sample.

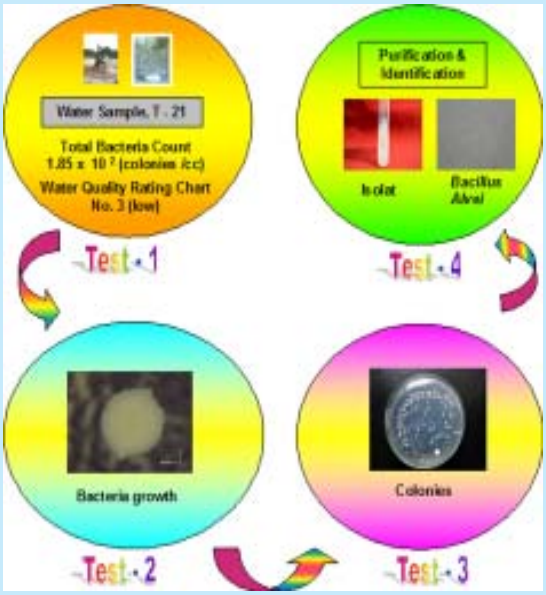

Figure 6
The results of analysis bacteria of T – 21 water sample

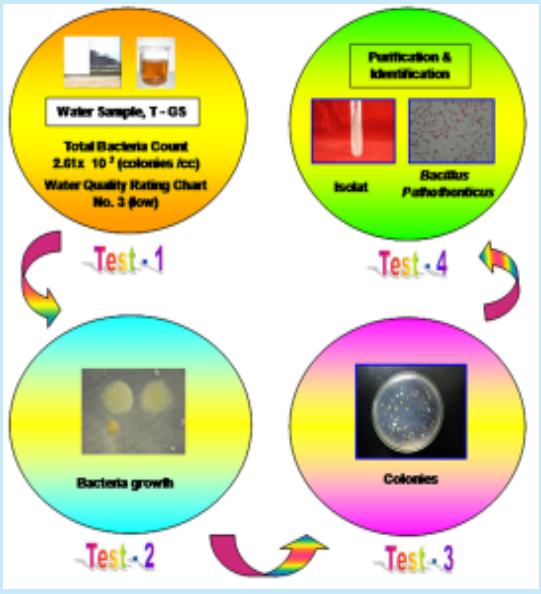

Figure 7
The results of bacteria analysis of T – GS water sample

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- *Bacillus Lateros porous* in G - 90 sample.
- *Bacillus Alvei* in T - 21 sample.
- *Bacillus Pathothenticus* in T – GS sample.

4. All analyzed injection water samples howed good water quality test results from total bacteria counts side.
5. Types of bacteria that were found in the analyzed injection water sample, were not dangerous type of bacteria (e.g. Subtilis is dangerous bacteria).

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