BENEFICIATION AND RECYCLING OF SOME INDUSTRIAL WASTES IN PARTICULAR CEMENT DUST FOR THE PRODUCTION OF GLASSES AND GLASS-CERAMICS

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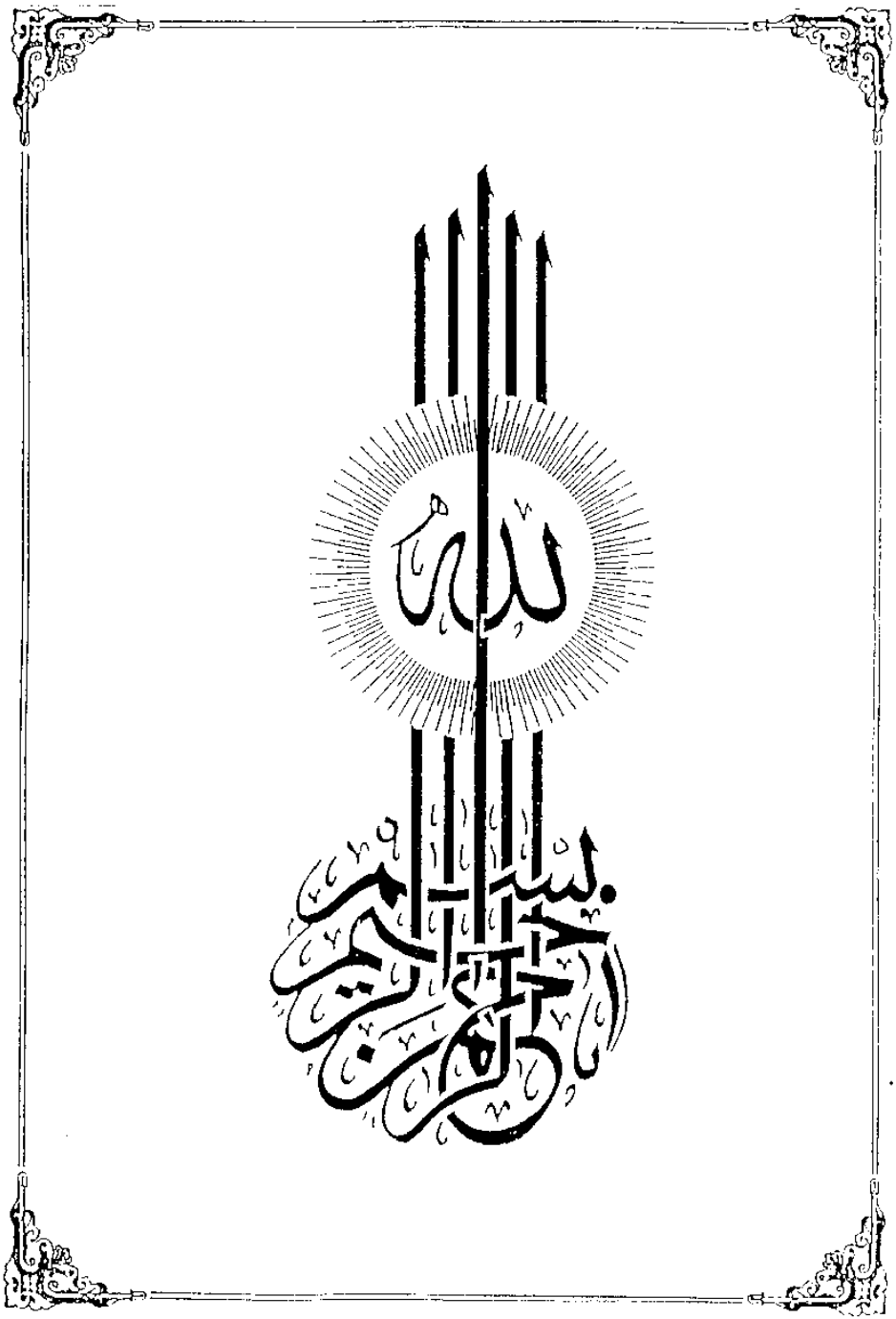

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ABSTRACT

The recycling or the use of cement kiln dust to produce beneficial glassy products is of prime importance economically and ecologically. The objectives of this thesis were focused on the utilization of two local cement kiln dust from two factories at Helwan and Beni-Suef, for the production of some traditional white and emarld green soda-lime - silica glasses. Also, the work was extended to investigate the progressive additions of calculated amounts of cement kiln dust to two basic glass systems, namely, Li_2O - B_2O_3 and Li_2O-SiO_2, which are known to give readily valuable glass-ceramic products. Also, the investigation included infrared absorption spectral studies of the obtained glasses and their corresponding glass-ceramic products. Also X-ray diffraction data were obtained for the phases crystallized during the preparation of glass ceramics.

All the glasses were melted in platinum 2% Rh crucibles in an electric furnace at temperatures ranging from 1100-1450°C ± 20°C depending on the glass composition. Exception was made by melting some traditional commercial glasses of the soda-lime - silica type which were melted in fireclay crucibles. The melting was extended to 3 hours with stirring every ½ hour to ensure homogenization. The melts were cast into rectangular molds 1 x 1 x 4 cm and the glass slabs were transferred to a muffle furnace adjusted to the appropriate temperature 350-480°C for annealing. The muffle furnace was allowed to cool at the rate of 30°C/hour to room temperature.

Differential thermal analysis (D.T.A.) was carried out to determine the thermal peaks which were used to nucleate and fully crystallized the glasses to fine-grained glass-ceramcis by controlled thermal two-steps heat-treatment.

Infrared absorption spectra measurements were made by the KBr technique for all the glasses and their corresponding glass-cermaics derivatives from 200-4000cm^{-1}.

X-ray diffraction measurements were done to investigate all the various crystalline phases precipitated during the ceramming process.

The chemical durabilities of the glasses and glass-ceramics were evaluated by considering the corrosion weight loss of these prepared products against the action of 0.1N hydrochloric acid solution at 95°C for 2 hours.

It was obvious that the experimental data indicate the ability of reformulating the waste cement kiln dust by adding the appropriate amount of sand and soda ash to obtain good quality traditional white soda-lime - silica glass together with green type of the same basic system.

Experimental results indicate that the main infrared absorption bands in the region 600-1650 cm^{-1} obtained from the glass and glass-ceramics are due to the vibrations of characteristic glass-forming units together with the low-frequency bands originating from the vibrations of the network modifying cations. Also the near-visible composite bands are believed to be due to hydroxyl or water molecules. The pronounced progressive additions of cement kiln dust are observed to cause variations in the sharpness, splitting and intensities of some of the absorption bands

due to the introduction of lime, silica and alumina together with some other minor constituents These additives are assumed to produce variations in the internal glass structure and the spatial arrangement of network building groups.

X-ray diffraction studies reveal that the precipitated lithium-bearing phases in the thermal-heat-treated glasses differ according to the glass-composition, heat-treatment regime and by the quantity added of the cement kiln dust.

The corrosion weight loss data were found to vary with the amount of cement kiln dust and that better durabilities could be obtained by adding certain calculated amounts of cement kiln dust to the glass batch.

The interpretation of the experimental data obtained was given on the basis of the current and acceptable theories of glass constitution and the dependence of variations of the investigated properties on the internal glass structure.

This piece of work carried out in this thesis indicate the ability to recycle and use the local cement kiln dust in producing beneficial and valuable glasses and glass-ceramics with outstanding physical and chemical properties.