CHAPTER 8

RECENT DEVELOPMENT IN ZEOLITE RESEARCH AND SCOPE FOR FUTURE WORK
Zeolite properties are being studied by nearly every type of modern scientific discipline, and they are being utilized in many chemical engineering processes. Important advances include detailed basic information on cations in zeolites, more understanding of the mechanism of zeolite formation, the role of zeolites in adsorption and catalysis and the increasing technology of the use of molecular sieve in catalysis and adsorption. Zeolites have unique properties which find use in many diverse fields. Zeolites are effectively used in removal of effluents from industrial waste, water purification, nuclear waste treatment, animal hygiene products, nutrition and health etc.

The growth of the zeolite research is reflected by the growth in the number of papers presented in the international conferences of zeolites; 31 papers in the first held at London in 1970, 150 papers in the fifth held at Napoli, Italy in 1980 and more than 300 papers have been presented in 12th international zeolite conference held at Baltimore, U.S.A. in 1998.

The detailed information about the zeolite structure plays an important role for industrial and agricultural applications. The basic structure of several natural and synthetic zeolites seem to have been resolved.

The crystal structure of heulandite both natural and synthetic is studied by many workers (1,2,3). The structural and ion exchange properties of different coloured heulandites were well interpreted by Ghan, S.D. (4). Structural studies on natural heulandite using infrared spectroscopy was reported by Joshi, M.S. et al (5).
Sorption properties of cation exchanged heulandite was well studied by Kasture, M.W. et al (6). The spectroscopic measurements in conjunction with powder XRD and $^{29}$Si MAS NMR data was studied by Godelitsas, A., et al (7). Formation of distorted Al tetrahedra during the dehydration process in heulandite crystals, had also been reported.

Thermal behaviour and adsorption properties of natural stilbite were well studied by Kasture et al (8). It was observed that stilbite could potentially be used as an adsorbent and catalyst. However, it's use is limited by collapse of the framework in the dehydration process at elevated temperature. The collapse is believed to be caused by cell contraction (9). Jun Li (10) investigated the adsorption behaviour of ion exchanged forms of stilbite. It revealed unusual selectivity to the length of carbon chain in the organic molecules. It is also observed that stilbite shows good catalytic selectivity in the isomerization of n-butene and iso-butene.

Our knowledge of pressure induced phase transformation of zeolites is very limited to the vast number of temperature dependent once studied over the past several decades. It is partially due to the experimental complexities as well as analytical ambiguities arising from porous nature of the material. Therefore, applying external hydrostatic pressure was likely to alter the chemical environment within the pores. Initially, different phase transitions, depending upon the type of cations were found in case of zeolite rho (11). Similar
study was carried out on natrolite crystals by Yohgjae Lee et al (12).

The thermal behavior of K exchanged forms of natrolite was reported by Yamazaki, A. (13). Similar study was carried out in case of scolecite crystals (14).

Research in zeolite synthesis has continued unabated. Zhao et al (15) synthesized heulandite type zeolite in the laboratory by hydrothermal method. Joshi and Bhoskar (16) reported synthesis of zeolites by gel method. The synthesis of zeolites using Kaoline clay as a source of silica was also reported (17). The use of natural zeolites for the removal of ammonia from waste water is reported (18). The use of natural zeolites in the field of animal odor absorbents, waste water treatment plant etc has already been reported. With increasing environmental conscious applications in pollution abatment, has gained importance, particularly when large amount of ion exchanger or absorber are needed. A recent development in the field of sorption indicates that, many other applications are also possible where the advantage of porous and bulk structure combined with specific properties of natural zeolites (19,20) has been considered.

The high resolution magic angle spinning $^{29}$Si NMR and $^{27}$Al NMR spectra were studied in order to obtain detailed information about structure of various natural and synthetic zeolites. The information about Si/Al ordering is also obtained using NMR spectra (21). The NMR spectra of $^1$H, $^{22}$Na and $^{27}$Al nuclei in natrolite were also studied (22).
**Scope for further Research**

Zeolites have unique properties which find use in many aspects of science and technology. Zeolites find use in many diverse fields. Molecular architecture has gathered interest from scientist all over the world. Natural zeolites, their modified form by ion exchange process has been widely used in industries by many countries in the world. The scope of natural zeolites in industrial applications is limited due to i) low thermal stability ii) less acid resistant and iii) variation in chemical composition.

In the present case of investigation a few fibrous and platy zeolites were collected. There is a chance to find new locations where the occurrence of zeolites have not been reported so far. A rigoures survey in this regard could be undertaken in coming years.

Different varieties of heulandite crystals are studied in present case. Their thermal behavior is discussed in detail. There is enough scope to study these crystals using X - ray fluorescence (XRF), scanning electron microscopy, energy dispersive spectroscopy,(SEM-EDS), X - ray photoelectron spectroscopy etc.

It is observed in the present case that the stability of stilbite can be considerably varied by ion exchange process. This work can be repeated for the other varieties of zeolites. The ion exchanged forms of stilbite can also be studied as molecular sieve and catalysis.

In the present case of investigation, $^{29}\text{Si}$ NMR spectra
and $^{27}$Al NMR spectra of natural zeolites have been studied. The temperature dependencies of NMR spectra can also be studied. There is enough scope to study NMR spectra to get information about different kinds of water molecular motion.

Crystal size obtained in synthetic zeolites is very small. Large single crystals of synthetic zeolites are needed for understanding the zeolite crystallization process. By studying the growth condition and controlling the growth parameters more accurately it is possible to grow bigger single crystals of synthetic zeolites. By increasing volume of the autoclave and quantity of the reacting substances, their influence on crystal size can be studied.

It has been already discussed that Si/Al ratio has significant influence on the crystal size and symmetry, attempts can be made to obtain the crystal with desired symmetry.
References


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