

Analyzing the Loss of Liquid from the Mud. And The Thickness of the Mud Cake. (XANTHAN GUM, PAM, CMC)

Wajahat Hussain¹, Mirza Muzaffar Baig², Mohd. Viqaruddin Ahmed³, M. Nishanth⁴, Rajesh Kanna^{5,*}

UG Students, Department of Petroleum Engineering, LORDS Institute of Engineering and Technology,
Hyderabad, India¹²³

Asst. Professor, Department of Petroleum Engineering, LORDS Institute of Engineering and Technology,
Hyderabad, India⁴

Professor & HOD, Department of Petroleum Engineering, LORDS Institute of Engineering and Technology,
Hyderabad, India⁵

ABSTRACT: The filter cake characterization is very essential for doing well selection of the drilling fluids that eliminates the drilling problems such as formation damage. A correct knowledge of filter cake properties gives petroleum engineers a tool for efficiently managing hydrocarbon production process of a field. This study aimed to experimentally investigate the effect of different concentration of PAM, xanthan gum and CMC on filter cake properties, filtrate loss and formation damage to select the optimum concentration of the PAM, xanthan gum and CMC. High Pressure-High Temperature (HPHT) filter press with ceramic disk device was used to conduct these experiments. Five samples of water-based drilling were used in this study. However, if PAM, xanthan gum and CMC is added, the fluid loses its property and becomes almost immobile. Thus, the PAM, xanthan gum and CMC concentration there is a less reduction in permeability of the ceramic disk. At this concentration, we got less reduction in the permeability of ceramic disk and good properties of filter cake.

KEYWORDS: PAM, Xanthan Gum, CMC, Filtercake Thickness and Loss of Liquid

I. INTRODUCTION

1.1 Spontaneous potential:

An **Industrial filter press** is a tool used in separation processes, specifically in solid/liquid separation using the principle of pressure drive, provided by a slurry pump. This filter press machine in the marble cutting work of the factory.

Concept Behind Filter Press Technology

Used in the Marble factories in order to separate the water from the mud for the marble in order to use it again. Generally, the slurry needed to be dewatered is injected into the center of the press and each chamber filled. The filling time should be as quick as possible in order to avoid cake formation in the first chamber before the last chamber is filled. While the chambers are being filled up, the pressure inside the system will increase due to the formation of thick sludge.^[2] Then, the liquid is filtered out through the filter cloths by adding streams of compressed air or water. The use of pressurized water requires more time to pass into the chamber compared to pressurized air, however this method is much more cost efficient.

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History

The first form of filter press was invented in the United Kingdom in 1853, used in obtaining seed oil through the use of pressure cells. However, there were many disadvantages associated with them, such as high labor requirement and discontinuous process. Major developments in filter press technology started in the middle of 20th century. In Japan in 1958, Kenichiro Kurita and Seiichi Suwa succeeded in developing the world's first automatic horizontal-type filter press to improve the cake removal efficiency and moisture absorption. Nine years later, Kurita Company began developing flexible diaphragms to decrease moisture in filter cakes. The device enables optimisation of the automatic filtration cycle, cake compression, cake discharge and filter-cloth washing leading to the increment in opportunities for various industrial applications.^[3] A detailed historical review, dating back to when the Shang Dynasty used presses to extract tea from camellia the leaves and oil from the hips in 1600 BC, was compiled by K. McGrew.

Types of Filter Press

There are three main basic types of filter presses: plate and frame filter presses, recessed plate and frame filter presses and automatic filter presses.

Plate and frame filter press

A plate and frame filter press is the most fundamental design, and many now refer it as a "membrane filter plate". This type of filter press consists of many plates and frames assembled alternately with the supports of a pair of rails. The presence of a centrifuge pump ensures the remaining suspended solids do not settle in the system, and its main function is to deliver the suspension into each of the separating chambers in the plate and frame filter. For each of the individual separating chambers, there is one hollow filter frame separated from two filter plates by filter cloths. The introduced slurry flows through a port in each individual frame, and the filter cakes are accumulated in each hollow frame. As the filter cake becomes thicker, the filter resistance increases as well. So when the separating chamber is full, the filtration process is stopped as the optimum pressure difference is reached. The filtrate that passes through filter cloth is collected through collection pipes and stored in the filter tank. Filter cake (suspended solid) accumulation occurs at the hollow plate frame, then being separated at the filter plates by pulling the plate and frame filter press apart. The cakes then fall off from those plates and are discharged to the final collection point.

Cake discharge can be done in many ways. For example: Shaking the plates while they are being opened or shaking the cloths. A scraper can also be used, by moving from one chamber to another and scraping the cake off the cloth. At the end of each run, the cloths are cleaned using wash liquid and are ready to start the next cycle.

Automatic filter press

An automatic filter press has the same concept as the manual filter and frame filter, except that the whole process is fully automated. It consists of larger plate and frame filter presses with mechanical "plate shifters". The function of the plate shifter is to move the plates and allow rapid discharge of the filter cakes accumulated in between the plates. It also contains a diaphragm compressor in the filter plates which aids in optimizing the operating condition by further drying the filter cakes. An animation showing this principal of operation can be seen here

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Fig. 1: Filter Press

Recessed plate filter press

A recessed plate filter press is made up of polypropylene squares at about 2 to 4 feet across with a concave depression and a hole in the center of each.

Two plates join together to form a chamber to pressurize the slurry and squeeze the filtrate out through the filter cloth lining in the chamber. It is capable of holding 12 to 80 plates adjacent to each other, depending on the required capacity. When the filter press is closed, a series of chambers is formed. The differences with the plate and frame filter are that the plates are joined together in such a way that the cake forms in the recess on each plate, meaning that the cake thickness is restricted to 32mm unless extra frames are used as spacers. However, there are disadvantages to this method, such as longer cloth changing time, inability to accommodate filter papers, and the possibility of forming uneven cake.



Fig. 2: Filter press

Applications

Filter presses are used in a huge variety of different applications, from dewatering of mineral mining slurries to blood plasma purification. At the same time, filter press technology is widely established for ultrafine coal dewatering as well as filtrate recovery in coal preparation plants. According to G.Pratt, the "filter press is proven to be the most effective and reliable technique to meet today's requirement". One of the examples is Pilot scale plate filter press, which is specialized in dewatering coal slurries. In 2013 the Society for Mining, Metallurgy and Exploration published an article

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highlighting this specific application. It was mentioned that the use of the filter press is very beneficial to plant operations, since it offers dewatering ultraclean coal as product, as well as improving quality of water removed to be available for equipment cleaning.

Other industrial uses for automatic membrane filter presses include municipal waste sludge dewatering, ready mix concrete water recovery, metal concentrate recovery, and large-scale fly ash pond dewatering.

Drilling Fluid

Drilling fluid or drilling mud is a component which was initially used to circulate cuttings from the borehole to the surface. Other functions of drilling fluid are maintaining wellbore stability, prevent formation fluids flowing into the wellbore, and control formation pressure^[1].

Water-Based Mud (WBM)

Water itself can be used as a drilling fluid. However, to maintain a better circulation of the Cuttings, WBM requires some degree of viscosity. The viscosity of WBM is generated by the addition of clay or polymers. There are two main purposes of adding clay which are first, increasing viscosity of the mud so that improves the lifting capacity of cuttings and second, building a filter cake (mud cake) in permeable zones to prevent fluid loss.

The viscosity

The viscosity of a fluid is a measure of its resistance to gradual deformation by shear stress or tensile stress. For liquids, it corresponds to the informal concept of "thickness"; for example, honey has a much higher viscosity than water. Viscosity is a property of the fluid which opposes the relative motion between the two surfaces of the fluid in a fluid that are moving at different velocities. When the fluid is forced through a tube, the particles which compose the fluid generally move more quickly near the tube's axis and more slowly near its walls; therefore, some stress is needed to overcome the friction between particle layers to keep the fluid moving. For a given velocity pattern, the stress required is proportional to the fluid's viscosity. A fluid that has no resistance to shear stress is known as an ideal or inviscid fluid. Zero viscosity is observed only at very in super fluids. Otherwise, all fluids have positive viscosity, and are technically said to be viscous or viscid. In common parlance, however, a liquid is said to be viscous if its viscosity is substantially greater than that of water, and may be described as mobile if the viscosity is noticeably less than water. A fluid with a relatively high viscosity, such as pitch, may appear to be a solid.

Xanthan Gum

Xanthan gum is a polysaccharide secreted by the bacterium *Xanthomonas campestris*, used as a food additive and rheology modifier commonly used as a food thickening agent and a stabilizer (in cosmetic products, for example, to prevent ingredients from separating). It is composed of pentasaccharide repeat units, comprising glucose, mannose, and glucuronic acid in the molar ratio 2:2:1. It is produced by the fermentation of glucose, sucrose, or lactose. After a fermentation period, the polysaccharide is precipitated from a growth medium with isopropyl alcohol, dried, and ground into a fine powder. Later, it is added to a liquid medium to form the gum



Fig. 3: Xanthan Gum

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PAM (polyacrylamide)

PAM is a polymer ($-\text{CH}_2\text{CHCONH}_2-$) formed from acrylamide subunits. It can be synthesized as a simple linear-chain structure or cross-linked, typically using N,N'-methylenebisacrylamide. In the cross-linked form, the possibility of the monomer being present is reduced even further. It is highly water-absorbent, forming a soft gel when hydrated, used in such applications as polyacrylamide gel electrophoresis, and can also be called ghost crystals when cross-linked, and in manufacturing soft contact lenses. In the straight-chain form, it is also used as a thickener and suspending agent



Fig. 4: PAM (polyacrylamide)

CMC (carboxymethyl cellulose)

Carboxymethyl cellulose (CMC) or cellulose gum is a cellulose derivative with carboxymethyl groups ($-\text{CH}_2-\text{COOH}$) bound to some of the hydroxyl groups of the glucopyranose monomers that make up the cellulose backbone. It is often used as its sodium salt, sodium carboxymethyl cellulose. It is synthesized by the alkali-catalyzed reaction of cellulose with chloroacetic acid. The polar (organic acid) carboxyl groups render the cellulose soluble and chemically reactive. Is used in food under the E number E466 as a viscosity modifier or thickener, and to stabilize emulsions in various products including ice cream.

It is also a constituent of many non-food products, such as toothpaste, laxatives, diet pills, water-based paints, detergents, textile sizing, and various paper products.



Fig. 5: CMC (carboxymethyl cellulose)

II. EXPERIMENTAL PROCEDURES

- 1) Firstly, cleaning all the equipment with clean water. Then, add the distilled water into the tank up to some liters. Now, check all the power supply for the agitator and pump.
- 2) Now adding the mud ingredients i.e.; barites, bentonite for the first sample and there after adding additives (i.e., PAM, Xanthan Gum, CMC) to the mud in the other samples, this solution is made in the water so; these are called water based mud.

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- 3) Then the mud is mixed and continuously, stirred because the mud in the tank should not be kept still as, it will settle in the bottom of the tank, so for this reason the agitator is given to it for continues mixing of the mud.
- 4) After mixing of the whole mud till 15mins then we should check the consistency of the mud in the tank. Now, we can start the pump and allow the transportation of the mud which is in the tank to the plates present in the filter press.
- 5) Now under the pressure the mud is passed through the plates where the canvas acts like a membrane.
- 6) The mud settles on the canvas and the liquid gets off by the pressure, the liquid which comes from the canvas/membrane is collected in to the rectangular tank which is called as loss of liquid.
- 7) The loss of liquid is calculated with respect to time, the stop watch is used here to note down the time.
- 8) Now, for every mixture of additives we must carry on the same procedure this is how the result of loss of liquid and cake thickness can be measured.



Fig.6: Mud cake of ordinary mud.



Fig.7: Mud cake when PAM added.



Fig.8: Mud cake when CMC added.

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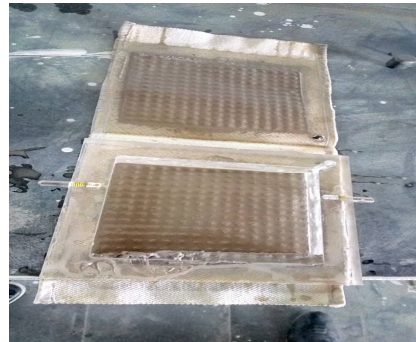


Fig.9: Mud cake when CMC and PAM added.

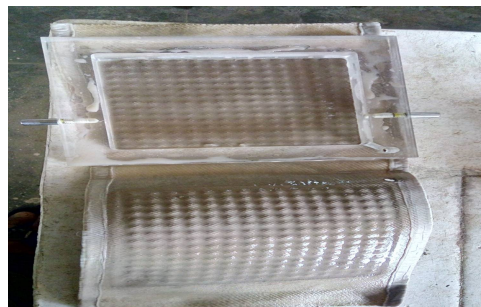


Fig.10: Mud cake when CMC, PAM, and Xanthan Gum.

III. TABLE

Samples	(sample 1)	Sample 2	Sample 3	Sample 4	Sample 5
Barite	1500gm	1500gm	1000gm	1000gm	1000gm
Bentonite	500gm	500gm	500gm	500gm	500gm
Distilled Water	3000ml	3000ml	3000ml	3000ml	3000ml
CMC	N/A	N/A	100gm	100gm	100gm
Xanthan Gum	N/A	N/A	N/A	N/A	10gm
PAM	N/A	50gm	N/A	50gm	10gm
Loss of Liquid (time) in sec	18.36cm 37.5sec	7cm 52.5sec	0cm 48.75sec	0.94cm 45sec	0cm 60sec
Filter cake Thickness (mm)	50mm	35mm	10mm	3mm	0.3mm

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IV. RESULT

The result of the above experiment as we have conducted is that when the additives such as Xanthan Gum, PAM and CMC the loss of liquid gets relatively lower when the additives are added one by one and all at a time. But when the mud with no additives that is just barites and bentonite, were the loss of liquid and the thickness of the cake is the maximum in this report.

But when the PAM is added the loss of liquid and the filter cake gets decreases with respect to the first sample.

And then when added to the CMC to the mud (barites and bentonite) here the loss of liquid is negligible and the filter cake is thinner i.e., 10mm. So, this we can say that the CMC forms the fluid very viscous and makes the pores of the membrane to be blocked and this doesn't allow liquid loss and then also makes the less filter cake around the membrane.

Then, for other sample as we added the PAM in the same mud which is having CMC in it respectively. Then, the PAM decreases the viscosity of the mud and here we get a low liquid loss and the thickness is also remained lower as the CMC acts like a barrier in to it.

For the last sample we added the other additive in the same mud i.e., Xanthan Gum, this chemical is very much effective to the water and some soluble solutions as it has the power of making the solution in to the gel. So, this chemical is added to the mud in a limited and preferred amount as it gives gel strength to the mud which increases the viscosity of the mud.

V. CONCLUSION

So, by this experiment we concluded to a point that when additives are added to the mud the mud property of viscosity in increases and the filter cake thickness to be formed will decrease in size.

When we added the additive PAM the loss of liquid from the mud was low then the simple mud and the filter cake thickness was also lesser. But the PAM is a toxic chemical so we should avoid using this chemical.

Instead we can use the CMC and Xanthan Gum which are eco friendly and harm less to the environment, as the dumping of the mud is a major problem faced by the drilling projects and sectors. The above mentioned chemicals have effective nature on the mud mainly the Xanthan Gum which has the gel forming factor when come under contact with the solution or water. These chemicals can be very useful and beneficial in the mud making processes which can create almost negligible loss of liquid and the thickness of the filter cake is also relatively low. As this is the reason of this project to be conducted and calculated the loss of liquid and the filter cake should be very low to keep the mud save and can be recycled for further purposes.

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