

Gypsum

Connecting Science and Technology

Richard A. Kuntze




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Gypsum: Connecting Science and Technology

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Preface

The purpose of this manuscript is to close a perceived gap between the academic and applied aspects of gypsum science and technology since a textbook covering these subjects is not available. Moreover, academic publications seem to deal with relatively narrow subjects and are concerned with cataloguing research results with little applied interpretation. In contrast, the practical literature is dispersed over a wide range of sources and gives the distinct impression of being unfocused. It is hoped that closing this gap will help to solve problems or to clarify situations that technologists and engineers may encounter and that may not necessarily be well understood.

Therefore, it is the intention to interpret the essential literature on gypsum and to place the information provided into its proper context. To achieve this, the characteristic properties of gypsum and cementitious materials derived from it have been discussed in terms of their strength and weaknesses, taking into consideration both historical and modern points of view. In any case, this manuscript is written in a manner which should make it acceptable and accessible not only to a specific audience but also to others generally interested in this subject.

An equally important reason for preparing this manuscript is the fact that misconceptions continue to resurface on key issues and these are unusually persistent. They touch on all categories from ancient history to modern properties such as dehydration, α -hemihydrate formation, water demand, aging and disintegration, rehydration and setting, as well as physical characteristics such as strength and gypsum board nail pull resistance. This has been the case since the time of Lavoisier and Le Chatelier in the 18th and 19th century, who first dealt with the dehydration and rehydration of gypsum in a modern scientific manner. A contributing factor has been the recent replacement of scientific research with current issues. Process research has become a most diluted and misquoted phrase. To a degree, the decline of gypsum research reflects the shift from gypsum plaster applied in the field to the manufacture of gypsum board in plants.

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Terminology

It is fairly well known that the English term gypsum is of Roman origin based on the Greek term *gypsos* for which various definitions exist. It is less well known that gypsum is also defined by archaic terms based on ancient usage, for example the location from which it is obtained such as alabaster, on descriptive terms such as the fibrous *satın spar*, or the specific application for which it is intended such as *selenite* and its transparent variety *Marienglas*. Since gypsum is a legitimate mineralogical term an attempt is being made in this manuscript to use it exclusively for the naturally occurring rock as well as synthetic gypsum and materials obtained from it by grinding, etc.

However, a distinction has to be made between the mineralogical term gypsum and the chemical term *calcium sulfate dihydrate*. Both are identical neglecting the impurities that may be present. *Calcium sulfate dihydrate* or just *dihydrate* is being used whenever purely theoretical concepts are being considered. It is therefore not uncommon to find the term *gypsum* used interchangeably with *calcium sulfate dihydrate*, even in modern scientific literature. This situation is being avoided in this manuscript and definitive terms are used wherever possible. This means that *gypsum* refers to practical considerations and *calcium sulfate dihydrate* to chemical or physical processes.

A similar situation exists with respect to the calcination of gypsum, that is, a heat treatment to produce stucco (first calcination stage) which consists largely of *calcium sulfate hemihydrate* or just *hemihydrate*. It should be noted that the term *stucco* is non-specific since it is also used for other cementitious materials based on hydrated lime or cement. If the heat treatment involves theoretical considerations of dihydrate the term dehydration is being used instead of calcination. This means that the term *dehydration* applies specifically to *dihydrate* whereas *calcination* is used for *gypsum*.

It should be noted that the term plaster is non-specific as well since it is being used for other materials such as hydrated lime, cements and a variety of other materials. However, for this manuscript, the term is used for plaster based on gypsum. Gypsum plaster is suitable for non-structural *interior* surfaces. In contrast to other materials it is not suitable for structural use or for *exterior* applications. Additives such as retarders and stabilizers are added to stucco to form *hardwall plaster*, which is mixed with perlite and vermiculite at the factory or sand and water in the field. In all these cases the term plaster is used, whether the material is dry or mixed with water. In addition, the term *plaster* applies to α -hemihydrate used for molding and medical/dental applications.

It is also common practice, particularly in Europe, to calcine gypsum completely to the second calcination stage which means that *insoluble anhydrite* is being produced. This dry material is referred to as *anhydrite plaster*, which is

often blended with *stucco*. Additives, sand and water are added when this material is to be used as finishing plaster for various construction applications. The term *insoluble anhydrite* is employed mostly when this chemically active component is referred to specifically.

More importantly, most of the *stucco* being produced in North America is presently used as plaster for the manufacture of paper lined gypsum board (plasterboard). For this purpose it is mixed with additives, water and foam. The term *slurry* is used for this type of *plaster* because a larger quantity of mixing water (i.e. *gauging* water) is employed than that required to produce a plaster of normal consistency (ASTM C472-99). Therefore, *gauging* water is the amount of water mixed with *stucco* to produce a plaster with a flow property that is desirable for a specific application.

