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Core Sampling Procedure For Use As Artificial Core In Enhanced `Oil Recovery (EOR) Study

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Abstract

The core sampling procedure must be carried out properly in order to produce cores of good quality. A good core sample will have an effect on the accuracy of the data that will be used. The core sampling method consists of Drill-string Coring and Wireline Coring. Enhanced Oil Recovery (EOR) study is a laboratory study to measure compatibility and amount of recovery. In that laboratory study, core samples from the reservoir are required to be carried out by the Enhanced Oil Recovery (EOR) study. Because the cost of taking the original core samples from the reservoir is quite expensive, usually the core samples used in this study are often called artificial core. A good candidate for an artificial core is a core that has similar characteristics and properties to the condition of the reservoir. The candidate quality of core samples is very important because the sample will represent the properties of the reservoir. By evaluating physical properties of the rock such as porosity, permeability, rock mineralogy, and the distribution of physical properties in the core sample, the best quality of the core sample will be obtained where the sample can represent the reservoir in the research area that Enhanced Oil Recovery (EOR) study will be conducted.

Keywords: Core, Artificial core, EOR

I. INTRODUCTION

Coring is carried out to find representative rock samples to obtain data on the characteristics, conditions, and properties of a reservoir. The data will be used according to the analysis required. Core sampling must be done in accordance with the procedure because it is to maintain the quality of the core sample. There are 2 types of retrieval methods, Drill-string coring, and Wireline coring. The things that need to

be considered in handling the cores are that the cores must be marked, insert the cores into the wooden box, must be protected from extreme conditions and shocks so as not to change the condition of the cores.

Coring and core analysis form an integral part of formation evaluation and provide vital information unavailable from either log measurements or productivity tests. Core information includes detailed lithology, the microscopic and macroscopic definition of the heterogeneity of the reservoir rock, capillary pressure data defining fluid distribution in the reservoir rock system, and the multiphase fluid flow properties of the reservoir rock, including directional flow properties of the system. Also, selected core data are used to calibrate log responses, such as acoustic, or neutron logs used to determine porosity. As a result, core data becomes an indispensable source in the collection of basic reservoir data directed toward the ultimate evaluation of recoverable hydrocarbons in the reservoir (Ubani et al.,2012)

Original cores are sample cores taken from the formation of a reservoir. Sample cores will be used for testing in oil and gas field development studies. Laboratory testing on cores to determine the nature and characteristics of a reservoir formation is needed when testing studies to be carried out.The Enhanced Oil Recovery (EOR) studies always begin with laboratory studies, that the laboratory studies use core samples. One of the laboratory tests to estimate the oil recovery factor on a one-dimensional scale is the core flooding test. This laboratory testing will require core samples or within the scope of this study sandstones as the testing medium. It takes sandstone criteria that can describe the characteristics of the reservoir to be used as a sample in core flooding testing in the laboratory. The native core is the best core sample in core flooding testing in the laboratory because it represents the real reservoir rock, but due to the limitations of the native core, many-core flooding tests are currently using Berea core samples which are considered to represent the characteristics of the native core (Nguyen et.al., 2014). The procurement of Berea core samples for testing in laboratories in Indonesia, in particular, is still experiencing difficulties because they have to go through the import process and the price is quite expensive.

The problem that is often faced is that in several tests for the Enhanced Oil Recovery (EOR) study, it requires several cores in the formation to be studied. The test was carried out several times because the core samples were tested with several surfactants with different concentrations and properties to choose which surfactant was most suitable to be applied to the formation to be studied. The candidate quality of rock samples is as important as the sample will be representing the reservoir property conditions. By evaluating the physical properties of the rock namely porosity, permeability, rock mineralogy, and distribution of physical properties in the core sample then you will get the best quality core sample, where the sample can represent the reservoir rock in the research area to be carried out by Enhanced Oil Recovery (EOR).

I.1. Methodology

1. Core sampling procedures
2. How to maintain sample cores
3. Laboratory analysis carried out to obtain data from core samples

II. RESEARCH METHODOLOGY

II.1. How To The Taking Of Core

Taking cores in a field is needed to determine the rock characteristics of a layer to be analyzed. Data from the core analysis is very necessary because it becomes a reference for the existing formation test. In the core sampling method, there are 2 methods that have their respective advantages. There is 2 type of taking core methods (Figure 1) :

1. Drill-string coring
    - The sample is taken from the bottom of the drill string
    - The tool is consists of an inner and outer metal barrel. The inner barrel is remains of the stationary and the outer barrel is attached to the bit and rotate.
    - The core size is about 30 ft in length.
    -

The advantages of drill-string coring are; a continuous vertical section of the formation, we can get a big core diameter, and have a big similarity to the original state.

2. Wireline core drilling is a special kind of drilling process that allows the core barrel to be removed from the base of the hole without taking out the drill rod. With wireline coring, the drill rod only has to be withdrawn up to the surface when the drill bit needs to be changed. Wireline coring, the Sample core can be taken at a different level in one run. Running wireline coring is faster than another method and get more sample from a different interval, and less rig time.

(A) (B) (C)

Figure 1. (A). Coring method, (B) & (C). Layne Rock Drilling

II.2. Core Recovery

Core samples that have been taken are marked and commented on based on the conditions of the core samples taken. The condition and quality of the core sample are very important to know because it relates to the quality of the core sample that can be analyzed. The percentage of Core Recovery will be one of the assessments of several parameters in the drilling process. The condition of the lithology, the competence of drilling operators, and the drilling method or performance of the drilling unit used.

Rock mass quality (RMQ) is a classification of core sample quality which is briefly based on the calculated RQD value. RQD (Rock Quality Designation) is the length of the sample core that is more than 100 mm (4 inches) that is successfully taken in one run.

Table 1. Rock Quality Description

RQD (Rock Quality Designation)	Description of Rock Quality
0 – 25 %	Very Poor
25 – 50 %	Poor
50 – 75 %	Fair
75 – 90 %	Good
90 – 100 %	Excellent

Cores should be stored in either wooden boxes or corrugated cardboard boxes (Figure 2).

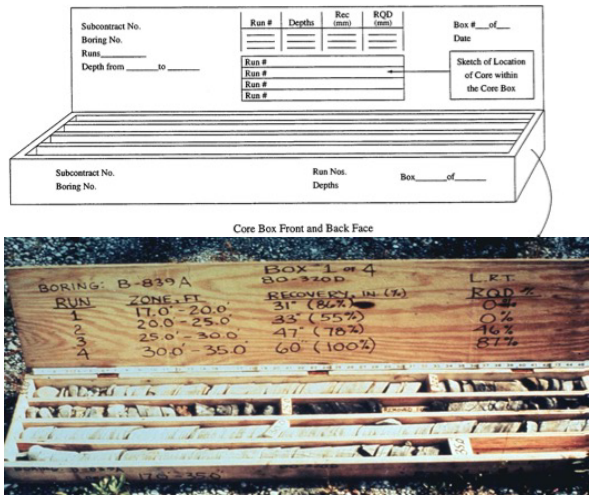

Figure 2. Box Marked Core

Box marked with a boring number, depth of core run, type core, bit type, core recovery (CR), rock type, Rock Quality Designation (RQD), and other notes.
Core operations should be documented: loss of fluid, rates, a sudden drop in rods, poor recovery, loss of core
The core runs taken in either 5-foot or 10-foot section (1.5- or 3-m sections)

Core Recovery is the percentage retained (Figure 3).

Figure 3. Core Recovery

II.3. Care and Preservation of Core Sample

Treatment of the core sample is carried out to maintain the condition of the core sample so as not to change its physical properties. Sample cores are protected from climatic conditions and external disturbances during storage and during delivery to the laboratory. Care and preservation of samples are very important to maintain core conditions.

- Sample must be marked and logged upon retrieval (identification, type, number, depth, recovery, moisture)
- Jar sample in wood or cardboard box
- Core sample should be protected from extreme condition (heat, freeze, and dry)
- Add sealed to minimize moisture loss
- Good packed and protected against external vibration and shock

II.4. Laboratorium Analysis

The analysis carried out in the laboratory is the initial stage to obtain reservoir characteristic data through the core sample that has been taken in detail. Laboratory analysis to determine the type of mineralogy that makes up the rock from the formation, rock texture, rock name, the amount of porosity, and permeability rock. The Testing Phase, at this stage the rock samples that have been taken will be entered into the laboratory for observation and analysis. Analysis carried out is petrographic analysis, porosity and permeability analysis, XRD analysis, and SEM analysis. The petrographic analysis will get parameters in the form of rock texture, mineralogy of rocks, and rock names. Porosity and permeability analysis will obtain parameters namely porosity and rock permeability. Analysis XRD will obtain parameters including mineralogy and minerals clay contained in the core sample. SEM analysis will be obtained parameters in the form of mineralogy, clay minerals, and pore geometry. The analyzes carried out at this stage will know the diagenesis of the reservoir rock. Laboratorium analysis was conducted after the sampling core. There is laboratory analysis :

- Petrography Analysis, obtained: mineralogy, rock texture, name of rock
- XRD Analysis obtained: mineralogy and shale

- SEM Analysis, obtained: mineralogy, porosity, and shale
- Porosity and permeability Analysis

II.5. Cores Usage

Core analysis to find data reservoir properties vary horizontally and vertical. Enhanced Oil Recovery (EOR) study data from core analysis is needed to find the compatibility of injection fluids and reservoir properties. There is cores usage :

- Obtain direct measurement of reservoir properties
- Used to correlate indirect measurement, such as wireline/LWD logs
- Used to test the compatibility of injection fluids
- Used to estimate the probability of formation failure and sand production

II.6. Core Analysis

Core analysis has two types, namely routine core, and Special Core Analysis. Routine core analysis is a basic and frequently performed analysis. In the core data routine obtained are basic rock properties such as; Porosity (storage capacity for reservoir fluids), permeability (reservoir flow capacity), saturation, and rock lithology. As for the Special core analysis, the data obtained is more detailed because it involves calculations from the laboratory. Data obtained from the Special Core analysis, among others; capillary pressure, relative permeability, wettability, pore volume compressibility, and electrical properties.

Data generated from the routine core and special core analysis will get the properties of fluid and rock. These data become references in making artificial cores. Making artificial cores is expected to have the same properties as original cores. After creating an artificial core, the core will be tested by validating it with the existing original core. Artificial core validation will be discussed in the next discussion.

II.7. Validation Artificial Core With Original Core Test

The original core is the core taken from the reservoir formation using existing extraction methods. In this test, the properties of the artificial core are validated against the original core sample. The selected artificial cores are cores that have the same properties as original rock. For example, to determine the success or failure of the validation, namely by testing the layers that have been successfully carried out Enhanced Oil Recovery (EOR).

III. FINDING AND DISCUSSION

The original score was taken from the reservoir formation using two methods, namely drill-string coring, and wireline coring or well-site coring. Each core retrieval method has its own specifications. Core analysis is performed to obtain rock and fluid properties data using 2 methods, namely routine core analysis (which is a basic analysis) and Special Core Analysis (obtaining more detailed data from basic analysis). The sample cores that have been taken will be well maintained and cared for because to keep the physical properties and characteristics of the original core unchanged. Taking the original core sample is expensive and to cope with this expensive cost, an artificial core is made. Artificial cores are made with the same characteristics as original cores. The purpose of making an Artificial core is because the Enhanced Oil Recovery (EOR) study requires an experiment using the core to test whether the study will succeed. Testing is done many times using cores, so it requires many cores to be tested. The original score was taken from the layers that Enhanced Oil Recovery (EOR) had done and was declared

successful. Core samples that have been taken from the reservoir are then analyzed in the laboratory to determine the rock properties. After knowing the properties of the original core, an artificial core will be created with the same characteristics as the original core sample. The artificial core properties that are created must be validated with the original core so that the accuracy and similarity of the properties are known. The Enhanced Oil Recovery (EOR) study was carried out in laboratory experiments with validated artificial cores. The use of artificial cores is done because the price of the original cores is very expensive and their collection has a high risk of failure, with the presence of artificial cores, laboratory analysis of Enhanced Oil Recovery (EOR) studies can be carried out repeatedly.

IV. CONCLUSION

1. Taking rock samples is needed to determine data on reservoir conditions, namely data on lithology, porosity, permeability, and other sub-surface data.
2. The quality of rock samples taken is protected from disturbances such as temperature, shocks during delivery to the laboratory, and extreme disturbances from the outside, therefore packing of rock samples must be safe.
3. Rock sample data analyzed by the laboratory is needed in addition to formation assessments but also to design what will be done for the next field, for example, when will an Enhanced Oil Recovery (EOR) studies be carried out.
4. The manufacture of artificial cores is carried out in the analysis of the Enhanced Oil Recovery (EOR) study because to take the original core requires high costs, therefore artificial cores are made with physical properties close to or the same as the original core.

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