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Amongst the naturally occurring minerals clays occupy a key position in ceramic industries. Besides the plastic properties for which clay is indispensable, the pyrochemical changes are also of great significance and are the great stimulating incentives to scientific workers for further research in this fascinating field.

A great deal of present day ceramic technology still exploits the properties of kaolin minerals because of the reasons, such as i) it occurs in relatively pure state or can be purified easily ii) it has got sufficient plasticity required for fabrication and this can be controlled by suitable addition iii) it is highly refractory and the pyrochemical changes are of great significance in many industries which mostly include dehydration, phase transformation, solid state reaction, sintering, vitrification etc.

The enormous growth of interest in the kinetic aspects of the transformation of clay minerals with respect to several parameters has led to considerable thinking in this subject. Phase transformation of clay minerals during heat treatment is also very much important from technological point of view.
It would be difficult nowadays to find a better example of the way in which the elucidation of chemical structure has acted as a catalyst upon diverse applications. Further unfolding of structural detail will proceed side by side with extensive studies of properties, and it is safe to predict that the applications will ramify greatly.

The introduction of x-ray technique has led to the elucidation of structure of the majority of clay minerals and whilst refinement of technique may result in some revision and elaboration, the basis appears sound. Clay minerals fall under the group of layer lattice structures where three oxygen atoms of each silica tetrahedron ($\text{SiO}_4$)$^-4$ are linked to similar units. One oxygen of each group of four is not fully satisfied electrically and requires to be linked to external cations. The sheet of silicon-oxygen atom is capable of extension in two directions at right angles. Therefore, mineral structure within this group are invariably platey. Definite layers are formed which are stacked one above the other and the bonds between the layers are relatively weak. Each mineral layer or plate is an independent unit and must be electrically balanced having each cation co-ordinated with anion in a way dependent
on their size ratio. In some cases the layers are not balanced within themselves (montmorillonite) and invite ions to be adsorbed on the surface of the layers.

During the period when colloid chemistry underwent its spectacular growth, the importance of extensive surfaces of clay minerals for adsorption was realised. Most clay minerals occur as particles too small to be resolved with the ordinary microscope. Furthermore, a considerable distribution of particle sizes is frequently present in all the clay minerals.

Control of particle size is very important in many high temperature reactions. Again, the strong effect of particle size relating to the surface energy is one of the basis for the use of clay minerals in ceramic technology. Their fine particle size aids in fabrication process since it is a source of plasticity. This fine particle size develops surface energy forces which cause densification during the firing process. In addition to specific particle size, the particle size distribution is also important. For very fine particle sizes there are electrostatic surface forces of repulsion.

Several properties involved in the production of
clay based ceramic articles are dependent on the specific surface area of the clays.

Water is an integral part of the clay structure and the complicated relationship between clay and water can be explained by the interaction of four factors such as

i) the charge on the clay particles

ii) their lamellar form

iii) the adsorption of water on the particles and

iv) the high surface tension of water.

Dehydration of water involves the loss of physically adsorbed water in kaolinite followed by loss of hydroxyl groups from the lattice in the form of water (dehydroxylation). At still higher temperature there is no loss in weight but the clays undergo some phase changes depending on the type of clay.

Studies have been made on the changes that take place in kaolinite on progressive heat treatment but as these changes are very much susceptible to minor changes of condition, there is wide scope of study in this line. Moreover, a knowledge of the effect of heat on clay minerals and their kinetic study are important for an understanding
of the firing characteristics of clay minerals. As various factors are involved in the characterization of clay minerals, single study on heat treatment can not generalise the phase transformation of clay minerals. From the view point of solid state chemistry and physics, the clay minerals offer a rich field for investigation. An outstanding feature of these phase transformation reactions in clay minerals is that they take place in a crystallographically ordered manner so that the main product is oriented in a significant way with respect to the parent phase.

The kinetics of the decomposition reactions in clay minerals belong to the heterogeneous solid state reactions. The importance of this subject is due to the fact that depending upon the rate of reaction their utilisation can be economised. As the decomposed material has got high surface energy, sintering is often carried out with the decomposed materials. Clays usually contain physically coordinated water and chemically bonded hydroxyl groups. Although bonding energies are different, both decompose at elevated temperatures to produce water. The particle size of the two layered mineral like kaolinite, where broken bonds are responsible for particle charge,
has a pronounced influence on the water content as well as bonding energies and they also influence the rate of expulsion of water molecules from the clay lattice.

There has been increased interest in the reactions taking place when clay minerals are heated because of two reasons.

i) It is possible to understand the structure of the original mineral by examining the high temperature phases as the structural inheritance is one of the most important factors in determining the changes.

ii) Industrial application of clays for specific purposes are also increasing day by day. There is enough possibilities of changing the rate of these thermal reactions and transformation by increase of surface area or addition of catalyst.

Present investigation was undertaken to study systematically the influence of surface area on the dehydration-rehydration along with some physiochemical behaviour of kaolinite clay mineral on progressive heat treatment. The basis of selection of kaolinite is due to the fact that it is a true clay mineral having a fixed composition and well crystalline structure. Moreover, the
natural kaolinite mineral has a wide range of particle size distribution. For this purpose purified kaolinite was separated into six different size fractions. After proper characterisation of each fraction they were subjected to equilibrium dehydration-rehydration on progressive heat treatment up to complete destruction of clay structure. The structural flexibility on thermal excitation and several others physicochemical characteristics of the fired clays have been correlated with the surface area.

The subject of clay dehydroxylation have attracted the attention of many scientists as heat of dehydration is the most important thermodynamic parameter of reactions in ceramic clays. Fundamental dehydration study was made by several workers on clay minerals. The stationary state was reached under isothermal conditions in heating clays and as the rate of dehydroxylation depends on shape, size, packing degree of samples etc. it is obvious that no reliable kinetic data and activation energies can be determined. The basis for the understanding the rate process was the Arrhenius relationship, which states that for many processes the logarithm of the reaction rate constant $K$ is proportional to the reciprocal of absolute temperature. Major portion of the dehydroxylation reaction was found to follow first order kinetics. To obtain further insight into the
mechanism of the complicated process the influence of surface area was thoroughly studied by carrying out experiments under identical conditions (isothermal weight loss experiment) and correlating the different kinetic parameters.

The dependence of particle size on the disintegration of clay particles at much higher temperature with the development of new phases in Al2O3-SiO2 system was studied by thorough measurement of some electrical characteristics.

Whether there was any relationship between the surface area of the original clay and the nature of the phases developed in the high temperature solid state reaction after decomposition was examined through x-ray diffraction, scanning electron microscopy and measurement of some physical characteristics of the sintered masses.