



Experimental Investigation of Pomegranate Peel and Grape Seed Powder Additives on the Rheological and Filtration Properties of Un-Weighted WBM

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Abstract

The chemical additives used to enhance the properties of drilling mud cause damage to humans and the environment. Therefore, it is necessary to search for alternative additives to add them to the drilling mud. Thus, this study investigates the effects of pomegranate peel and grape seed powders as natural waste when added to un-weighted water-based mud. The test includes measurements of the rheological properties and filtration, as well as the alkalinity and density of the drilling mud. The results showed a decrease in PH values with an increase in the concentrations of pomegranate peel or grapeseed, and a decrease in mud density with an increase in powders of pomegranate peel and grape seed concentrations that resulted from the formation of foam. The rheological properties appeared with increasing except for the plastic viscosity. Grape seed powders reduce the filter cake thickness required to solve drilling problems caused by an increase in the mud cake thickness. From the laboratory results, it's possible to use powders of pomegranate peel and grape seed as additives to reduce plastic viscosity and filtrate volume.

Keywords: water-based mud, local material additives, powders of pomegranate peel and grape seed, rheological properties, filtration properties.

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1- Introduction

Drilling muds can be considered complex systems made up of multi phases like solid phase, a liquid phase, and also, contain a chemical phase [1].

The journey of the drilling fluid starts first from the pumping process at the surface to enter the well below the drill string then Out of the holes in the bit and through the annular space, it returns to the surface [2].

Drilling fluids have a lot of functions such as the cutting's removal from the hole and transport them up to the surface, To transfer hydraulic horsepower to the bit that drills the well, It's used for cooling and lubricating the bit and drill string, To present supporting and protecting for the hole walls, For exerting adequate hydrostatic pressure in the purpose of controlling fluids in the filtrated formations and Minimizing of the cuttings settling and weight substance in suspension while circulation is discontinued and For ensure getting maximum information around the penetration of the formations [3].

Drilling fluids are broadly classified into pneumatic (gases) or liquid. Relying on the continuous phase, Drilling fluids of liquid type are divided into water-based mud and oil-based mud [4]. Water-based mud is consists of water as the continuous phase, which can be fresh, salt, etc.

Depended on the additives type utilized to improve its properties, water-based mud is moreover classified into non- inhibitive mud, inhibitive mud, and polymer muds [5].drilling fluids rheological properties include plastic & apparent viscosity, yield point, and gel strength, while the filtration properties of drilling muds include both of filtrate volume & filter cake thickness [6]. The high cost of chemicals and their harm to humans and the environment calls for moving to natural materials [7].

When drilling an oil well, different problems associated with drilling fluid properties will appear. As an example, a stuck pipe may be cut or stop the drilling progress for some time (weeks for example) [8]. This period had been named as non-productive time (NPT) which is the amount of time spent to free a stuck pipe [9]. The most encouraging to happen stuck pipe is when drilling the wells that need accurate noticing and high technology such as wells with high inclined, drain hole, multilateral, horizontal wells, etc. this problem can ranges in seriousness from small trouble to big complexity, that can have side effects, like drill string loss or in the worst case, a whole loss for the well [10]. Different estimates show that stuck pipe costs more than \$250 million every year [11].

The drill string sticking is divided into two main types: differential and mechanical sticking. Differential sticking happens when the drilling fluid's hydrostatic pressure is higher than the permeable formation's pore pressure.

This overbalance compresses the drill string into the wellbore. This happens firstly while the drill string has been stationary or moving unhurriedly and becomes in contact together with a thick mud cake or with a permeable formation [12].

On the other hand, Mechanical sticking happens when: insufficient removal of the cutting that drilled exists, instability of the borehole is found, like hole caving, collapse, or sloughing, salt sections squeezing or plastic shale, and key seating [13].

This study focuses on the utilizing of eco-friendly materials (two local materials) to know their influence on the sticking problem. So, the main goals of the present research are to investigate the influence of pomegranate peel powder and Grape seed powder with various concentrations on the rheological and filtration properties of un-weighted WBM.

2- Experimental Work

2.1. The Materials

The materials that were used to prepare un-weighted WBM were given by the Baghdad oil Training institute. These materials are:

a. Bentonite

The shape of bentonite is illustrated in **Fig. 1**.



Fig. 1. Bentonite

b. Sodium Hydroxide (NaOH)

Fig.2. Illustrates the shape of sodium hydroxide.



Fig. 2. Sodium hydroxide

c. Pomegranate Peels Powder (PPP)

The color of the material is light brown color, similar in its appearance to the dust, relatively lightweight. It blends quickly with drilling muds when it mixes with them but changes the color of the drilling muds to brown or light orange. The shape of PPP before and after grinding is shown below in **Fig. 3** (a and b). The chemical and structural composition is shown in **Fig.4**.



(a)



(b)

Fig. 3. (a. Pomegranate peel and b. pomegranate peel powder)

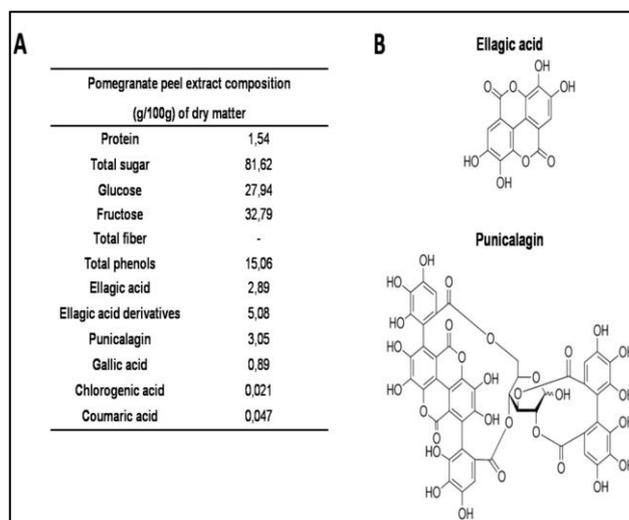


Fig. 4. structural and chemical composition of pomegranate peels (14).

d. Grape seeds powder (GSP)

The Chemical composition of GS is includes: water (28-40%), oil (10-25%), cellulose (28%), tannin (4-6%), nitrogenous (0, 8-1, 2%), mineral substances (2-4%), acids of fat and other components [15].

Grape seeds are found inside the fruit in varying numbers: two, four, more or less, depending on the type of grape. After grinding the seeds, the powder becomes a rough texture like granules with black or dark purple color, which need to mix them well with the drilling fluid. The shape of GSP before and after grinding is shown below in Fig. 5 (a and b).

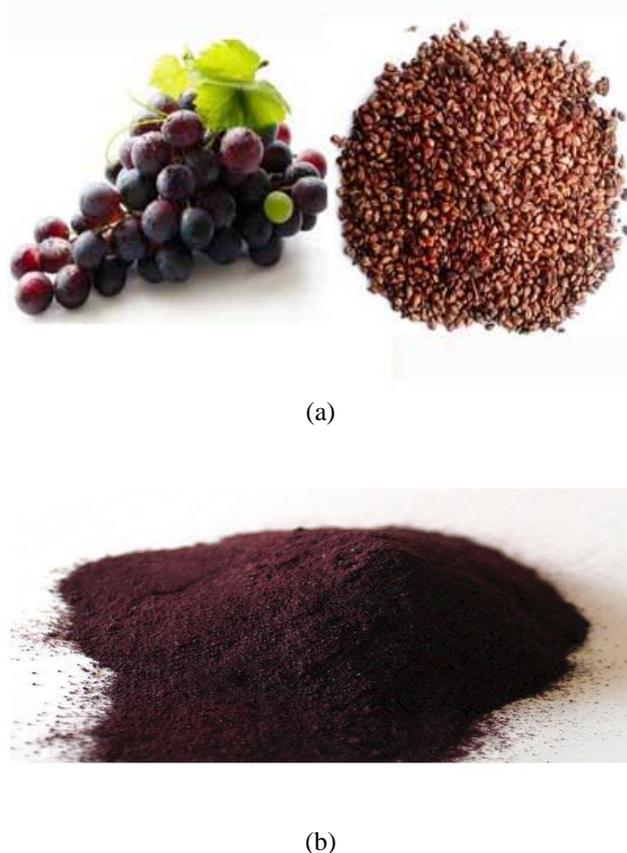


Fig. 5. (a. grape seeds and b. grape seed powder)

Table 1. Caustic Soda Specifications [16]

Chemical Name	Sodium Hydroxide
Chemical Formula	NaOH
Colour	White
Boiling Point (°C)	1390
Melting Point (°C)	318
Solubility (water)	Soluble with the evolution of heat
Specific Gravity	2.13
Bulk Density (g/ml)	1.175

2.2. Equipment

The devices used in this research include secondary ones like a blender to mix the solution, electronic balance to weigh the materials, and grinder to grin the local materials. The primary devices include mud balance to measure the drilling muds density, the rotational viscometer to measure the rheological properties, and the API filter press to measure the filtration properties.

2.3. Preparation Procedure

The materials utilized to prepare drilling mud and their concentrations were explained in Table 2.

The first step in the preparation is to clean the local materials well and dried them for some time, then grind the dried materials more than once to obtain good powder free of big pieces and sieve them also to disposal of large blocks if found, This will facilitate the mixing process with drilling mud.

By utilizing electronic balance, the materials have been measured. Also, water was measured by measuring cylinders. After the measuring process, water, bentonite, and chemical additives were mixed inside the Hamilton Beach mixer for 20 minutes. After 22 hours, the local materials were added in different concentrations (0.5, 1, 3, 5, and 7 gm.) and mixed for about 15 minutes. The mixtures were ready for testing different properties (rheology, filtration, density, PH, and gel strength).

Table 2. compositions of drilling mud samples

Materials and additives /350ml	Quantity of additives
Water(ml)	350
Bentonite(gm)	30
NaOH(gm)	0.4
Pomegranate peel powders(gm)	0.5,1,3,5,7
Grape seed powders(gm)	0.5,1,3,5,7

2.4. Rheological Properties Calculation

Rheological properties contain:

1- Plastic viscosity (PV) in cp that can be calculated from equation (1)

$$PV = \Theta_{600} - \Theta_{300} \quad (1)$$

2- Yield point (YP) in lb/100ft² can be calculated by equation (2)

$$YP = \Theta_{300} - PV \quad (2)$$

3- Apparent viscosity (AV) in cp which can be calculated by equation (3)

$$AV = \Theta_{600} / 2 \quad (3)$$

3- Results and Discussion

3.1. Drilling Muds Rheological Properties

Un-weighted WBM has been prepared to contain: the basic composition (the known additives) and local material (powders of pomegranate peel & grape seed).

To study the nature of these local materials on the behaving of drilling mud, the rheological properties had been measured as shown in Table 3 and Table 4, Fig. 6 to Fig. 10.

Table 3. Properties of un-weighted WBM with pomegranate peel powders

properties	Concentrations of PPP(gm.)					
	0	0.5	1	3	5	7
Density(ppg)	8.67	8.3	8.25	8.15	8.1	8
AV(cp)	10	15.25	17	24.5	30	33.5
YP(lb/100f ²)	14	11.5	21	35	44	55
PV(cp)	8	9.5	6.5	7	8	6
PH	11.3	11	10.5	10	9	8.5
Gel strength (lb/100f ²) 10 sec	9.7	3	7.5	26	28	35

Table 4. properties of un-weighted WBM with grape seed powders

properties	Concentrations of GSP(gm.)				
	0.5	1	3	5	7
Density(ppg)	8.35	8.25	8.1	8	7.95
AV(cp)	15.5	19	22.5	29	29
YP(lb/100f ²)	11	20	34	48	50
PV(cp)	10	9	5.5	5	4
PH	11	10	9.5	9	9
Gel strength (lb/100f ²) 10sec	5.7	10.5	12	12.3	14

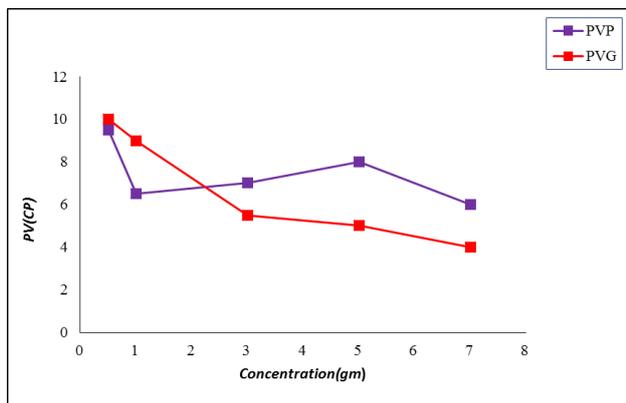


Fig. 6. Plastic viscosities of local materials versus their concentrations of un-weighted WBM

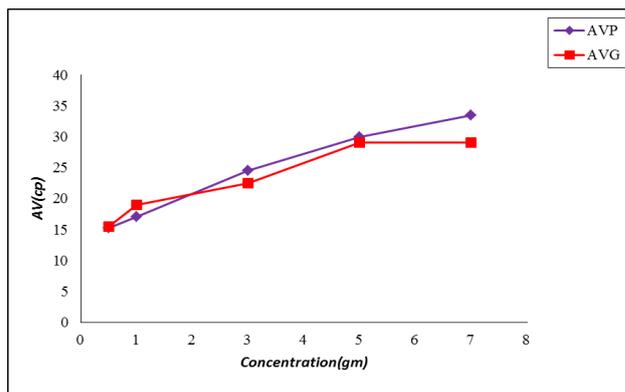


Fig. 7. Apparent viscosity of local materials versus their concentrations of un-weighted WBM

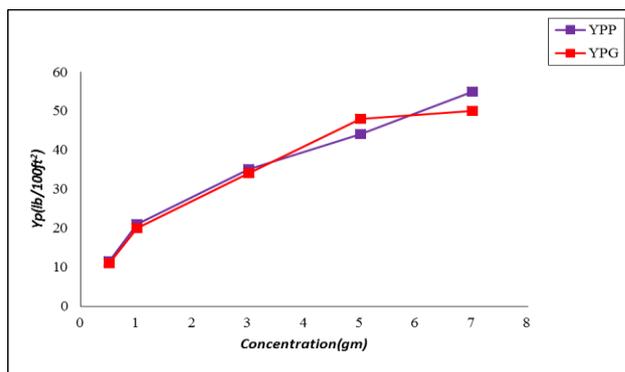


Fig. 8. yield point of local materials versus their concentrations of un-weighted WBM

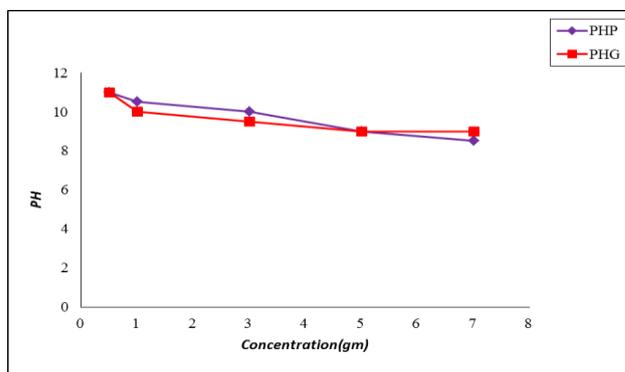


Fig. 9. The alkalinity of local materials versus their concentrations of un-weighted WBM

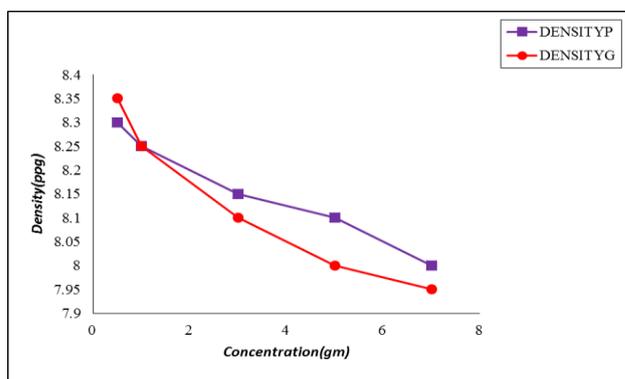


Fig. 10. Densities of local materials versus their concentrations of un-weighted WBM

3.2. Filtration Properties of Drilling Muds Contain Various Concentrations of Local Materials:

Filtration properties in terms of filtrate volume and mud cake thickness had been tested for Un-weighted WBM with additives of powders of pomegranate peel and grape seed as shown in **Table 5**.

Table 5. filtration properties of un-weighted WBM with local material additives

properties	Concentrations of PPP(gm.)					
	0	0.5	1	3	5	7
V2(ml)	2.5	4.2	3.9	3.5	2.5	2
V4(ml)	4	5.5	5	4.8	4	4
V6(ml)	5.5	6.7	6.02	5.8	4.8	4.9
V7.5(ml)	6	7.2	6.55	6	5.1	5.1
V30(ml)	12	14.4	13.1	12	10.2	10.5
Mud cake thickness(mm)	0.65	1	1	1	1	1

properties	Concentrations of GSP(gm.)					
	0	0.5	1	3	5	7
V2(ml)	2.5	3.5	3.7	3.7	3.7	3.8
V4(ml)	4	5	4.9	5.5	5.2	5
V6(ml)	5.5	6.2	6.1	6.1	6.1	5.8
V7.5(ml)	6	6.8	7.1	7	6.8	6.4
V30(ml)	12	14.2	14.2	14	13.6	12.8
Mud cake thickness(mm)	0.65	1	1	0.55	0.52	0.52

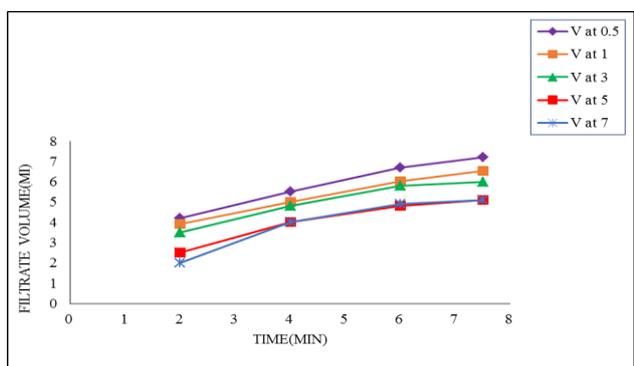


Fig. 11. Filtrate volume of different concentrations of pomegranate peel powders versus time of un-weighted WBM

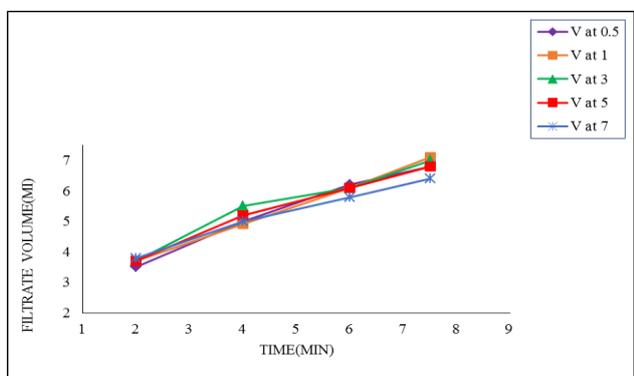


Fig. 12. Filtrate volume of different concentrations of grape seed powders versus time of un-weighted WBM

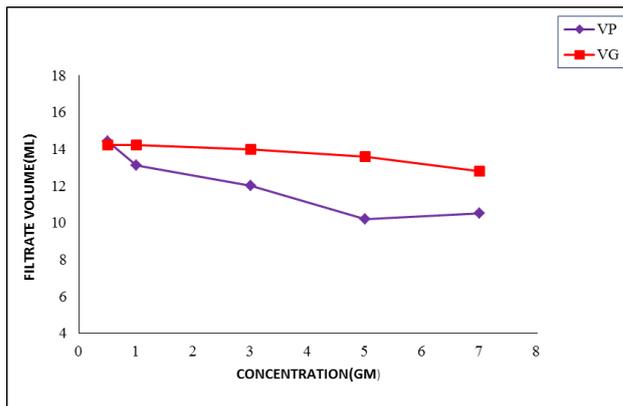


Fig. 13. Filtrate volume of local material additives versus their concentrations of un-weighted WBM

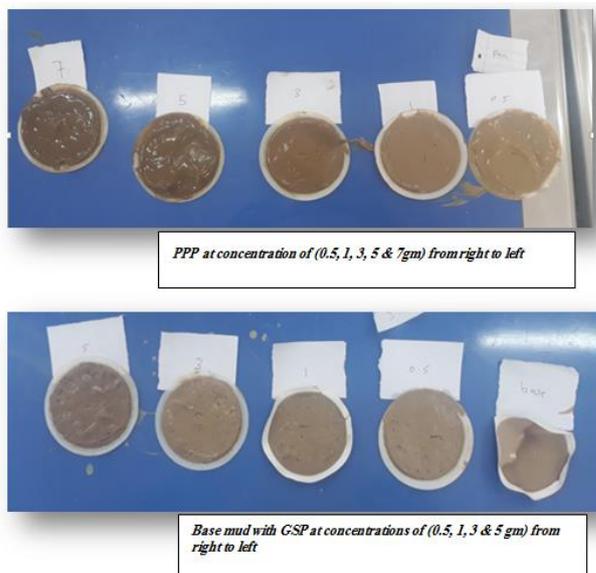


Fig. 14. The thickness of the mud cake of local material additives at different concentrations of un-weighted WBM

After adding the local materials (PPP & GSP) to un-weighted WBM, the results as shown in tables and figures above presented that, adding PPP made the Plastic viscosity smoothly decreased from a concentration of 0.5 gm. to a concentration of 1 gm. with a rate of (3 cp) and PV increased in (3 & 5 gm.) and return to decrease in (7 gm.) concentration to (6 cp) which was the lowest value among the concentrations.

When adding GSP with 3 gm concentration, PV, AV, and YP were 5.5 cp, 22.5 cp, and 34 lb/100ft² respectively. GSP additives were increased in AV and YP and were decreased in PV, density, and PH. The decrease in density yielded from the formation of the foam which occupied volume and made decreasing in the density from 8.34 ppg to 7.95 ppg.

Also, from the above figures and tables, adding PPP to un-weighted WBM appeared good behavior in terms of filtration properties.

For example, when comparing the filtrate volume at 2 minutes with different concentrations, the results appeared improvement in the filtrate loss which is decreases from 4.2 ml at 0.5 gm. to 2 ml at 7 gm.

Also, GSP showed improvement in the filtrate volume but less effective when compared with PPP. The concentration of (7 gm.) was the best among the rest concentrations which gave filtrate volume equal to 12.8 ml.

To compare the results with the previous researches [17] Experimented with new additives to prevent or decrease differential sticking by using Nanoparticles of black carbon with drilling mud to change mud properties.

The experiment gave that Added black carbon with 30nm initial size of particles has shown improvement in decrease cake thickness, The viscosity decreases and dropped further when the temperature increases, reduced yield point at adding black carbon, and also the reduction rate increases with increasing temperature and black carbon proven its activity to enhance mud properties to decrease pipe sticking.

Also, (10) investigated the influence of bentonite which is a chemical name called partially hydrolyzed polyacrylamide, lubricant, and Carboxymethylcellulose (CMC) on the differential sticking that caused by fluid in the water-based mud.

The results show As bentonite clay percentage rise, the torque needed to set free pipe sticking also rise, When CMC was adding to the bentonite clay with the proportion of 5%, the torque needed to set free pipe sticking lowing as well as when CMC portions rise, Using 5% of lubricant made the torque required to set free of pipe sticking low and became lower as the adding increase and for obtaining the perfect solution, it should use both CMC and lubricant additives to control the happening of differential pipe sticking.

4- Conclusions

Pomegranate peel and grape seed powders showed a decrease in the PH values for all concentrations, which deduce the possibility of using these substances to reduce the high pH of the drilling muds.

The use of grape seed powders gives the same impression in changing the rheological properties as in the use of pomegranate peel powders, which resulted in reduced plastic viscosity which reflects the presence of low solid concentration or small internal resistance to flow and an increase in both apparent viscosity and yield point as a result of increasing the attractive forces.

The mud density decreased for all samples after adding different concentrations of pomegranate peel and grape seed due to the formation of foam, which indicates the need for anti-foaming materials.

With increasing concentrations, grape seed powders have succeeded in reducing the thickness of the mud cake and hence the possibility of using these local materials to decrease pipe sticking problems.

Abbreviations

WBM:	Water-based mud.
PPP:	Pomegranate peel powder.
GSP:	Grape seed powder.
AV:	Apparent viscosity (cp).
PV:	Plastic viscosity (cp).
YP:	Yield point (lb/100ft ²).
V ₂ :	Filtrate volume at 2 min, ml.
V ₄ :	Filtrate volume at 4 min, ml.
V ₆ :	Filtrate volume at 6 min, ml.
V _{7.5} :	Filtrate volume at 7.5 min, ml.
V ₃₀ :	Filtrate volume at 30 min, ml.
Θ ₆₀₀ :	The dial readings at 600rpm.

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دراسة تجريبية لاضافات مساحيق قشر الرمان وبذور العنب على الخواص الريولوجية والترشيح لطين ذو القاعدة المائي غير المثقل

فالح حسن المهداوي و نور صبيح اموري

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الخلاصة

الاضافات الكيميائية المستخدمة لتحسين خواص طين الحفر سببت خطر على الانسان والبيئة. لذلك من الضروري البحث عن اضافات بديلة لاضافتهم الى طين الحفر. لذلك هذه الدراسة تبحث عن تأثير مساحيق قشور الرمان وبذور العنب كمخلفات طبيعية عند اضافتهم الى طين المائي القاعدة غير المثقل . الفحص يتضمن قياسات الخواص الريولوجية والترشيح كذلك فحص القاعدية والكثافة لطين الحفر. النتائج اظهرت نقصان في القاعدية مع زيادة التركيز لقشور الرمان او بذور العنب , ونقصان في الكثافة مع زيادة تراكيز مساحيق قشور الرمان وبذور العنب وهذا ناتج من تكون الرغوة. الخواص الريولوجية اظهرت زيادة عدا اللزوجة البلاستيكية . مسحوق بذور العنب قلل سمك كعكة الطين المطلوبة لحل مشاكل الحفر الناتجة من زيادة سمك كعكة الطين. من النتائج المختبرية , من الممكن استخدام مساحيق قشور الرمان وبذور العنب كاضافات لتقليل اللزوجة البلاستيكية و حجم الترشيح.

الكلمات الدالة: طين ذو قاعدة مائية, اضافات مواد محلية, مساحيق من قشور الرمان وبذور العنب, الخواص الريولوجية, خواص الترشيح