© *Proc. Indian natn. Sci. Acad.*, **50**, A, No. 5, 1984, pp. 479-482.
Printed in India.

NATURAL OCCURRENCE OF CLINOPTILOLITE FROM WESTERN MAHARASHTRA : ITS UTILISATION IN REFRIGERATION USING SOLAR ENERGY*

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(*Received 13 September 1983*)

Experimental studies suggest that clinoptilolite (a zeolite) identified to occur at many places in Maharashtra may be utilized, if necessary after preliminary beneficiation, in refregeration. This would be a very economical proposition in the light of the present energy shortage as the proposed system does not include any moving parts and requires no additional source of energy.

Key Words : Clinoptilolite; Western Maharashtra; Solar Refrigerator

INTRODUCTION

NATURAL occurrence of Zeolites in India has been known from early in the 19th century, when Brooke (1831) described a zeolite under the name 'Poonahlite', which later turned out to be mesolite (Bowman, 1909). During the last 150 years numerous papers have been contributed by a large number of workers dealing with identification and optical and physical properties of zeolites. These papers have been recently reviewed by Phadke and Kshirsagar (1981) who expressed an urgent need to investigate the physico-chemical characters of these minerals in greater detail to assess their industrial potential. No published literature on Indian zeolites is available in this field although in the West much work has been done in recent years and a concise account is available in a compilation edited by Sand and Mumpton (1978). Clinoptilolite is amongst the few natural zeolites which has attracted greater attention than others on account of its wide industrial applications. Its utilisation in refrigeration and air conditioning is a novel aspect dealt with by Tchernev (1978). In the present paper the natural occurrence of clinoptilolite from India is described and the results of the preliminary investigations towards its application in refrigeration are presented.

OCCURRENCE

The known occurrence of zeolites in India is restricted to the basaltic lava flows belonging to the Deccan Traps and occur as beautiful minerals grown in cavities. On the basis of the work of Walker (1951, 1960*a*, 1960*b*, 1969) in Ireland and later in India, Sukheswala *et al.* (1974) established that zeolites are distributed in three different vertical zones viz., the Uppermost *Heulandite zone*, the middle *Scolecite zone* and the lower *Laumontite zone*. These zones have been established by them on

*Paper presented at the Symposium on Role of Research and Development for Planned Utilization of Mineral Resources held at INSA, New Delhi from 4-6 October, 1982.

the basis of the frequency of their occurrence and the nomenclature of the zone corresponds to the mineral having highest frequency in that particular zone.

Clinoptilolite, a hydrated aluminosilicate of Ca, Na and K, investigated in the present study, occurs in the *Heulandite zone* as coffin-shaped crystals in cavities in both 'aa' and 'pahoehoe' type basaltic lava flows. It is often associated with mordenite, silica minerals, stilbite and apophyllite. The mineral appears very similar to heulandite and in hand specimens it could be easily mistaken for it. In fact the initial specimens collected by the author were treated as heulandite till XRD and DTA data became available. The crystal plates are as large as 3 cms across and given rise to curved aggregates of euhedral laths which are usually colourless, transluscent and pearly, but pink and orange colours are also not uncommon. The XRD patterns and the DTA curves for the different coloured varieties do not show any significant variation. The data conforms perfectly with the published literature (Berry, 1974; and Mumpton, 1960) and establishes its identity.

TABLE I

X-Ray powder diffraction data for clinoptilolite from Poona

dÅ	I/I_1	dÅ	I/I_1	dÅ	I/I_1
8.9267	100	3.7047	11	2.9520	80
7.9286	12	3.5380	9	2.7944	22
6.7782	10	3.4502	8	2.7160	38
5.621	3	3.4112	20	2.5045	14
5.1035	15	3.3511	5	2.4596	18
4.6426	28	3.1684	30	1.9552	12
3.9656	60	3.1131	30	1.7791	10
3.9037	48	3.0701	10	1.721	14

REFRIGERATION EXPERIMENTS

Different coloured varieties of clinoptilolite identified in hand specimens were separately subjected to these experiments. The mineral was initially separated from cavities and other associates by hand picking and about 20–30 kg of each was ground to a fine powder (170–200 mesh). X-ray diffractograms of the representative portions of each were obtained to confirm the bulk identity. It was observed that more than 80 per cent of the material was clinoptilolite in each case. Three different varieties were subjected to out door tests in the months of March, April and May on the lines suggested by Tchernev (1978). About 4–5 kg of the powder of each was loaded in 0.1 sq. meter panels fabricated out of copper, and having a depth of 7 cms. The panels were connected by copper tubing, properly insulated, to a water storage tank placed in a heat insulated refrigeration box having a room area of 0.035 cubic meters. The solar panel and the water tank connected by the copper tube formed a closed system which was sealed, outgassed and evacuated to a pressure 0.1 psia when the ambient temperature of the atmosphere was about 25°C. The water tank was also loaded with about 300 c.c. of water. In a heating cycle it was observed that on an average sunny day approximately 200 to 300 c.c.

of water was desorbed by the zeolite and condensed and stored in the water tank. The cooling cycle began in the evening when the ambient temperature was reduced to 26°–27°C and pressure inside the system dropped to 0.1 pisa and water was adsorbed by the zeolite. The zeolite panel was thus recharged during the night cycle and was ready to desorb the water during the following day. The evaporation of water from the water tank during the night produced a cooling effect which could be enhanced to even ice formation in the differentially loaded water tank after several cycles extending over a period of two to three weeks. Thereafter, melting of the ice during the course of the day caused cooling also during the day. An alternative arrangement of providing some sort of buffer and an adsorbent as suggested by Tchernev (*op. cit.*) would enhance the efficiency of the system giving day and night cooling. The crude equipment used by the author (Fig. 1) may be further refined in several ways towards a commercial manufacture of a Solar Refrigerator.

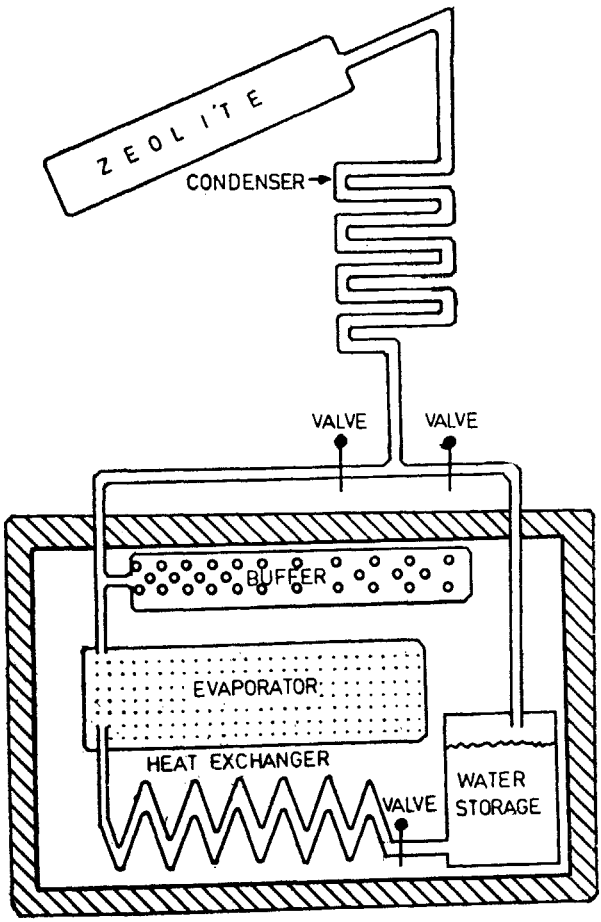

FIG. 1. A sketch diagram illustrating working of the Solar Refrigerator using Solar Energy and Zeolite (clinoptilolite) as a solid adsorbing and disorbing agent.

Potential Reserves of Clinoptilolite

The zeolite zones marked by Sukheswala and his coworkers (*op. cit.*) indicate that the best exposures of the *Heulandite zone* are observed in the highlands of the plateau in the region around Poona. The base of this zone is marked at approximately 600m above msl and covers approximately 40,000 sq. km. This zone is the topmost zone reaching even upto the highest point Kalsubai. In this zone the lava flows have a very gentle gradient but the zeolite zones are practically horizontal. The pahoehoe type lavas made up of small flow units are comparatively richer in zeolites than the 'aa' flows. Although for obvious reasons it is very difficult to estimate the total reserves of clinoptilolite in this region, one may expect about 20–30 per cent of the volume of rock occupied by zeolites and other cavity minerals in pahoehoe flows, and a high proportion of it is constituted of the mineral clinoptilolite. More extensive work in this direction would yield specific estimates.

Conclusions

In the light of the acute energy crisis faced by our country it will be worthwhile to utilise the freely available Solar energy in every possible manner. A successful utilisation of clinoptilolite, after necessary beneficiation, in refrigeration and air conditioning as a solid adsorbent will go a long way in energy conservation and finding new applications to our natural resources.

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