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BEHAVIOR OF AN IMMERSED CORE SAMPLE IN A FLUID CONTAINER DURING A SATURATION TECHNIQUE

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Abstract

The objective of this paper is to present the behavior of some core samples immersed in a fluid container during a saturation technique. The experimental work was carried out by using two different fluids. The results obtained are similar except for the saturation stages. They are caused by different viscosities and surface tensions.

***Key words**: Sandstone core samples, Saturation, Water, Paraffin, Pressure effect, Buoyancy, Air, Interconnected pores, Equilibrium, Behavior, Isolated pores, Spreading velocity, Viscosity, Surface tension.*

Résumé

L'objectif de cet article est de montrer le comportement de quelques échantillons de carottes immergées dans un récipient durant une technique de saturation. Le travail expérimental a été fait avec deux fluides divers. Les résultats obtenus ne sont identiques que pour les étapes de saturation. Ils sont dus à des viscosités et des tensions superficielles différentes.

***Mots clés**: Echantillons de carottes gréseuses, Saturation, Eau, Paraffine, Effet de la pression, Poussée, Air, Pores interconnectés, Equilibre, Comportement, Pores clos, Vitesse de dispersion, Viscosité, Tension superficielle.*

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ملخص

الهدف من هذا المقال هو إظهار السلوك لبعض العينات الجزرية المغمورة في إناء أثناء تقنية تشبع. جرى العمل التجريبي في المخبر بواسطة مائعين متنوعين.كانت النتائج المحصل عليها متشابهة إلا في ما يخص مراحل التشبع. وهي راجعة للاختلاف في اللزوجة والتوتر السطحي.

***الكلمات المفتاحية**: العينات الجزرية من الحجر الرملي، التشبع، الماء، البرافين، تأثير الضغط، الطفوية، الهواء، المسام المتواصلة، التوازن، السلوك، المسام المنعزلة، سرعة الانتشار، اللزوجة، التوتر السطحي.*

This paper deals with the behavior of some core samples during a saturation technique. It describes a test procedure conducted with water and later paraffin(*) saturation of three sandstone core samples, selected from three faces: A, B and C of a large cubic block and where one core was taken from each face. The core samples were carefully prepared taking into account a thin clay bedding planes exhibited on one face of the block.

EXPERIMENTAL WORK

The principle of the method used consists of weighing at time intervals each immersed core sample, from initial saturation to the approximate final saturation stage [2]. The core sample was laid on a small basket support, totally immersed in the fluid container. The basket was suspended on the top side of an accurate electronic balance by a nylon fishing line.

The experimental work was carried out by using water first and then paraffin, and by taking a constant height from the surface of fluid to the core sample.

A particular attention was, therefore, given to the pressure effect of the fluid column acting upon the core sample. This pressure would be significantly apparent, only because of the two different fluid characteristics.

The following formula has been taken into account: $P = W.H$, where P denotes the pressure acting upon the core sample, expressed in g/cm²,

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(*) A white, tasteless, odorless and chemically inert waxy substance composed of natural hydrocarbons (C_nH_{2n+2}) and obtained from petroleum (A.P.I. -American Petroleum Institute- Gloss. Refg. Terms, 1953) [1]. Here, the type of this substance concerns a paraffin oil or kerosene.

W the specific weight, expressed in g/cm^3, and H the vertical distance from the fluid surface to the core sample, expressed in cm.

The initial and final saturation weights (respectively $W_{in.}$ and $W_{fi.}$) of the immersed core sample were determined by:

$$W_{in.} = W_d - V.\, D_f$$

$$W_{fi.} = W_s - V.\, D_f$$

where W_d and W_s denote, respectively, the dry and the saturated weights of the core sample in air, expressed in g; V the volume of the core sample, expressed in cm^3, and D_f the specific gravity of the fluid, expressed in g/cm^3.

The product ($V.D_f$) is known as buoyancy, expressed in g.

It should be noted that the values of saturated weights were directly taken by using the electronic balance and expressed in percentages (%).

RESULTS AND DISCUSSION

Once all the temporal and saturated weight values were obtained and plotted, the resulting curves $S(t)$ could be analyzed as follows:

Figures 1 and 2 show a plot, which can be called a retardation function and may be divided into three parts:

First, a displacing air stage, where a core sample rapidly gained some fluid molecules. The latter have an energy corresponding to a work performed to be placed at the surface of the core sample [3]. Simultaneously some air bubbles were displaced from the core sample into the fluid solution. Therefore, the core sample increased in saturated weight.

Second, a solution of air in the interconnected pores stage, where the core sample accumulated only a minute quantity of fluid penetrated into the core sample. There occurred an equilibrium partitioning between the fluid and solid phases. This is the stage, which presents a behavior of the core sample known as a retardation function due to the presence of dissolved air in the liquid. This second stage is due to the surface tension effect.

The surface tension or interfacial tension between two phases appears, for example, when a water molecule situated at the interface liquid-air is attracted on one part of its surface by the other water molecules and on the other part by the air molecules [4].

Third, a solution in the isolated pores stage, where the core sample slowly gained some fluid. Here, all large pores were filled.

Three ranges of fluid saturation may be distinguished between the limits of 0 and 100 %, namely [5].

They are defined as [5]:
- equilibrium water saturation;
- funicular saturation; and
- insular saturation.

From the physical aspect of this core sample behavior, paraffin, which was used as the second fluid saturation, gave approximately the same responses. The three preceding stages were also represented with a same trend but with a lower saturation value than for water.

Because of the same testing conditions maintained during the experiment, this different saturation could be explained by the spreading velocity of fluid over the core sample surface. Being affected by surface tension and by viscosity, the spreading velocity was increased by lower surface tensions and lower viscosities [6].

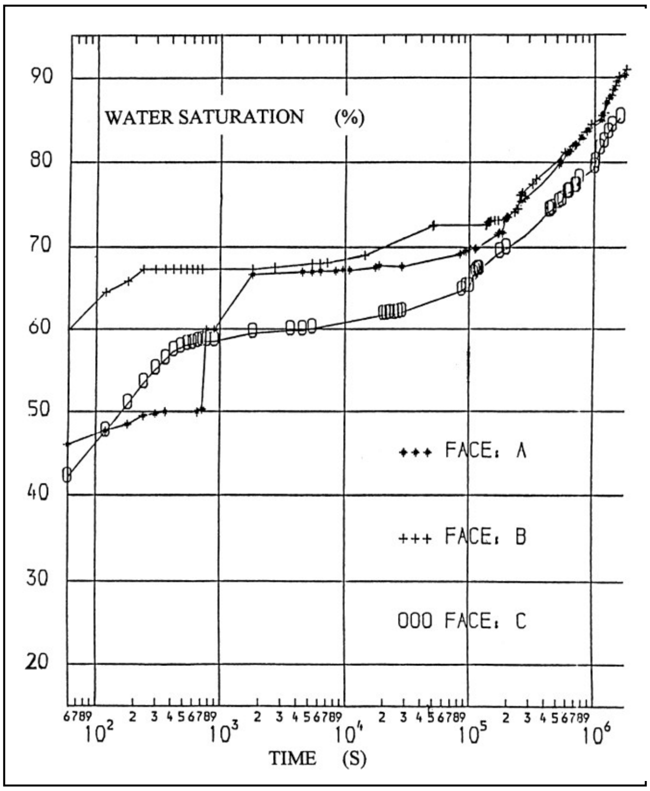

Figure 1: Schematic curves relating water saturation S to time t.

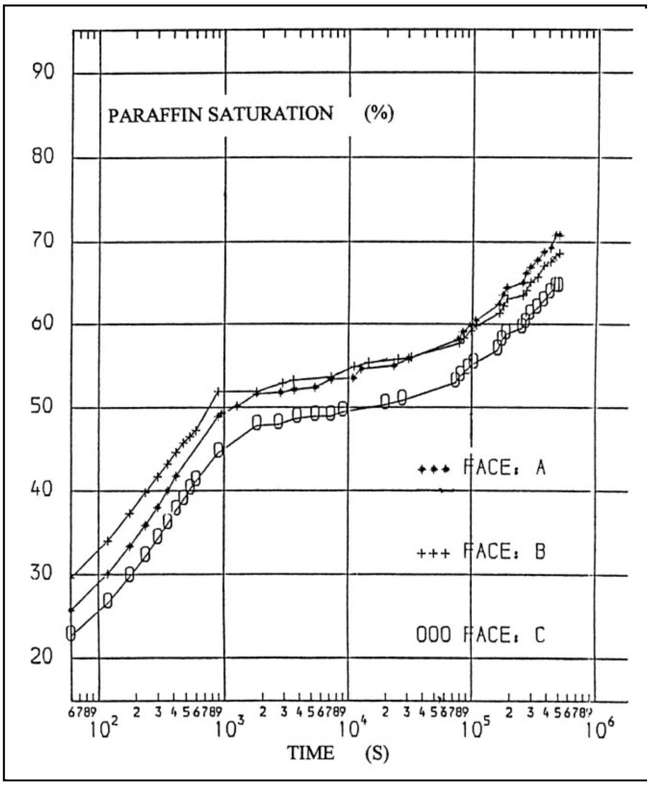

Figure 2: Schematic curves relating paraffin saturation S to time t.

The difference in saturation, therefore, is due to a smaller viscosity and a smaller surface tension of one fluid leading to a faster spreading velocity for water than for paraffin.

CONCLUSION

With particular reference to saturation technique, the experimental work has shown a behavior of some immersed core samples. For both fluids, the test procedure conducted revealed equilibrium, a funicular and an insular saturation. However, paraffin presented a lower saturation values than water.

A further experimental work might be carried out, in order that emphasizes should be focused at the quantitative aspect of this character.

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