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RESEARCH ARTICLE

A NEAR WELLBORE SIMULATOR

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Abstract— The major objective of this project is to develop a Near Wellbore Simulator, a software programme, which will assist oil and gas companies in effective chemical squeeze treatments in oil and gas fields. This report contains methodology planned to apply to develop the complete software package for proposed Near Wellbore Simulator.

This document contains information about purpose and requirement of such programme, design of user interface for the programme users, methodology to do flow computation, and result calculation from flow computation have been described in sequence. In the beginning, the background information about challenges oil and gas companies are facing has been described along with the demand of this type of software programme.

The objective of this project is to develop a near wellbore simulator (a software package) to simulate the scale inhibitor squeeze treatment operations and evaluate post squeeze well behavior. The proposed simulator will serve for all the challenges (described above) faced by operator during scale squeeze treatments.

All the mathematical equations for solution flow, adsorption, desorption, will be provided and will be coded inside the software. The user of the software will input required data and compute squeeze treatments to solve various challenges they face during scale inhibitor squeeze.

There is important demand of a software programme, a near wellbore simulator, which assist oil and gas companies in effective squeeze treatments The region or rock layers, which is close to wellbore (let's say up to 50 meters away from wellbore) is called near wellbore region. Due to deposition of scale mineral either on the rock surface in the near wellbore region or inside the wellbore, oil and gas production decreases.

This software will help the oil and gas industries to determine what amount of chemicals should be used so that minerals should not get deposited on the wellbore.

Keywords— Simulator, Wellbore, Oil, SWT, Java

• Introduction

Oil and gas is reserved in the various rock layers, thousands feet below sea level, of the earth. Exploration and production companies like Shell, BP are involved with producing oil and gas by drilling wellbore into the earth. During oil and gas production, three phases of fluid: oil, water and gas produced.

There are different types of chemical compounds that are dissolved in different phases of production fluids. Here we discuss about a group of chemicals called Scale (combined name of inorganic minerals like BaSO4, CaCO3, FeS etc.), which is dissolved in water phase. During production, these scale minerals flow with water, from the rock layers to the wellbore; and then to the surface. On its flow path, scale mineral deposits on the rock surface as well as on the wellbore surface on regular basis.

The region or rock layers, which is close to wellbore (let's say up to 50 meters away from wellbore) is called near wellbore region. Due to deposition of scale mineral either on the rock surface in the near wellbore region or inside the wellbore, oil and gas production decreases.

Therefore, operator's major challenge is to avoid the deposition of mineral scale in the near wellbore region as well as inside the production wellbore. To do so, oil and gas companies inject a chemical (in solution form) called scale inhibitor into their production wells. This scale inhibitor goes down into the wellbore and further into the formation; and deposited on the rock in the near wellbore region. These inhibitors retained on the rock during production and do not allow the scale mineral to deposit.

Note the wellbore orientations can either be vertical or inclined or slanted. During production period, three phases of fluid (oil, water and gas) will flow out from the porous rock to the wellbore and finally to the surface. Producing water phase, when get in contact with deposited scale inhibitor in the near wellbore region, it does not allow mineral scale to deposit, but desorb some concentration of scale inhibitor and flush them out on continuous basis. Therefore, the concentration of scale inhibitor in the near wellbore reason continuously decreases.

Generally it takes about 2 to 3 months for the concentration of inhibitor on the rocks to go below a certain minimum value called MIC (minimum inhibitor concentration). The period during which scale inhibitors protect a well from the scale problems, is called squeeze life. Operators inject scale inhibitor on regular basis to always keep the inhibitor concentration above MIC; and therefore, they squeeze scale inhibitor on after every 2-3 months.

Operator major challenge during scale inhibitor squeeze treatments is:

- How to optimize squeeze treatment to enhance the squeeze life (to reduce cost of operation)?
- Which Chemical will perform the best for the kind of specific problem their well is facing?
- What percentage of inhibitor is placed in which layers
- How to improve inhibitor placement to the layer which require more inhibitor.
- How to minimize the formation damage effect?

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- **Scale Inhibitor Squeeze Treatment**

Scale inhibitor squeeze treatment is the process or operation of injection of scale inhibitor into the production wellbore. There are various systematic steps are performed during squeeze operations.

Generally, injection of inhibitor solution is performed into three stages consecutively called Preflush, main injection and overflush. In preflush, a very dilute (e.g., 0.5%) solution is injected. In main injection, high concentration (e.g., 10%) of solution is injected, and in overflush, fluid with no concentration of chemical or very dilute (e.g., 0.1%) is injected. These three injections are performed at three different injection rates.

When fluid or solution goes into the wellbore, its pressure at the wellhead (top of the well) is known along with injection rate at the wellhead. The injected fluid pressure changes while it goes down into the well due to friction and gravity effects. Once the fluid arrived at the mouth entry of the porous rock (i.e., at perforations), it starts diffusing or flowing into the rock formation.

Different layers of rock have different capacity to flow; and therefore, different percentage of total injected-solution distributed among different rock layers attached to the wellbore. The layers capacity depends upon several factors like rock permeability, porosity, perforation, pressure, formation damage etc. All the reservoir layers already contain three phases of fluid says oil, water and gas. The injected solution penetrates inside the formation rock by forcing in the fluid already available there.

After three stages (Preflush, main injection and overflush) of injection, the well is shut-down (usually for 1 or 2 days) to provide time for the solution to get deposited on the rock. After shut-in period, production of oil, water and gas begins.

• ECLIPSE, SWT & RCP

• *ECLIPSE*

Most people know Eclipse as an integrated development environment (IDE) for Java. Today it is the leading development environment for Java with a market share of approximately 65%.

Eclipse is created by an Open Source community and is used in several different areas, e.g. as a development environment for Java or Android applications. Eclipse's roots go back to 2001.

The Eclipse Open Source community has over 200 Open Source projects covering different aspects of software development.

The Eclipse projects are governed by the Eclipse Foundation. The Eclipse Foundation is a non-profit, member supported corporation that hosts the Eclipse Open Source projects and helps to cultivate both an Open Source community and an ecosystem of complementary products and services.

The Eclipse IDE can be extended with additional software components. Eclipse calls these software components plug-ins. Several Open Source projects and companies have extended the Eclipse IDE.

It is also possible to use Eclipse as a base for creating general purpose applications. These applications are known as Eclipse Rich Client Platform (Eclipse RCP) applications.

Eclipse requires an installed Java runtime. Eclipse 4.2 requires at least Java 5 to run.

For this tutorial you should use Java in version 6 or higher.

Java can be downloaded in two flavors, a JRE (Java runtime environment) and a JDK (Java development tools) version.

The Eclipse IDE contains its own Java compiler hence a JRE is sufficient for most tasks with Eclipse. The JDK version of Java is required if you compile Java source code on the command line and for advanced development scenarios, for example if you use automatic builds or if you develop Java web application.

• *SWT*

The Standard Widget Toolkit (SWT) is the user interface library used by Eclipse. It provides widgets, e.g. buttons and text fields, as well as layout managers. Layout managers are used to arrange the widgets according to a certain rule set.

SWT supports several platforms, e.g. Windows, Linux and Mac OS X. The design target of SWT is to stay closely to the operating system (OS); therefore the SWT API (Application Programming Interface) is very close to the native API of the OS.

As the SWT API is relatively low-level, programmers typically also use JFace.

SWT uses the native widgets of the platform whenever possible. The native widgets of the OS are accessed by the SWTframework via the Java Native Interface framework. The Java Native Interface (JNI) is a programming framework that enables Java code running in a Java Virtual Machine (JVM) to call, and to be called by, native applications and libraries written in other languages such as C, C++ and assembler.

The approach of using native widgets can also be found in AWT, a standard user interface library available in Java. In comparison SWT provides more widgets than AWT, as AWT does not provide widgets if they are not natively available on all platforms. In case a widget is not available on one platform but on another, SWT will emulate this widget on the first and uses the native widget on the latter. For example AWT does not have table or tree widgets included, while SWT has

Display and Shell

The Display and Shell classes are key components of SWT applications. An org.eclipse.swt.widgets. Shell class represents a window.

The org.eclipse.swt.widgets. Display class is responsible for managing event loops, for controlling the communication between the UI thread and other threads and for managing fonts and colors. Display is the base for all SWT capabilities. Every SWT application requires at least one Display and one or more Shell instances. The

main Shell gets, as a default parameter, a Display as a constructor argument. Each Shell should be constructed with a Display as an input parameter.

- *RCP (RICH CLIENT PLATFORM)*

- Eclipse RCP is a platform for building and deploying rich client applications. It includes Equinox, a component framework based on the OSGi standard, the ability to deploy native GUI applications to a variety of desktop operating systems, such as Windows, Linux and Mac OSX and an integrated update mechanism for deploying desktop applications from a central server.

- Eclipse was originally started as a modular IDE application. In 2004 Eclipse version 3.0 was released. Eclipse 3.0 supported the re-use of the Eclipse platform to build stand-alone applications based on the same technology as the Eclipse IDE.

- At this point the term Eclipse RCP was coined. Eclipse RCP is short for Eclipse Rich Client Platform and indicates that the Eclipse platform is used as a basis to create feature-rich stand-alone applications.

- The Eclipse 4 platform simplifies and unifies the Eclipse programming model and extends the concept of building Eclipse based applications with new technologies, like dependency injection and declarative styling via CSS files.

- The minimal required plug-ins to create and run an minimal Eclipse RCP application (with UI) are the two plugins "org.eclipse.core.runtime" and "org.eclipse.ui". Based on these components an Eclipse RCP application must define the following elements:

- • Main program - A RCP main application class implements the interface "IApplication". This class can be viewed as the equivalent to the main method for standard Java application. Eclipse expects that the application class is defined via the extension point "org.eclipse.core.runtime.application".

- **Methodology**

Design of the Graphic User Interface (GUI) will be one of the important tasks. According to user's demand, GUI should be very user friendly so that small training can provide then opportunity to user the software on regular basis. We have explained here all the options that will be available on GUI and their functionalities.

The GUI of the simulator has been planned to develop as standard GUI available in standard modeling tools like Petrel or ECLIPS (Schlumberger). It will be developed such that user can input data, perform simulation, obtained and analyse the output results.

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• OIL FIELD CHALLENGES AND SOLUTION

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There are different types of chemical compounds that are dissolved in different phases of production fluids. Here we discuss about a group of chemicals called Scale (combined name of inorganic minerals like BaSO4, CaCO3, FeS etc.), which is dissolved in water phase. During production, these scale minerals flow with water, from the rock layers to the wellbore; and then to the surface. On its flow path, scale mineral deposits on the rock surface as well as on the wellbore surface on regular basis.

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CONCLUSION

Oil and Gas companies use wellbore to dig out the oil from thousands of feet below the sea level. During production, these scale minerals flow with water, from the rock layers to the wellbore; and then to the surface. On its flow path, scale mineral deposits on the rock surface as well as on the wellbore surface on regular basis. Due to deposition of scale mineral either on the rock surface in the near wellbore region or inside the wellbore, oil and gas production decreases.

The chemicals are used to avoid the deposition of mineral scale in the near wellbore region. To do so, oil and gas companies inject a chemical (in solution form) called scale inhibitor into their production wells. The chemicals which are injected into the wellbore is very costly and that's why we cannot inject the chemicals again and again for some small deposition of mineral in a particular place of the wellbore. This software tells where to inject the chemical i.e. where is the deposition of the mineral exist and what quantity of chemical is needed to remove the deposition of minerals, so that we can use only that amount of chemical that is needed to reduce the cost.

In this way it will help Oil and Gas Companies take out oil and gas at low cost as the software determines the amount of chemicals needed.

The major objective of this project is to develop a Near Wellbore Simulator, a software programme, which will assist oil and gas companies in effective chemical squeeze treatments in oil and gas fields. The final result is in the form of graph which shows the values for the different chemicals i.e. which chemical will go upto what depth and which chemical is best suited for the purpose. The results for different cases can be compared also so that the user will be able to understand better their comparisons and their results. Another result for this GUI is the 3D view which has not been made yet. With the help of 3D view user will be able to view the wellbore and can check all the things related to the wellbore. The user can also modify the wellbore by shifting its sides.

FUTURE SCOPE

- The GUI could be enhanced based upon the end user needs.
- The number of chemicals for comparison could be increased.
- A 3-D view of the near wellbore simulator could be generated to improve the understanding of the project.

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