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PRODUCTION AND APPLICATION OF
CERAMIC WOOL MATERIALS IN TURKEY*

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ABSTRACT

Very fine ceramic material fibers known as 'ceramic wools' have been in industrial use for sometime. Basic applications are especially for insulation and protection purposes against flame, heat, moisture and noise. Ceramic wools, sometimes called 'mineral wools', have superior properties compared to glass wool materials. They have better resistance to heat, flame, moisture and noise. In this respect, they are known to be the best insulation materials in various applications.

Even tough the technology has been well established in industrialized countries, the production of ceramic wools in Turkey is still in the planning stage. With this presentation, production routines of ceramic wool materials will be outlined according to the Turkey's potential raw materials and technical capabilities. It will be suggested that blast furnace slags are ideally suited raw materials for the production of ceramic wools. Small compositional modifications on these materials can make a very high quality product which can be utilized extensively in everyday life systems such as in housing and other constructions. Utilization of slags and fly ashes will be very beneficial for the environmental protection of those industrial regions in the country.

INTRODUCTION

Ideally, the basic raw material for producing ceramic wools is DIABASE which is the natural deposit occuring after volcanic eruptions. Ceramic wools, sometimes called 'mineral wools', can be produced by melting the raw material and subjecting it to a blast of steam or air as it is poured from a furnace. Molten material is disintegrated into very fine fibrous wool-like mass. After this stage of wool-making, ceramic wool materials are processed by various heat treatment and binder addition cycles in order to be shaped into their final forms as slabs or plates. These materials have been in use in industry for sometime for insulation, isolation and protection purposes against heat, flame, moisture and noise. They have superior heat resistance compared to other insulation materials such as asbestos and glass wools. With their high water resistivities, they are extensively applied in marine applications.

Even tough these materials have extensive applications in housing, construction, industrial and technological fields, the production in Turkey has not been realized yet. The purpose of this study is basically to utilize Turkish blast furnace slags as ceramic wool raw materials and initiate a program to establish this technology in Turkey. This will also serve the environmental protection of those industrial regions and it will be a potential input to Turkish economy as a high value end-product with minimum raw material cost. Applications in housing, constructions and other fields will be extensive.

CERAMIC WOOL PRODUCTION PROCESS

A typical composition of ceramic wool materials is given in Table 1. In this table, a typical composition of Turkish blast furnace slags is also shown for comparison.

Element	*% in ceramic wools*	*% in slags*
SiO_2	48.00	38.00
Al_2O_3	13.00	14.00
TiO_2	1.50	0.44
Fe_2O_3	0.50	0.24
FeO	7.00	
CaO	16.00	34.00
MgO	11.00	9.12
MnO	0.50	
Na_2O	2.50	0.54
K_2O	1.0	1.70

Table 1. Typical Compositions of Ceramic Wool Materials and Turkish Blast Furnace Slags

Initially, the raw materials are processed through crushing and grinding steps for the preparation of furnace charges. Crushed and ground furnace charge is heated to high temperatures and held there to obtain a homogeneous melt. Molten mass is then poured through a nozzle and blown by a blast of steam or air into its fibrous state and condense on the walls of collection chambers. Wool-like materials are then processed to their final shape. A schematic drawing of the production process is given in Figure 1.

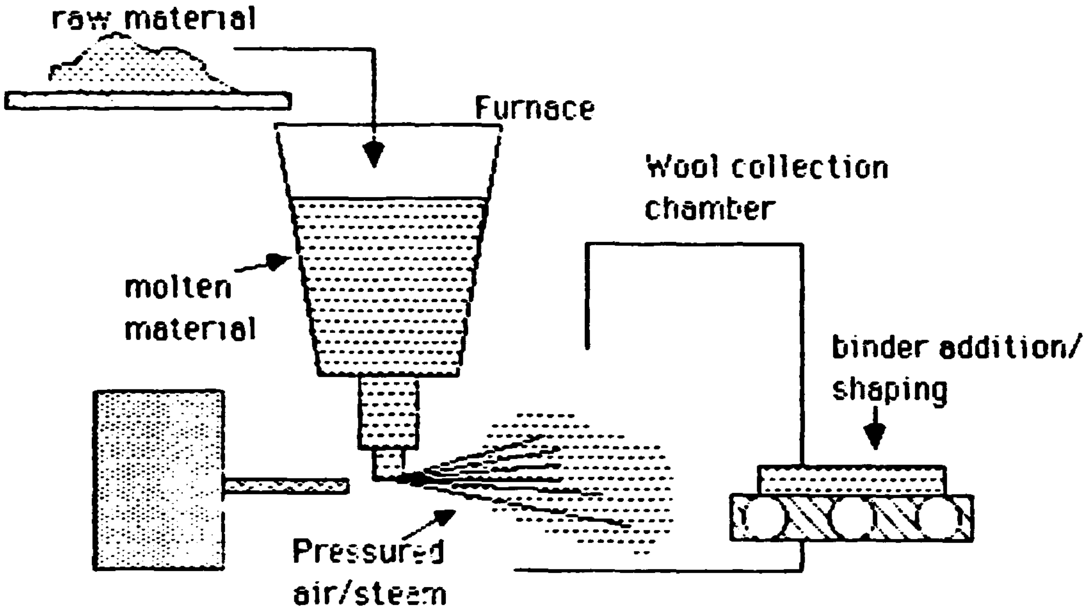

Figure 1. Ceramic Wool Production Process

The properties of ceramic wools are effectively controlled by the size, shape and quality of the fibers. By controlling the composition and fiber quality, desired properties for the given application can be obtained through the processing. Phenolic resin is added to fibers to ease their compaction into their final shape. Mineral oil is also added to increase their water resistance.

STRUCTURE OF CERAMIC WOOLS

There is a number of chemical and physical factors effecting the quality of a ceramic wool material. Before the pouring and blowing stage, the material should be in its thoroughly mixed homogeneous molten state. This can be achieved by holding the material at high temperatures, about 1500 C degree for extended periods. Different oxides shown in Table 1 react with silica to form silicates. These silicates can be basic or acidic in nature depending initial composition. The close control of composition is essential to obtain high quality fibers. Unwanted oxides, impurities, and dusts can result in the formation of brittle phases and unstabilize the product.

In Figure ?, suitable compositional regions for good quality ceramic wools are shown schematically on a ternary phase diagram.

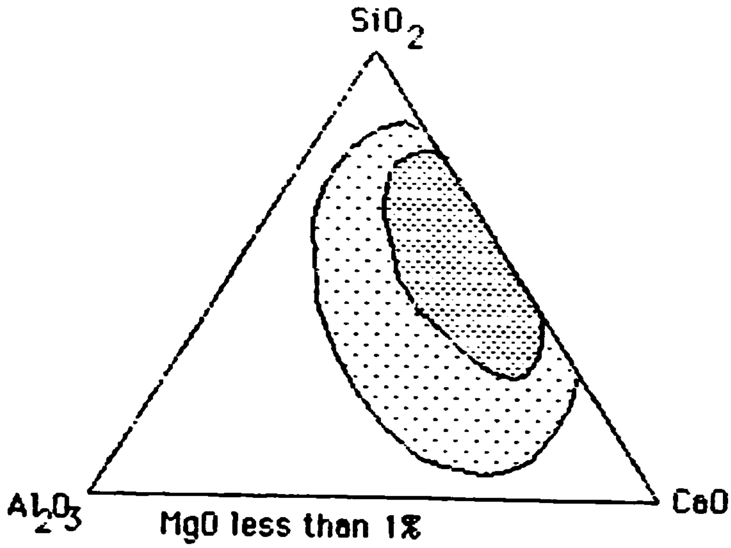

Figure 2. Ceramic Wool Composition Regions

In a typical microstructures, fibers are contacting to each other through phenolic resin layers. Approximate radius of a fiber is about 5 micron and each fiber is coated with a layer of 0.01 micron thick resin. Finer fibers can easily be compacted and shaped into desired forms and can have higher densities. Such materials have higher heat resistance compared to coarser fibers.

PROPERTIES OF CERAMIC WOOLS

In Figure 3, superior flame resistance of ceramic wool materials can be seen as compared to other materials. Ceramic wools can withstand the heat of 1000 C degree for about 2 hours. The limitation for further periods is due to additives which have lower melting points.

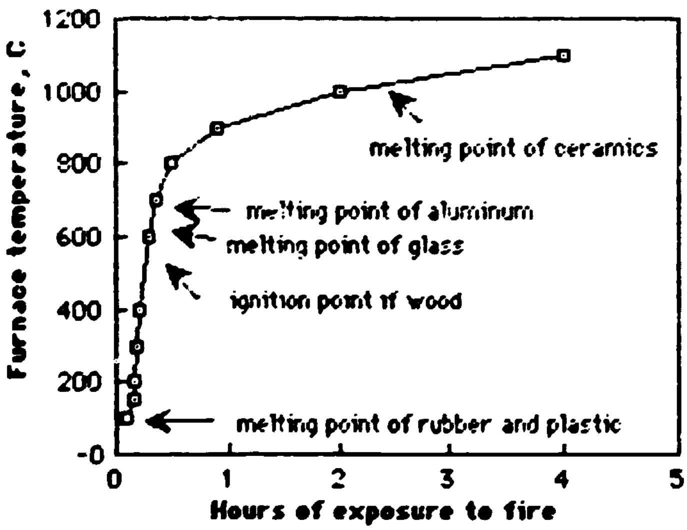

Figure 3. Thermal Properties of Ceramic Wools

A typical ceramic wool material can have density values in the range of 30-40 kg/m^3 and their thermal conductivity values about 0.034 W/mK.

Ceramic wools can be used as shock and noise absorbers in industrial machines and they are water and moisture resistant materials. Their moisture content can be around %0.02.

POSSIBLE IMPLICATIONS OF CERAMIC WOOL TECHNOLOGY

As of the potential raw materials resources concerned, the Turkish blast furnace slags and fly ash reserves can be utilized to produce ceramic wool materials with minimum cost. At the moment these raw materials are being used partly in cement industry, and the remaining amount is not being utilized for any purpose causing environmental problems in those industrial regions in the country. Only in Iskenderun Iron and Steelwork plants, 1 million ton slag materials per year are being produced regularly. Counting the remaining other two major plants in Karabuk and Eregli, Turkey has enough resources for the production of ceramic wool materials.

At present, this valuable insulation material is being imported in vast amounts causing considerable loss for the economy. Only constraint in this field is the lack of know how to establish the technological knowledge and background. At Marmara Research Center, extensive research and development studies are in progress to gain this technology and presenting the know how to the potential small and medium investors.

Production of ceramic wool can be concerned as an efficient process since the return rate for the produced material is about 75%. In this sense, such an efficient technology can be utilized extensively in developing countries. Low cost raw material resources can be used effectively to produce high value materials for energy conservation in domestic industries and in housing. Ceramic wool materials are highly recommended in housing for protection purposes against very cold and humid weathers.

Technological background and know how established in Marmara Research Center can serve to those developing countries in need of such materials for their housing and/or domestic industries.

CONCLUSIONS

Turkey has the raw material and technical potential for producing such an important industrial product. Turkish blast furnace slags and fly ash reserves can be utilized efficiently for this purpose and this may also serve to the environmental protection of those industrial regions in the country.

This technology can be presented to other developing countries. Establishment of an institute in Marmara Research Center is strongly recommended for this purpose. Such an institute can act as a coordination center for collaborative research and application activities among developing countries.