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THE POSSIBILITY OF OBTAINING PLASTER THROUGH HEATING GYPSUM ORE WITH ENERGY

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Summarry

In this paper we present the base techniques of a new fabrication procedure for β plaster,which is a construction material used in the making of phonoabsorbant panels,casetated ceilings,regypsums and decagypsums as well as an added material in making mortars and polishing plaster coats or even orthopaedical corsets.

The plaster is an aerial binder obtained through the dehydration of gypsum (CaSo4 2H2O) and forming semyhidrated calcium sulphate (CaSO4 ½ H2O) at temperatures ranging between 85 – 120 degrees Celsius.Obtaining plaster on a semihydrate basis is made at an atmospheric pressure (β plaster) and at pressures larger then the atmospherical one through autodivisation (α plaster) or boiling,the first being construction β plaster and the second being modeling plaster.

Plaster fabrication procedures used to this day are uneconomic and not safe for the environment.The proposed fabrication procedure uses microwave energy and is based on the dielectric propriety of gypsum.As such,it is possible that the gypsum is dehydrated through dielectrical heating into a resonant cavity with microwave power.

The termic energy dissipated in the dielectric with losses in Ca SO4H2O in the microwave field leads to the dehydration of gypsum at a normal atmospheric pressure,transforming it into β plaster (CaSO4 ½ H2O).The advantage of the process consists in accuracy,quality and environmental safety.

1. INTRODUCTION

Phonoabsorbant panels,casetated ceilings and plates are applied in concert halls,gyms,libraries, amphitheatres,offices,commercial complexes,civil and industrial buildings,etc.,being made of composite materials based on α or β plaster.The main matrix is composed of plaster mixed with magnesite and cellulose fibres or minced expanded polistyrene grains [6,8] or expanded perlite,the plaster offering them chemical and mechanical stability.Plaster (CaSO4 ½ H2O) is a white dust obtained through partial dehydration 1 ½ H2O of the mineral gypsum (CaSO4 2H2O),a calcium sulphate composed of calcium,sulphur,oxygen and water [12,13].

Plaster with added cellulose fibres,mineral wadding and cardboard,known simply as regyps,improves the termic and phonic isolation of rooms and halls.Several fabrication procedures of plaster through the dehydration of gypsum are known.Forming semihydrated calcium sulphate is presently obtained in two ways [13,14,15]:

a) Through the dehydration of gypsum in open installations under the effect of atmospheric pressure,obtaining β construction plaster

b) Through the dehydration of gypsum in closed installations at pressures larger then the atmospherical one.

Using the first way of fabrication,the main tool we use is the oven in which the dehydration of crushed and washed gypsum ore takes place.The ovens used are room ovens,vertical ovens and rotative ovens.

The second way implies the dehydration of gypsum using boilers and autoclaves,a high-resistence plaster being obtained.After we remove the plaster from the autoclave,it is dried at 160 degrees Celsius.Heating gypsum in an autoclave is made at a temperature ranging at 120 + 125 degrees Celsius at 1,3 atm,with hot gasses.

The above-mentioned dehydration procedures present with certain disadvantages like being rather costly and expensive,having a high fabrication time and a high environmental pollution risk,using special installations that treat residual waters that are very expensive.In this work we present a new possibility of obtaining plaster through heating crushed and washed gypsum ore with microwaves.The tries are made at S.C. Congips S.A. Oradea working together with The University Of Oradea,I.M.T. Faculty,doctoral school,lead by prof. dr. ing. Ioan Mihaila.

The theoretical and practical aspects that the tries are based on are further presented in this paper.

2. SPECIFIC THEORETICAL ASPECTS

Along with the fact that plaster is a hydraulic binder that,when treated with water,forms a barbotine that strengthens through the engagement phenomena,it is also a dielectric [21] with losses.

The fundamental reaction that sits at the base of obtaining plaster from gypsum through heating at temperatures ranging between 95 – 125 degrees Celsius is:

$$CaSO_4\ 2\ H_2O = CaSO_4\ ½\ H_2O + 1\ ½\ H_2O$$

with the adverse reaction of transforming semihydrate into dehydrate being:

$$CaSO_4\ ½\ H_2O + 3/2\ H_2O = CaSO_4\ 2\ H_2O.$$

The reaction is produced with the emission of heat,that is equal to the quantity of heat absorbed at it's dehydration.

After submerging plaster into water,until the engagement phenomena takes place,we can distinguish three phases:

1) The disolvation of semihydrate in water,when it's hydration is produced.
2) The saturation of the semihydrate solution and it's suprasaturation in dihydrate.
3) The separation of small dihydrate particles,that are surrounded with water.

After these phases,the dihydrate crystals are blended together forming a rigid mass that lacks plasticity.The passing from a plastic state to a rigid state marks the beginning of the engagement phenomena (the intake of 1/ ½ molecules of H2O),the moment in which the mixture becomes solid is the end of the phenomena.Contrarily,through the heating of gypsum,1 ½ of water molecules are lost,obtaining plaster.

Taking into consideration the dielectric aspect of 2 molecules of H2O of hydrated plaster used in electrotechnique under the form of isolation plates and the smiliarity of a dielectric with losses with the gypsum ore,both having two water molecules,there is the possibility of heating gypsum ore through microwave energy. [21]

Microwaves are electromagnetic waves with a frequency ranging from 225 KHz to 100

GHz,having a high penetration capacity on non-metalic materials [21].In the case of dielectric materials,microwaves powerfully interact,eliminating water from the composition [29].The fundamental fizical relations that are available at the heating of gypsum in the microwave field are reffering to dielectric losses that take place in the polarization process of water in an alternative electric field.

Dielectric losses lead to the absorbtion of caloric energy ,heating the dielectric and loss of water through evaporation.Electric induction D in this case is given by the relation [21]:

$$D = E + 4\pi P \quad (1)$$

Where: E is the alternative electric field that varies after the law E = E0pxp (inst); P is the total polarization of water.The power of energy losses that transform into heat into a volume unit is [21]:

$$Q0 = E \times J \quad (2)$$

,where J = dP/dt is the density of the moving electricity in the dielectric.The relation (2) is transformed in [21]:

$$Q_0 = \frac{\varepsilon E_0^2 \omega}{8\pi} tg\delta \quad (3)$$

From which we can conclude that in a dielectric with losses,a variable electrical field dissipates a termic energy Qo,where E0 is the variable electrical field,ε is the real dielectrical constant,ω is the high frequency of the electrical field and δ is the loss angle.

To obtain a larger deviated power,the application of a more intense electrical field is necessary.The dissipated power can be also increased by increasing the frequency,that can be done easily by using microwaves.These are applied more and more in industrial heating techniques,using high-frequency generators with large powers and high-power magnetones.The microwave generators that use high-power magnetones have the advantage that they are simple and cheap (24).The dissipated energy in the microwave band for the gypsum,for research and heating tries can be used through the resonant cavity of a microwave oven.

The resonant cavities used for heating dielectrical materials have a paralelipipedic form with large dimensions in comparison to the wave length they use.The resonance frequency of a paralelipipedic cavity is expressed through the following relation [21]:

$$F = c\left[\left(\frac{l}{2a}\right)^2 + \left(\frac{m}{2b}\right)^2 + \left(\frac{n}{2d}\right)^2\right]^{1/2} \quad (4)$$

where c is the speed of light; a,b,d are the lengths of the sides of the paralelipipedical cavity and l,m,n are whole numbers.

3. HEATING GYPSUM ORE USING MICROWAVES

For tries made in a laboratory,a microwave oven is used to heat up the gypsum,having the following characteristics: the distribution of electric field (E) and magnetic field (N) in the paralelipipedical cavity of the microwave oven as shown in Fig. 1

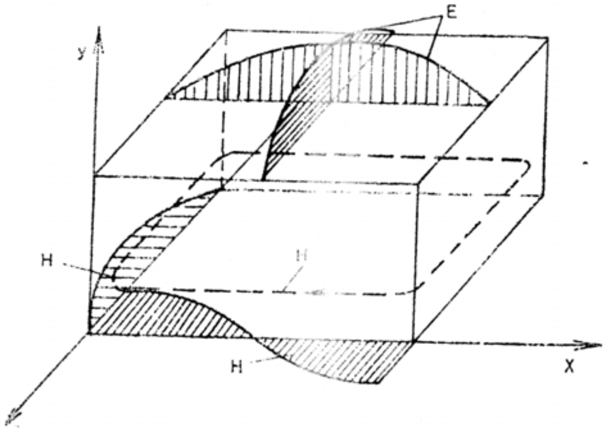

Fig. 1 – The distribution of electrical fields E and magnetic fields H in the paralelipipedical cavity.

For uniform heating,three moving objects are introduced into the cavity,on which the dielectrical sample is put and is then heated.In Fig. 2,a resonant cavity of the microwave oven is sketched,in which the heating of the gypsum ore is made,spinning on a rotative disc.

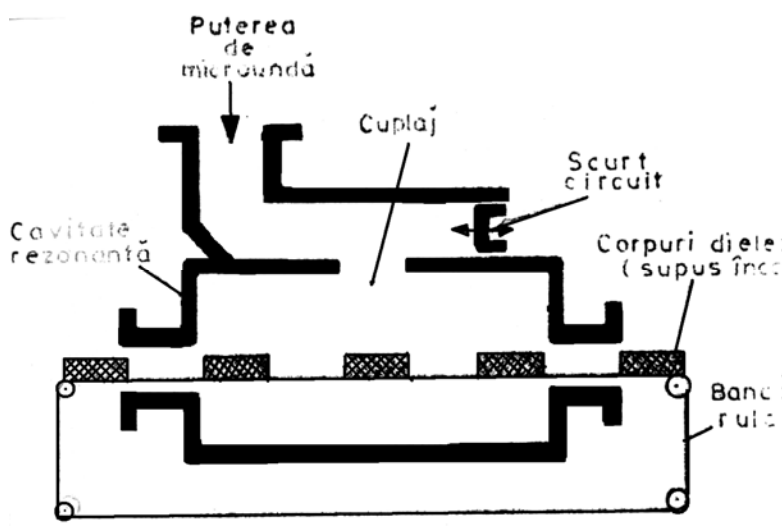

Fig. 2 – The resonant cavity for heating gypsum samples.

When the resonant cavity is put into function,the protection of the generator in the microwave must be assured.The cavity is connected to a magnetron,loaded only with the dielectric material with losses ($CaSO_4$ 2 H_2O).For the heating of the gypsum ($CaSO_4$ 2 H_2O) through a microwave field,in a laboratory,we use a microwave oven model Samsung GE 82 W with the following characteristics: alimentation source 230v – 50 Hz,consuming power of 1300 W,outlet power of 100/850 W,operating frequency of 2,45 Ghz,0M75P(31) magnetron ,ventilation cooling, exterior dimensions WxHxD = 489x275x406,5 mm,interior cavity of the oven 330x211x329mm,volume of 23 l and net weight of 15 kg.

The chemical reactions for the dehydration of gypsum are as follows:

$$CaSO_4\ 2\ H_2O = CaSO_4,\ \tfrac{1}{2}\ H_2O + 3/2\ H_2O.$$

After dehydration,the β plaster that is obtained undergoes a stabilization treatment for several days after which it is grinded and the tries are made.The results of the research and tries made at S.C. Congips S.A. will be published afterwards.

4. CONCLUSIONS

1) Because of the fact that gypsum is a natural dielectric material with losses (CaSO4 2 H2O) it is possible to use it in creating plaster through heating in a microwave field.
2)For the equal heating of the gypsum samples in a microwave field in resonant cavities,they are in a continuous rotation movement on a rotative disc.
3)Research and tries are simple and easy to do.

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