The effect of saturation Methods on natural gypsum rocks

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Abstract

When the gypsum rock is exposed to the relative humidity in a closed environment for a continuous period, the result is an increase in the weight of these rocks after the passage of the first 24 hours, and there is no effect on the percentage of gypsum that the rocks contain, as the weight increase occurred at the same time for the different gypsum ratios. For rocks submerged in potable water and located within a humid environment, most of these rocks witnessed weight gain, with some exhibiting dissolving behavior. As for the gypsum rocks submerged with water saturated with aqueous calcium sulfate salt, they witnessed weight gain without any solubility. It is worth noting the important effect that relative humidity plays in the atmosphere at high levels, as it stimulated the saturation property to cover and overcome the famous property of gypsum rocks, which is the melting at high humidity.

Keywords: Natural gypsum rocks; saturation; humidity; exposure.

1. Introduction

Iraq includes several geological formations, including Al-Fatha formation, which is revealed on the surface of the earth in different governorates, such as Erbil, Kirkuk, Mosul, Diya, Wasit, Sulaymaniyah, and Anbar, and it includes several deposits, including the primary gypsum.

Taking the engineering view, we find that the presence of gypsum rocks within the soil layers of a specific project negatively affects the effectiveness of the project[1], and the reason is due to the high sensitivity of the gypsum rock to the existence of water [2, 5]. This sensitivity is represented in the saturation process that rocks are subjected to when in contact with water and the relative humidity for continuous periods depending on the surrounding conditions that accelerate or slow the saturation process. Exploring the effect of saturation is important to find out the highest percentage of water that can fill the pores of the gypsum rock and the effect that it can have on the weight of the rock and its resistance to the stresses, and later the stability of the structures built on layers of gypsum rocks saturated with water, relative humidity or both, so the researchers addressed this effect under consideration.

Sadeghiamirshahidi and Vitton [3] examined the effectiveness of different types of saturation methods during the test (freshwater, gypsum-saturated water, vacuum saturation, and improved vacuum saturation) they concluded that 30 h is a convenient saturation time for gypsum cores using the first three methods and 24 h was recoded as the required time to saturate gypsum cores using the improved vacuum saturation with additional 24 h time needed for sample preparation. Mohammadi et al.[4] investigated the
saturation of gypsum rocks in terms of sensitivity for dry vacuum saturation, wet vacuum saturation, and time of applying each one of them their result appointed 5 h was enough time to achieve saturation using a dry vacuum method under initial dry vacuum pressure \( P_{\text{vac(dry)}} = -0.5 \text{ atm} \), and \( P_{\text{vac(wet)}} = -0.5 \) recorded 95% weight gain at 96 h. Hoxha et al. [5] studied the deformation that occurs in the gypsum rock due to the existence of relative humidity in the underground quarries they used three different percentages of relative humidity \( RH = 30\% \), \( RH = 60\% \), \( RH = 90\% \) kept in under-controlled conditions. Relative humidity was achieved using the salt solution method which maintains placing rock samples in closed-cell with atmosphere responding to a source of an over-saturated solution. For a constant relative humidity, a specific type of salt should be added to the solution placing a rock sampling in that cell accompanied with mass change (absorbing \ releasing of water) because of the present equilibrium process between vapour pressure and water pressure in the rock sample pores. When equilibrium complete no mass change happen in the rock sample mass in this study equilibrium took place between 15 to 30 days.

In this paper we present a new perspective of saturation using a new method for imposing the relative humidity, studying the effect of the relative humidity environment on the gaining \ losing process and the time required for achieving the maximum weight gain.

2.Methods and Materials
Geology of the studied areas
The rock samples have been taken from three different districts all over Iraq Figure (2) Zurbatiya in Wasit governorate( E:589795 N:3693005 UTM ), Bazyan in AL-Sulymania governorate ( E:512004 N:3940373 UTM ), and hit in AL-Anbar governorate ( E:307715 N:3705260 UTM ) containing three different percentages of gypsum content (42.28%, 73.91%, and 72.48%) respectively. The total number of the samples 36 sets in three groups each group represent a district then each group was subdivided into 4 samples to resemble each saturation case the samples have an irregular shape, dissimilar in weight, their colors included white, dark grey mixed with white, and pale yellow.

**Figure 1.** cool-steam humidifier.  
**Figure 2.** relative humidity devise.
Figure 3. Rock samples from Zurbatiya, Bazyan, and Hit.

Figure 4. Gypsum salt (CaSO$_4$.2H$_2$O) powder.

Figure 5. (a) Left samples submerged in a potable (b) right samples submerged in a gypsum-saturated water.

Cool-steam Humidifier to stimulate the high relative humidity environments ‘Figure 1’.

Container to maintain the relative humidity in a specific place and keeping the water level in the vessels under control from the evaporation process ‘Figure 6’.

Vessels for submerging samples in potable water and gypsum-saturated water ‘Figure 5’.

Hygrometer measures the relative humidity in a closed container ‘Figure 3’.

A sensitive balance that is accurate 0.01 in grams ‘Figure 4’.
3. Results

**Figure 6.** Container where all the saturation methods kept.

**Figure 7.** Saturation methods effect on Hit district samples.
Gypsum is considered a salt with high solubility and has a solubility in liquids with different properties[5], and in this paper, the results showed that gypsum samples gain weight upon the passage of the first 24 hours and maintain this gained weight, but the gypsum shows its lack of stability throughout the subsequent period as it shows signs gain and loss. But these changes, if any, are small, and they are a phenomenon that expresses the tendency of gypsum to interact with the influencing effect. Therefore, there was no need to continue the experiment after 200 hours.

The use of relative humidity with its direct effect and simulating its presence in nature to discover its effect on samples is considered unprecedented and the mechanism of its effect is still unknown. There is a lot to know about relative humidity especially since there are regions in the world known for their high humidity and may be associated with low temperature. Many researchers considered the solubility of gypsum in water[6, 7] and with different influences to find out the reaction of rocks with variable gypsum content[8]. Because this solubility is the source of the problems that threaten the stability of structures built on layers with gypsum content, and in the worst case, it is the cause of damage to the structure and rendering it unusable.

In addition to the reported human losses but the main results from this paper cleared weight gain might lead to a different kind of failure in the gypseous strata and the samples to show different types of failure criteria. For samples saturated using gypsum-saturated water also experienced a dissolution behavior due to the gypsum ability to form an over-saturated solution[3].

4. Conclusion

• There was no effect for gypsum content percentage on the saturation (dissolution \ absorption) behavior.
• Further investigation and studies need to be made about the relative humidity effect on the mechanical behavior of gypsum rock, especially with the low-temperature present.
• All three methods effective and can be used for saturation 24 h is enough time to achieve a weight gain in the three methods inside a high humid environment.

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