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EFFECT OF ADDITIVES ON THE SEDIMENTATION RATE OF MAGNESIUM HYDROXIDE PRECIPITATED FROM SYNTHETIC MAGNESIUM CHLORIDE

By

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ABSTRACT

Many trials have been attempted to improve the sedimentation rate of $Mg(OH)_2$. In this respect, it has been reported that flocculants are added. But the choice of particular flocculant and its dosage cannot be simply obtained from the literature. This is because the action of flocculants is affected by many process variables such as the type of flocculant and its chemical composition, thus the aim of the present work is to test the different types of flocculants (anionic, cationic, non - ionic) at different doses (0.1 - 0.6 %) with synthetic magnesium chloride (Mg^{++} 34.56 g/l) and CaO (90 %). The best result obtained is by using cationic polyacrylamide with percentage dose of 0.3.

INTRODUCTION

The efficiency of solid / liquid separation may be greatly improved by the application of synthetic polymeric flocculants. This improvement is achieved[1] by bringing dispersed particles together, thus increasing the effective particle size of the solid phase. The stability of the suspension is broken and the liquid phase is released.

Most flocculants in use today are synthetic polymers based on repeating units of acrylamide and its derivatives, which may contain either cationic or anionic charge. Coagulation is basically electrostatic in that it is brought about by a reduction of the repulsive potential of the electrical double layer. Flocculation is brought about by the action of high molecular weight materials such as starch or polyelectrolytes, where the material physically forms a bridge between two or more particles, uniting the solid particles into a random, three dimensional structure which is loose and porous.

2.GENERAL MECHANISM OF FLOCCULATION

Flocculation may be brought about by a number of different processes:

a) Inter - particle collosion; when solid surfaces are brought close enough together the London - Van der Waals forces over power the repulsion forces.

b) Reduction of electrical charge; charge reduction lessens electrical repulsion and enables coagulation to proceed to a further degree. Charge is neutralized by the addition of reagents giving rise to charge ions opposite in charge to that carried by the particle.

c) Synthetic bridging flocculants; these are synthetic water - soluble organic polymers of very high molecular weight. They are strongly adsorbed onto the particles, and capable of spanning the gab between the particles. Synthetic polymers of high molecular weight are long enough for one end to adsorb onto one particle and the other end onto a second particle. Higher molecular weight polymers will adsorb on several particles at once, forming a three dimensional matrix.

d) Natural bridging polymers; such as starch, gums, glue, function as bridging flocculants but are of much lower molecular weight than synthetics and are only capable of much lower degree of flocculation.

The mechanism of flocculation can be studied in two stages; adsorption of reagent onto the particles and the formation of aggregates.

There are several hypotheses for the mechanism of formation of the flocs; one possibility, is the reduction of zeta potential by the adsorbed charged polymer molecules, allowing the particles to come together by Van der Waal's attraction. A second possibility is that the polymer attaches simultaneously to two particles by its two ends **Fig. (1)**. Further adsorption then occurs and as the polymer molecule is contracted, the particles are drawn closer togther. The third possibility assumes the polymer molecules to be well tangled so that one polymer molecule will adsorb at several points on the surface of a particle, leaving loops, which may be of varying length, projecting out from the surface. Collision of these partially covered particles, results in bridge formation **Fig. (2)**.

3. EXPERIMENTAL WORK

3.1-Raw Materials:

Magnesium hydroxide suspension obtained from the reaction between magnesium chloride, (97 % purity) and calcium oxide (85 - 90 % purity).

Both are obtained from "El - Nasr Pharmaceutical Chemicals Company".

Flocculating aids; different types of synthetic polymers **Table (1)** were tested.

Name	I	II	III	IV
Molecular weight	Ultra high	High	High	Ultra high
Type	Cationic polyacrylamide	Cationic polyacrylamide	Anionic polyacrylamide	Anionic polyacrylamide
Physical form	Free-flowing white powder	White free flowing, micro beads	White free flowing, micro beads	Free flowing, white granular powder
Ionic charge	Low to medium cationic charge	High cationic charge	Low anionic charge	High anionic charge
Bulk density g/cm^3	0.7	0.8	0.8-.0.9	0.5-0.6
Particle size	98% Less than 1400 microns	100% Less than 1000 microns	85% Less than 425 microns	98% Less than 750 microns
pH of 1% solution	3.3-4.3	3.1-4.1	5.5-6.5	6.0-7.0
Optimum pH activity range	4-9	4-9	5-11	5-11
Viscosity at 25°C and 0.25% concentration cPs	300	420	280	850

3.2-Experimental Set - up:

The set - up **Fig. (3)** consists of 6 vertical tubes, each is of 4 cm diameter and 105 cm height. They are fixed on a wood board with stands.

3.3-Experimental Technique:

Calcined lime (1050°C for 2 hr) was slaked with water (1 : 4) with vigorous stirring for half an hour[(2)].

Different doses of flocculating aids, depending on the theoretical amount of precipitated magnesium hydroxide, were added to the magnesium chloride solution (34.56 g/l) with gentle stirring. Prepared slaked lime was added slowly with gentle stirring on the previous solution. Tinie of addition was 10 minutes. Efficient stirring was continued for 10 minutes after complete addition. The produced reaction mixture was then transferred into glass cylinders **Fig. (3)**. Magnesium hydroxide was left to settle and the height of the interface was recorded with time for different doses of flocculating adis **Table (2)**.

Table (2) : Doses of flocculating aids studied in settling of $Mg(OH)_2$ (34.56 g/l Mg^{++}; 90 % CaO).

Run No.	**1 - 8**	**9 - 15**	**10 - 22**	**23 - 30**
Polyelectrolyte type	I	II	IV	III
% Polyelectrolyte	0 - 0.6	0.1 - 0.6	0.1 - 0.6	0.1 - 0.6

4-RESULTS AND DISCUSSION

The precipitation of magnesium hydroxide using different flocculating aids were investigated. The results of settling rates (height of interface versus time) are illustrated in **Figs. (4 - 7)**.

From figures it can be noticed that, at the beginning, the height of interface has rapidly decreased with time, and as time increased the rate of sedimentation became lower. This may be due to the consolidation of the sediment, liquid is forced upward around the solid particles forming a loose bed with the particles in contact with one another, also the flow area is gradually being reduced, hence the resistance to the flow progressively increases[3].

It is noticed that, the addition of flocculating aids no. II and I at different doses has a great effect on improving settling of $Mg(OH)_2$ as they are cationic polyacrylamide. These polymers function as destabilizing agents by either charge neutralization or bridge formation or by both of them simultanously[4]. But settling rate of $Mg(OH)_2$ was very rapid with less percentage dose of flocculating aid no. I as compared to that no. II, and this may be due to higher molecular weight which allows more bridging to take place.

In spite of the fact that high doses of flocculating aid no. IV were used, the settling was very slow, **Fig. (6)**, (compared with no. II and I) which may be due to that no. IV is anionic polyelectrolyte type and may prove to be unsuitable for that type of suspension.

From **Fig. (7)** it is obvious that, the same trend of results (high initial rate of settling and over dose phenomena) were obtained by increasing the percentage doses of flocculating aid no. III.

CONCLUSION

In general, the use of polyelectrolytes as flocculants improved the settling rate of $Mg(OH)_2$ suspension. This may be attributed to the following:

1- The magnesium hydroxide suspensions are characterized by low settling rates and also filtration of the sediment is very difficult, because of the great number of water molecules tied to precipitated $Mg(OH)_2$[5]. Thus its settling is very difficult.

2- When $Mg(OH)_2$ is precipitated out by adding salt to alkali, OH^- ions are most probably adsorbed and when the order of addition is reversed, Mg^{++} ions are most predominantly adsorbed. This is in conformity with the general observation that ionizable substances preferentially take up ions which are common to both of them, thus indicating a natural tendency for the crystals to extend their own space lattice.

However, charged particles exhibit both attraction and repulsion. When the force of repulsion, which is judged by the zeta potential, is greater than the Van der Waal's force, the suspension is stable. If the zeta potential is caused to decrease, e.g. by the addition of an electrolyte or if precipitationis carried out in strong electrolyte solution, the particles come within the range of Van der Waal's attraction[6].

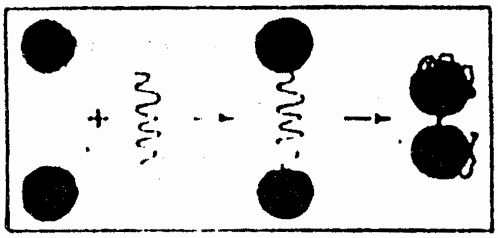

Fig. (1) The polymer attaches to two particles simultaneously by both ends.

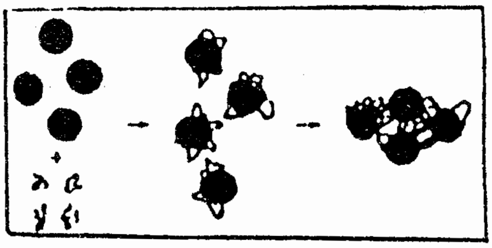

Fig. (2) Another theory assumes that the polymer attaches at several points leaving loops projecting which attach to other particles.

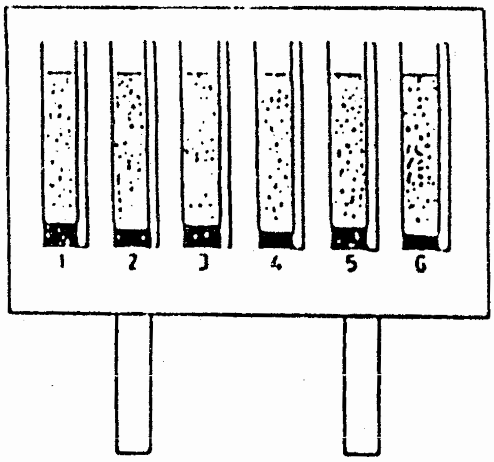

Fig. (3) Experimental set-up for settling tests.

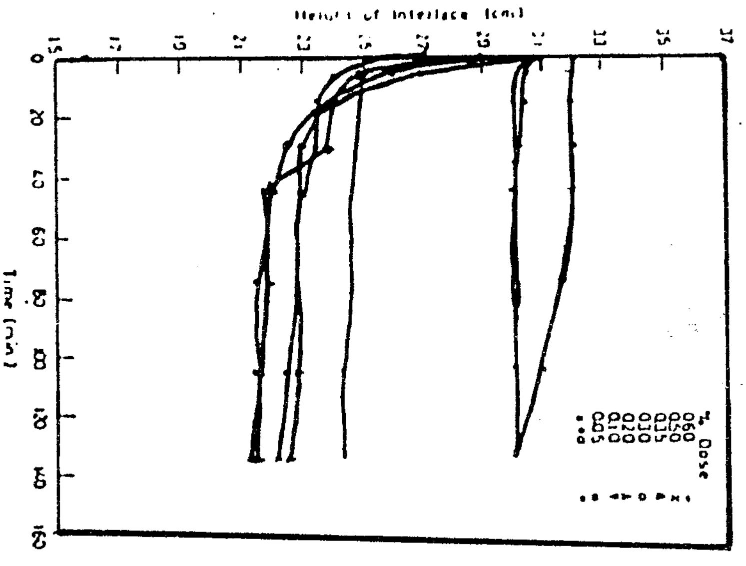

Fig. (4) Settling rate curves for $Mg(OH)_2$ using different doses of flocculating no. II. [Initial concentration of Mg^{++} 34.56 g/L and CaO 90%].

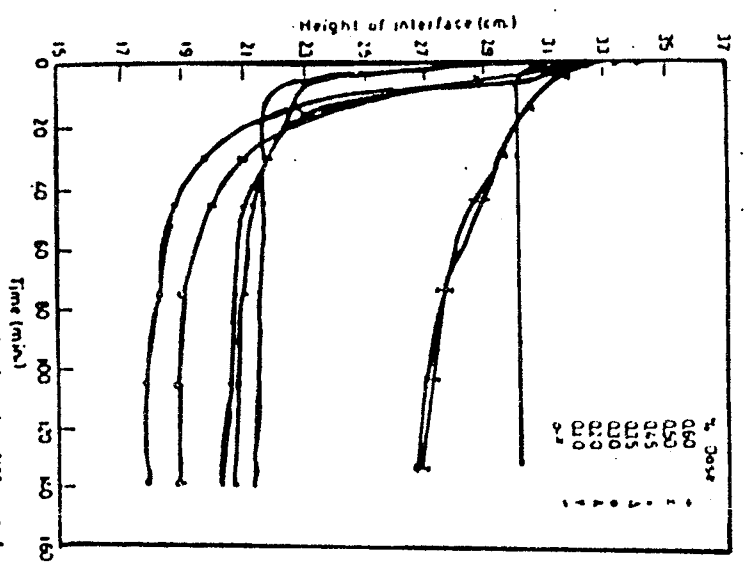

Fig. (5) Settling rate curves for $Mg(OH)_2$ using different doses of flocculating no. I. [Initial concentration of Mg^{++} 34.56 g/L and CaO 90%].

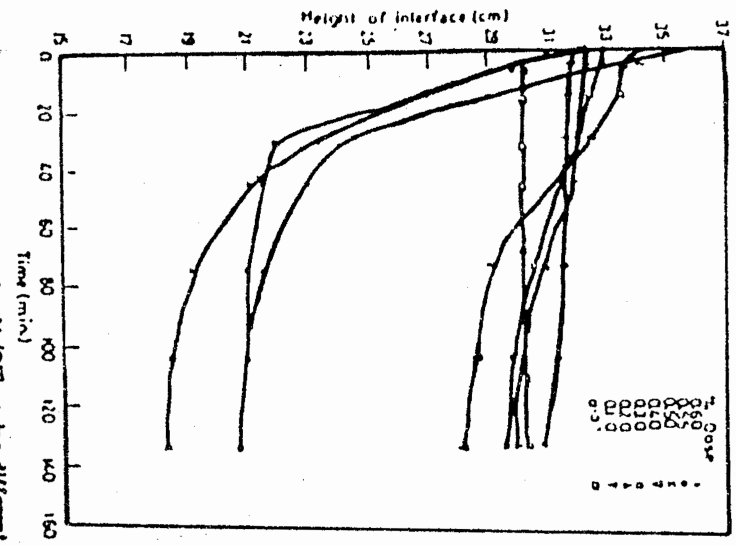

Fig. (6) Settling rate curves for $Mg(OH)_2$ using different doses of flocculating aid no. IV. [Initial concentration of Mg^{++} 34.56 g/L and CaO 90%].

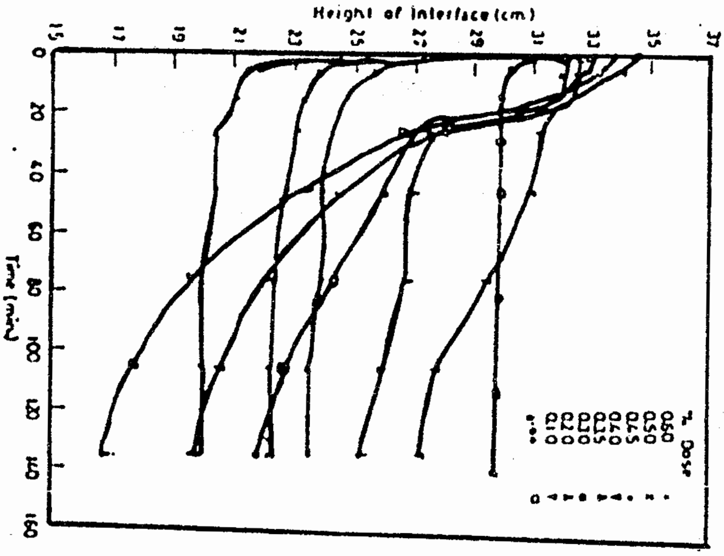

Fig. (7) Settling rate curves for $Mg(OH)_2$ using different doses of flocculating aid no. III. [Initial concentration of Mg^{++} 34.56 g/L and CaO 90%].

So, in absence of flocculants, the rate of settling is very low. As flocculants are added, the water molecules tied on the particles are removed and the electrical charge is neutralized and consequently flocculation occurs and the settling rate increases. It is also concluded that the cationic polyacrylamide are most suitable because it function as destabilizing agent by either charge neutralization or bridge formation or by both of them simultaneously.

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تأثير الإضافات على معدل تركيدإيدروكسيد الماغنسيوم المترسب من كلوريد الماغنسيوم المخلق

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ملخص البحث:

أجريت عدة محاولات لتحسين معدل تركيد إيدروكسيد الماغنسيوم وذلك بإضافة عدة محسنات. ولم يكن من السهل إختيار أنسب محسن وجرعته وذلك لأن تأثير المحسن يتوقف على عدة عوامل مثل نوع المحسن وتركيبه الكيميائى.

والهدف من هذا البحث هو إختبار أنواع مختلفة من المحسنات (أيونية، كاتيونية، غير أيونية) بجرعات مختلفة (٠,٠١ – ٠,٦ ٪) على محلول كلوريد الماغنسيوم المخلق (Mg^{++} ٣٤,٥٦ ٪ جرام / لتر) وأكسيد الكالسيوم (٩٠ ٪). تم الحصول على أفضل النتائج بإستخدام كاتيونك بولى أكريلاميد بجرعة ٠,٣ ٪.