Pakistan J. Sci. Ind. Res., Vol. 30, No. 4, April 1987

EFFECTS OF SOME LIGNOSULPHONATES ADDITIVES ON SOME PROPERTIES OF GYPSUM PANELS

A.M. Khater*, E.H. Khater, A.N. Mahdy** and M.F. Abadir**

Pilot Plant Lab., N.R.C. Dokki, Giza, Egypt

(Received February 20, 1986; revised October 10, 1986)

This paper deals with studying the main factors affecting some gypsum panels properties and the effect of adding some types of lignosulphonates on improving these properties.

It was found that an increase in the (water/gypsum) ratio is accompanied by a decrease in compressive strength, density, impact strength and an increase in the setting time and water absorptivity. It was also found that (water/gypsym) ratio required for moulding decreases with increasing gypsum purity.

Adding some lignosulphonates was found to improve some mechanical and physical properties of the moulded gypsum. The degree of improvement was found to depend on the lignosulphonate purity, degree of sulphonation, weak proton content, molecular weight and the system pH.

Key words: Lignosulphonates, Gypsum, Panel.

INTRODUCTION

Extensive experimental investigations were carried out to study the different characteristics and potentialities of gypsum to be used for producing various components of housing units, walls and roofs. These researchs were carried out to choose the suitable type of ore required and to modify the properties of partition gypsum wall.

The gypsum setting time is reported to depend on the way of preparing the plaster [1]. A wide range of substances could be used either as accelerators or retarders [2,5]. Some lignosulphonates such as Ultrazine NA & CA were reported to have no retarding effect, particularly at low dosages [6].

Theoretically only 18.6% water is required for chemical hydration of plaster, on the other hand excess water is used to improve plaster workability. This excess water causes porosity on drying the plaster and consequently decreases density. Different additives were recommended to produce light weight gypsum [7,10].

Controlling the plaster particle size in a slurry mix was reported to increase strength at constant dry density [11]. Many attempts were made to improve plaster strength using different additives. For example impregnating old gypsum in 2 mol% solution of Me-Methacrylate for one day improves its strength by 600%. and also reduce the panel absorption when immersed in water 1.6-2.4% [12].

* Icon Co.

** Chemical Engineering Department, Faculty of Engineering, Cairo University, Egypt.

EXPERIMENTAL

Techniques. The experimental program consisted of two parts. In the first part some physical and mechanical properties of a three gypsum types (A, B and C) were determined as a function of mixing water percentage, gypsum purity and setting time. The samples were calcined to the hemihydrate at 150°C for two hours after which the chemical analysis was performe.d. In the second part the effect of four lignosulphonate additive on the properties of the moulded gypsym of type B was studied. The chemical composition of the calcined gypsum and lignosulphonates are illustrated in Tables (1,2 and 3).

Preparation of moulds: Six test cubes (10x10x10cm) were prepared for each mixture having a certain (water/gypsum) ratio. All the specimens were left after moulding in moist air for seven days, then placed in a drier at 45° and left till constant weight is obtained.

Fluidity (workability). The workability was measured as the time needed for a gypsum slurry to fill a 200 ml beaker from another 400 ml beaker with an orifice of 2mm diameter at its bottom. The time of mixing was fixed at 30 seconds at a working temperature of 25° (to simulate the practical conditions).

Setting time. The initial and final setting time is measured using a standard Vicat apparatus [13].

Water of absorption (W). The percentage water absorption is calculated using the follwoing equation:

$$W = \frac{A_2 - A_1}{A_1} \times 100$$

where:

A_1 = Dry specimen weight after drying it at 45°C for more than 24 hours.

A_2 = The specimen weight after being immersed in pure water at 15-30°C for 24 hours.

Compressive strength. The compressive strength, S_c, is estimated by dividing the recorded fracture load, F, using the standard universal hydraulic testing machine [13] by the contact specimen cross sectional area, A.

Chemical constitution. The chemical constitution of investigated raw materials was done as an attempt to follow the raw materials quality. The analysis was done using a standard analysis techniques [14,16].

RESULTS AND DISCUSSION

The effect of water/gypsum) ratio with and without additives on the physical and mechanical properties will be discussed as follows:

Table 1. Chemical analysis of samples.

Item	Sample A	Sample B	Sample C
Insol.	5.0 %	2.55 %	0.2 %
NaCl.	2.0 %	1.0 %	0.3 %
Free H_2O.	0.41 %	0.54 %	0.3 %
Comp. H_2O.	3.7 %	4.9 %	6.08 %
CO_2	2.4 %	2.1 %	1.5 %
SO_3	45.91 %	50.63 %	55.0 %
Ca O	39.88 %	37.44 %	40.0 %
Mg O	0.75 %	0.8 %	0.5 %
Total	100.05%	99.96 %	103.88 %

Table 2. Mineralogical analysis of samples.

Item	Sample A	Sample B	Sample C
$CaSO_4.½H_2O$	55.944 %	74.088 %	93.0 %
Ca SO_4	22.062 %	11.938 %	1.4 %
Mg CO_3	1.463 %	1.756 %	1.04 %
Ca CO_3	3.72 %	2.69 %	2.17 %
Na Cl	4.537 %	2.326 %	1.0 %
Insol	11.342 %	5.62 %	1.0 %
Free H_2O	0.931 %	1.26 %	0.5 %
Total	99.999 %	99.318 %	100.11 %

Effect on relative workability. Fig. 1 represents the effect (water/gypsum) (W/G) ratio on the relative workability of the three tested gypsum types. It is clear from the Figure that maximum relative workability occurs at high (W/G) ratio for a low quality gypsum (Type A) and with low (W/G) ratio for a good quality gypsum (Type C). Since type B is the most widely used and available locally the rest of the experiments were performed on it. Adding Ultrazine NA at a value of 0.5% by weight of dry gypsum causes a shift of the maximum relative workability from (W/G) ratio of about 0.9% to around 0.5% as Ultrazine NA tends to repel water from the moulded sample (Fig. 2).

Effect on setting time: The setting time was found to increase as (W/G) ratio increases (Fig. 3) this is obvious since excess water tends to decrease the hydration reaction. Fig. [4] represents the effect of some lignosulphonates percentage on the setting time of type B gypsum. As shown Ultrazine type has the lowest setting time effect even at higher percentages.

Effect on density: The effect of (W/G) ratio on the density of type-B gypsum before and after adding Ultrazine NA is illustrated in Fig. [5]. It is clear from this Figure that adding Ultrazine NA by a percentage more than 0.5% causes a decrease in the density, and in general increasing (W/G) ratio results always in a decrease in density since excess water creates pores, hence decreasing the bulk density.

Table 3. Chemical and physical data on lignosulphonates

Item	Vanisperse CB	Ultrazine CA	Ultrazine NA	Borrespers B
Chemical Data				
pH, 3% solution	8.8	7.0	8.3	3.0
Total Sulphur, % S	2.4	6.0	6.4	6.9
Sulphate (SO_4 -), % S	0.03	0.2	0.6	0.8
Sulphite (SO_3 -), % S	0.03	0.2	0.2	0.6
Sulphonate (SO_3-), % S	2.3	5.6	5.6	5.5
Degree of sulphonation*	0.17	0.46	0.46	0.60
Reducing sugars,				
Pentoses, %	None	2.0	1.0	0.5
Methoxyl, %–OCH_3	11.7	10.8	10.8	7.8
O_2, %	0.005	0.005	0.005	0.005
Na, %	8.2	6.2	8.3	6.8
Ca, %	0.004	0.3	0.08	0.3
Physical Data				
Colour	Dark brown	Light brown	—	—
Mositure, %	6.0	6.0	6.0	6.0
Insolubles in water, %	0.02	0.2	0.1	0.1
Bulk density, kg/1	0.06	0.50	0.55	0.52

(*) Number of sulphonic acid groups per phenyl propane unit.

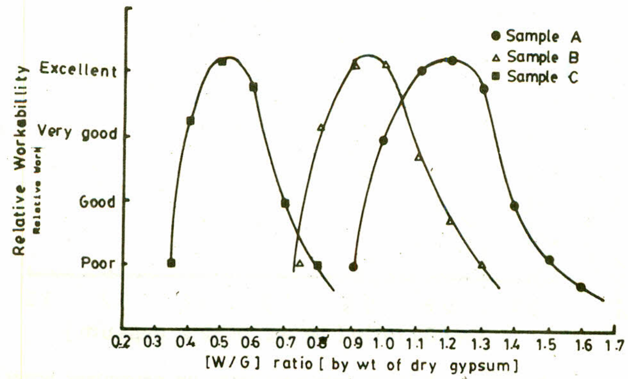

Fig. 1. Effect of (water/gypsum) ratio on relative workability

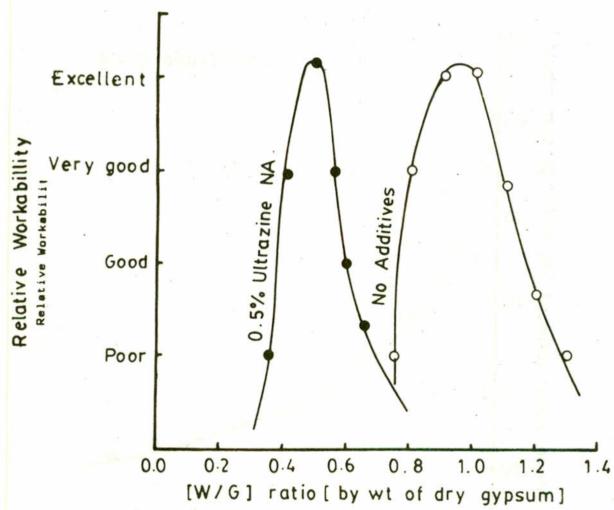

Fig. 2. Effect of ultrazine NA on type-B gypsum workability

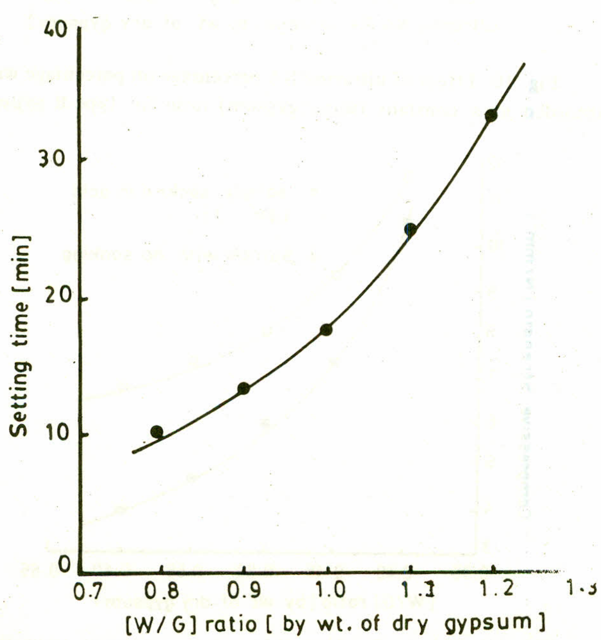

Fig. 3. Effect of (water/gypsum) ratio on setting time of type-B gypsum.

Effect on compressive strength: The compressive strength was found to increase by increasing (W/G) ratio till a maximum at (W/G) ratio of about 0.8 then started to decrease (Fig. 6). In general it was found that at a constant (W/G) ratio, for example 0.6 the compressive strength increases compared to plain gympsum (Fig. 7). It was also found that at any constant (W/G) ratio the compressive strength tends to decrease and at the same Ultrazine NA percentage the compressive strength increases as the (W/G) ratio decreases. With (W/G) ratio of 0.4 and Ultrazine NA of 0.5% the compressive strength was found to be four times that of plain gypsum at the same (W/G)

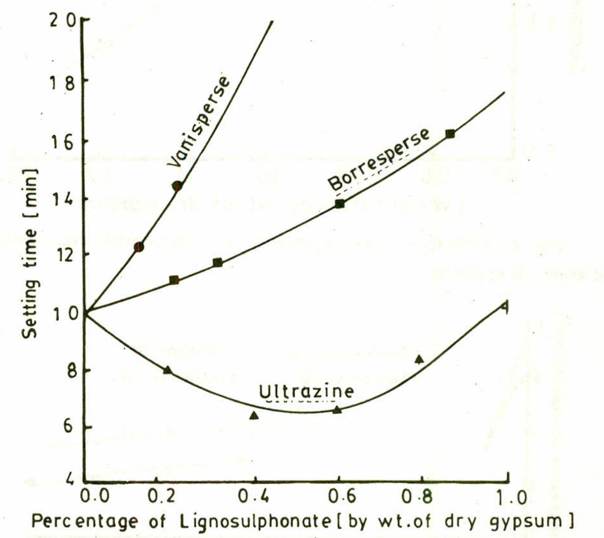

Fig. 4. Effect of lignosulphonates percentage on setting time of type-B gypsum.

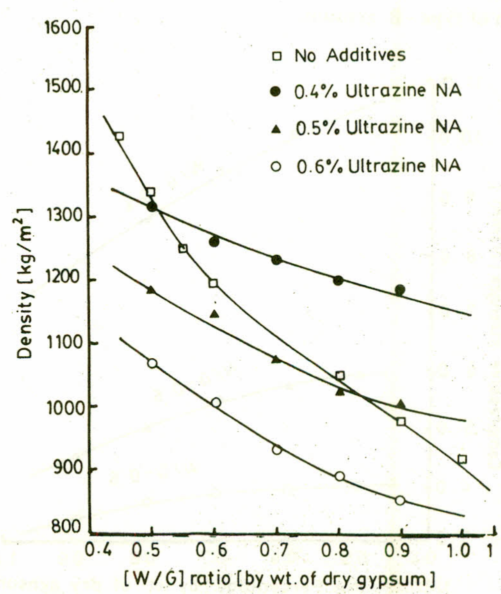

Fig. 5. Effect of ultrazine NA percentage on type-B gypsum density.

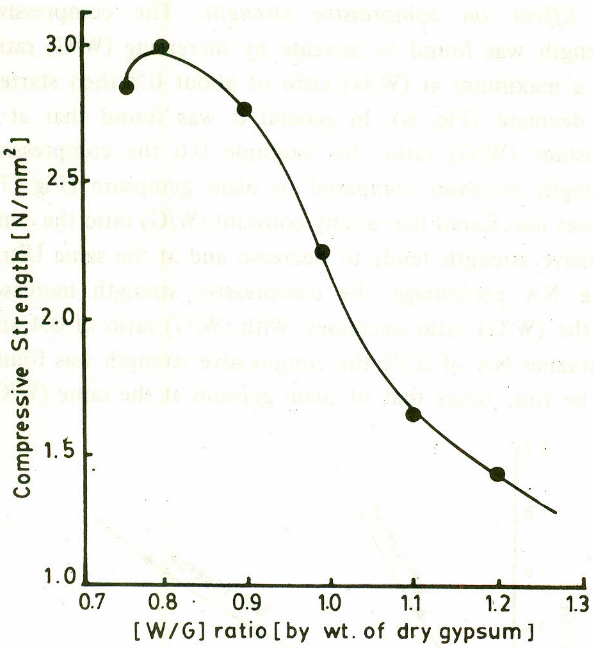

Fig. 6. Effect of (water/gypsum) ratio on compressive strength of type - B gypsum.

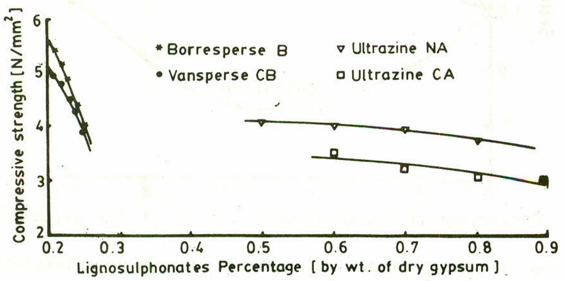

Fig. 7. Effect of lignosulphonate percentage on compressive strength of type - B gypsum.

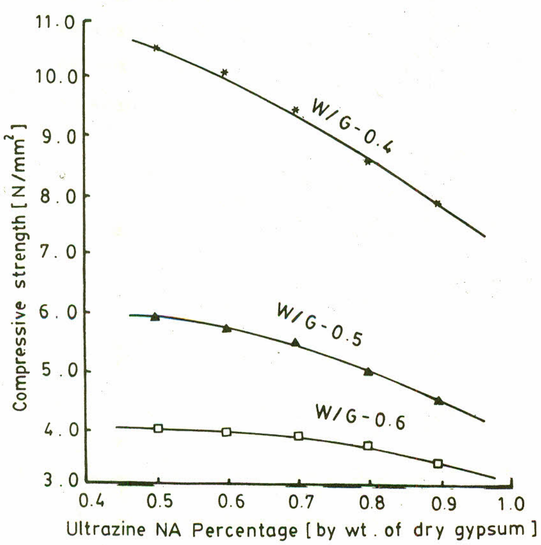

Fig. 8. Effect of ultrazine NA percentage on compressive strength of type-B gypsum at different (water/gypsum) ratio.

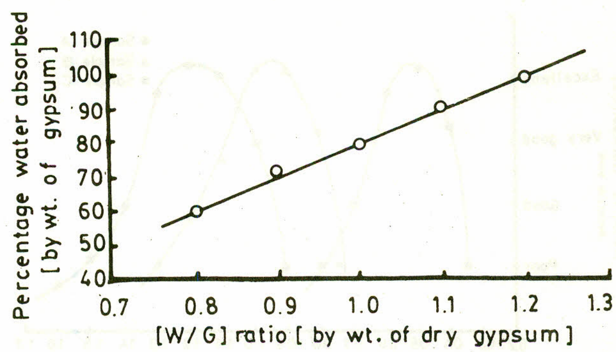

Fig. 9. Effect of (water/gypsum) ratio on percentage water absorbed.

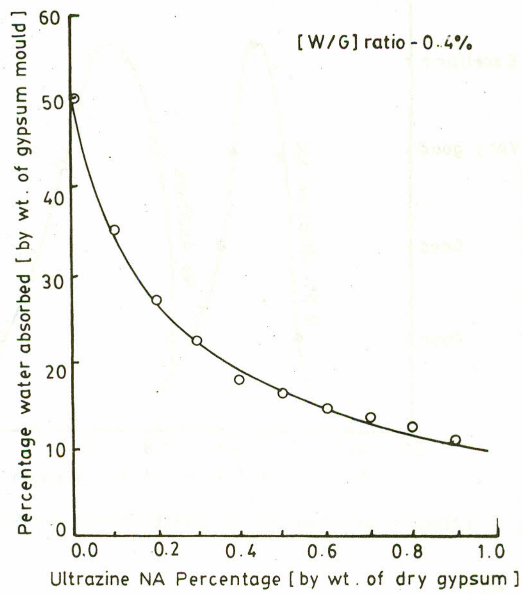

Fig. 10. Effect of ultrazine NA percentage on percentage water absorbed at a constant (water/gypsum) ratio for type-B gypsum.

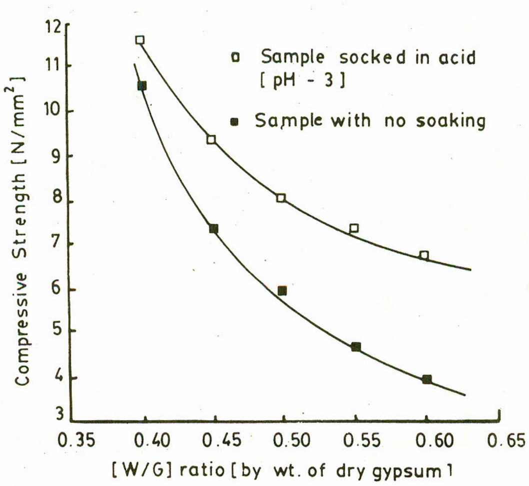

Fig. 11. Effect of acid soaking on compressive strength of moulded gypsum for type-B gypsum and 0.5% ultrazine NA addition.

ratio (10.5 N/mm^2 Compared by 2.9 (N/mm^2) (Figure 8).

Effect on water absorpitivity: After setting of moulded gypsum and on drying, excess water is vaporized leaving behined some pores. These pores are the causes of water absorpitivity upon using gypsum panels or blocks. So it is clear from (Fig. 9) that as (W/G) ratio increases percentage water absorption also increases. On the other hand, adding Ultrazine NA decreases the pores left behind on drying as it expells excess water and consequently water absorption decreases. It is also clear from (Fig. 10) that increasing the percentage of additives decreases the percentage of water absorption as a result of the forementioned reason.

Effect on compressive strength with acid soaking: It is clear from (Fig. 11) that on soaking a gypsum mould [containing 0.5% by weight Ultrazine NA] in weak acid as acetic acid (pH=3) the compressive strength increases by a value ranges between 10-50%. The reason is that on mixing gypsum with a lignosulphonate, negative charges surround the gypsum particles, thus retarding the approach by water. On soaking in acid, neutralization occurs and the hydration reaction proceeds to completion, thus giving rise to a higher compressive strength.

CONCLUSION

1. (W/G) ratio has a great effect on both the physical and mechanical properties of moulded gypsum.
2. Ultrazine NA with a percentage of 0.5 (by weight of dry gypsum) and (W/G) ratio of 0.4 gives the best results. The improvement in gypsum properties can be summarized as follows:

Property	No additive	With additive
Water absorption (%)	50	15
Setting time (min)	10	6
Compressive strength (N/mm^2)	2.9	10.5
Acid attack	yes	slight
Impact strength (kg. cm)	114	588

3. These improvements can allow more production of gypsum panels as the setting time decreases, hollow blocks may be used due to increased compressive strength together with lower losses due to broken blocks because of the increased impact strength.
4. Finally the increase in cost due to Ultrazine NA addition has been calculated to be about 30 P.T (about 0.2 U.S.$) per square meter of wall which represents about 7% of the actual cost of gypsum wall. However, this increase in cost is only fictitious since it will be highly overcome if hollow blocks are produced. In this case as much as 30% of gypsum can be saved.

REFERENCES

1. M.E., Enayetallah, A. A. Khalil and A.M. Gadalla, Trans. J. British Ceramic Soc., **76**, 95 (1977).
2. S. Sen and G.M. Srikauton, General Glass and Ceramic Bull., **7**, 70 (1960).
3. E.C. Combe and D.C. Smith, J. Appl. Chem., **15**, 367 (1965).
4. E.C. Combe and D.C. Smith, J. App. Chem., **16**, 73 (1966).
5. Canadian Patents and Development. "Plaster Set Retarded" Ltd., Brit:, **993**, 177 (1965).
6. A.S. Borregaard Company, "Borregard's Lignin Dispersants for the Deflocculation of Gypsum Slurries' (Speciality Chemical Section, P.O. Box 162, N-1701 Sarpsborg-Norway).
7. R.G. Smith "The Ore of Gumpsum in Developing Countries". Note N 13, 7176, October 1976.
8. Y.O. Murase, Chem. Abs., **92**, 134735 (1980).
9. H.E. Masumi, Chem. Abs., **93**, 78440 (1980).
10. T.S. Taku, Chem. Abs., **92**, 2025830 (1980).
11. M.K. Lane, Amer Ceram. Soc. Bull., **54** 231 (1970).
12. B.V. Guser and Khobak Pushev, K.G. Chem. Abs., **92**, 27512e (1980).
13. A.M. Khater M.Sc. Thesis, Cairo University, 1985.
14. *"Standard Methods for Testing Gypsum and Gypsum Products".* (C 26-60. ASTM, Philadelphia, U.S.A., 1958), Vol. **5**, p. 265.
15. W.W. Scott. *"Mineral Analysis".* (The Tech. Press, Ltd., London, 1947). Vol. 1.
16. G.R. Rigby, *"Thin Section Mineralogy of Ceramic Material"* (Published by the B.R.R.A., 1948).