

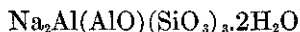
The use of the iodide for radium concentration would not be practical unless it were possible to recover a large per cent of the iodine at the end of the process. Accordingly when the radium had been practically all removed from certain fractions the barium iodide solutions were saturated with chlorine. The displaced iodine was filtered off, dried and resublimed. The barium chloride solution was evaporated and the crystals used in the precipitation of the next batch of radium-barium sulfate. The iodine was mixed with a little less than the theoretical amount of red phosphorus and water was slowly dripped over the mixture. In this manner hydriodic acid was obtained which was also used in the next series. The recovery was satisfactory, indicating that the operating cost for iodine would be quite reasonable.

#### THE ARTIFICIAL PRODUCTION OF A ZEOLITE.

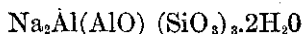
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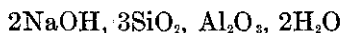
I was required to produce an artificial, i.e., a synthetic substance to replace the natural ore used in commercial water softeners. I inquired of the water softener committee and also of the Wayneite Softener Company and found that any hydrated metallic silicate containing sodium would soften water but that Bergen Hill, N. J., produced about the best ore. I then looked up in a mineralogy the analysis of the Bergen Hill ore. This is called natrolite and is the first of the zeolite series. The approximate formula is as follows:



A glance at this formula will readily show that the constituents would require a very high temperature to cause fusion. By means of the following calculation I determined the charge for the furnace.



Collecting these constituents in their most available forms,



Then by molecular weights, divided by ten, I had the following recipe:

Sodium Hydroxide,	8.0 g.
Silica,	18.0 g.
Alumina,	10.2 g.

(Note, the hydrogen and extra oxygen in the sodium hydroxide combine to form water which is vaporized in the furnace.)

I placed the charge in a fire clay crucible in a glass furnace and fired it for about 2 hours when, all the charge being fused, I drew the fire and cooled the substance. I then pulverized it and placed it in a dish of water in a steam pressure cooker. I kept it at a temperature of 133°C. and a pressure of 20 lbs. for about two hours. This latter treatment, of course, was to hydrate the silicate which was formed in the furnace. I cooled and dried the substance and tested it by treating a small sample with hydrochloric acid with which it gelatinized. As this is one of the group tests for zeolites I was fairly assured of some measure of success and immediately proceeded to try out the substance as a water softener.

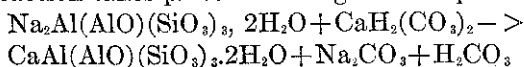
I built a small tower filter, along the lines of a large water softener and packed the finely divided product of my experiment into it. I made up a constant soap using lg. of LUX, 90c.c. of distilled water and 10c.c. of grain alcohol. I tested 5 c.c. of ordinary city hard water and found that it took 46 drops of the soap to break it, that is, to form a suds that would stand for five minutes. I then passed about 10 c.c. of the same hard water through my filter of zeolite and tested it with the soap solution in the same manner. It required but 35 drops to break it which almost spelled success. Only one other thing was required of the product to establish it as a water softener; that after being exhausted by passing an excess of hard water through it, it could be renewed by passing salt brine through it. I killed my substance by passing several hundred c.c. of hard water through it. I then prepared a saturated solution of salt and allowed it to stand in the apparatus about ten minutes after which I washed it out thoroughly with clear water. Then again I passed ten c.c. of hard water through the filter and tested it with the soap solution. This time the renovated zeolite softened the water so that it required but 34 drops of soap to break it which was convincing proof that the new product was a success.

Taking into consideration the small amount of the zeolite that I made and the crude method of having it react with the hard water I am convinced that under the almost ideal conditions of pressure and position found in the commercial water softener the artificial product which was the result of the foregoing experiment would be just as efficient if not more efficient than the natural ore now in use.

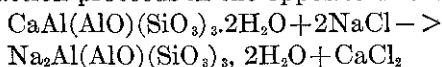
The following equations are supplementary and give the reactions of the zeolite with the hard water and the salt brine.

## Supplement.

The zeolite reacts with the magnesium and calcium salts which form the hardening matter in the water effecting an exchange whereby these salts are converted into sodium salts which are not noticeable in the water as they do not harden it. This reaction takes place according to the equation:



The foregoing reaction is reversible and when an excess of sodium ions is furnished, as in the case of the brine treatment, the reaction proceeds in the opposite direction as follows:



which leaves the zeolite ready for use again.

It would appear from the foregoing that the zeolite could be used indefinitely but the truth of the matter is that the latter reaction is not carried absolutely to completion, though it is very nearly, and consequently the zeolite in time becomes useless and must be replaced.

Specimen report of a high school chemistry pupil in a project class.

<sup>1</sup>The above report was prepared, without assistance, by the pupil whose signature accompanies it. The project was the second undertaken by the pupil. After completing his first project, which dealt with the artificial fixation of nitrogen, he asked to be assigned a project that would require some originality for its solution. He had no knowledge, at the time, of the existence of artificial zeolite processes for water softening so that his solution of the problem was entirely original.

The report is offered as an example of what can be done by a high school pupil under the stimulus of the project method of teaching chemistry. It should be said that the project work occupies only the last two months of the course, and is preceded by thirty weeks of preparation in the fundamentals of the subject.—Frank B. Wade, Shortridge High School, Indianapolis, Ind., June, 1922.

## HONORS FOR MEMBERS OF THE UNIVERSITY OF CHICAGO FACULTY.

Among Chicago men who have recently had honorary degrees conferred on them is Forest Ray Moulton, Professor of Astronomy in the University of Chicago, who received the degree of Doctor of Science from Albion College, Michigan, at its recent commencement. Professor Moulton, who received the degree of Doctor of Philosophy from the University of Chicago *summa cum laude*, is a research associate of the Carnegie Institution of Washington and has been for eight years secretary of the astronomical section of the American Association for the Advancement of Science.

Professor Frank R. Lillie, Chairman of the Department of Zoölogy at the University of Chicago, has recently been made chairman for 1922-23 of the division of biology and agriculture in the National Research Council. Professor Lillie, who is also Director of the Marine Biological Laboratory at Woods Hole, Mass., has been President of the American Society of Naturalists and of the American Society of Zoölogists.