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RESEARCHING AND SPREADING A NEW TECHNIQUE OF PARTIAL  
DESALINATION BY ION EXCHANGE USING CARBON DIOXIDE AS REGENERANT

DP/CPR/86/023/11-01

PEOPLE'S REPUBLIC OF CHINA

FINAL REPORT

on

Mission in Beijing (P.R.China)

Prepared for the Government of the People's Republic of China  
by the United Nations Industrial Development Organization, acting  
as executing agency for the United Nations Development Programme

Based on the work of Expert  
Wolfgang H. Holl

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION  
VIENNA

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## 1. Background

In 1983 and 1984 Mrs. Yun Guichun from the Institute of Nuclear Energy Technology (INET) of the Tsinghua University spent 18 months at the Kernforschungszentrum Karlsruhe (KfK) during a fellowship. In this time she got informations about the development of a process for partial demineralization of water by ion exchange in which the exchange resins are regenerated by means of carbonic acid. The particular advantage of this process is the fact that the amount of salt which has to be discharged equals the amount which was eliminated during the service cycle. As a consequence the process is non polluting for the environment. Back in China Mrs. Yun initiated laboratory scale experiments at the INET with this technique, which demonstrated that the so-called CARIX process (CARIX = Carbon dioxide Regenerated Ion eXchangers) allows a decrease of salinity which is sufficient for several industrial applications. The process is of particular interest in companies which have  $\text{J}_2$  as a by-product as e.g. breweries or petrochemical factories. The experiments at INET were carried out in cooperation with the Qilu Petrochem. Comp. (subsidiary of SINOPEC) which is interested in applying CARIX for softening of cooling water and which payed part of the experimental equipment.

## 2. UNDP - Project

In order to emphasize the research on CARIX and in order to obtain enough fundamental and technical know-how, INET started a UNDP project in summer 1987. The main objectives of this project are: a) to develop the CARIX process for application in the field of industrial and drinking water treatment, b) the construction and operation of a pilot plant (in cooperation with a company), and c) to obtain a staff of coworkers with sufficient knowledge about the process. The UNDP project also includes the invitation of consultants from the F.R.G. and the U.S.A. and visits of Chinese scientists in these countries in the form of both study tours as well as fellowships.

The invitation of Dr. Höll thus was part of this project.

### 3. Activities in the P.R. China.

The activities in the Peoples Republic of China were the following:

- a) Lectures about CARIX at the Institute of Environmental Technology (IET) of Tsinghua University.
- b) Discussion of some laboratory scale experiments carried out at INET. (It should be stated that no complete information about these Chinese experiments was given, although a printed report exists).
- c) Presentation of CARIX at Qilu Petrochem. Comp. at Xindian, Prov. Shandong, including a visit of the future pilot plant. It turned out, that this company was interested in informations also about other ion exchange processes and problems. Due to the lack of any pre-information by INET such assistance could not be given.
- d) Visit of Beijing Brewery with discussion of a possible application of CARIX.
- e) Seminar about laboratory and pilot scale experiments at the brewery.
- f) Visits of the laboratories of IET and INET.
- g) Short discussions about the entire mission with UNDP staff.

### 4. Actual situation of the development

During the last two years INET carried out laboratory scale experiments were carried out with respect to the softening of cooling water in cooperation with the Qilu Comp. Although not the most favourable resins were used the results are excellent and demonstrate that a sufficient degree of softening is reached. Actually Qilu fits out a pilot plant in order to continue the CARIX experiments in a technical scale. In the past this plant has been used for other purposes. It contains all the components which are required for carrying out

service an regeneration cycles. Disadvantages during operation might be due to the relatively small volume of the regenerant vessel and from the fact that the whole plant is neither rubber-coated nor from stainless steel, which is important in case of carbonic acid solutions. The plant has a cross-sectional area of about  $1.8 \text{ m}^2$  and allows a throughput of  $15 \text{ m}^3/\text{h}$ . It thus has four times the dimensions and throughput of the pilot plant which was built in 1983 by KfK licensee WABAG.

Pilot scale experiments shall be started in November 1987. If they turn out to be successful, Qilu will build or order a full scale plant for  $200 \text{ m}^3/\text{h}$  throughput.

According to the tests at INET, also a sufficient dealcalization of water for the Beijing Brewery should be possible. As a result of the discussions, the brewery would allow laboratory scale experiments to be carried out which seem to be necessary for the design of a pilot plant. Also the brewery is interested in running a pilot plant for about  $5 \text{ m}^3/\text{h}$  throughput. For the laboratory scale experiments the existing plant should be moved to the brewery, since there seems no possibility to build a second small installation. Based upon the design of the first CARIX plant in Germany for the treatment of drinking water, the staff of INET presented a design for such a pilot plant. However, since there was no knowledge about the particular requirements of brewing water, this is not an appropriate proposal.

##### 5. Results, Recommendations

Based on the existing results CARIX should be suitable for the production of cooling water for Qilu as well as brewing water for the Beijing Brewery. (Possible applications at other places/in other companies can only be judged from the individual raw water analyses and the desired product water qualities). Thus there is a possibility for practical application. Since Qilu seems to be a very reliable company, the scaling up into technical dimensions becomes likely. Nevertheless, it depends on the results of the pilot scale experiments.

The Beijing Brewery is interested to operate a pilot plant for 5 m<sup>3</sup>/h. Compared to the full scale throughput of about 10 m<sup>3</sup>/h this seem rather big. However, this depends on the necessity of brewing experiments with treated water in the existing devices.

So far the experiments have been carried out using resins which are not very favourable for CAREX. Also the pilot plant will not be equipped with appropriate material. However, with respect to optimum results such resins should be available. Therefore, as a first measure, some free samples were ordered from a manufacturer of suitable resins. In the meantime, these were shipped to INET, so that further laboratory scale tests can be accomplished. A quick supply of INET or Chinese companies with the appropriate resin material from the same manufacturer would be possible.

The visits and discussions have demonstrated that further informations and further assistance are necessary in order to introduce such a relatively complicated ion exchange process successfully in Chinese companies. This assistance has to include improved basic knowledge as well as technical know-how. In addition, it seems doubtful, if all kind of equipment which is required for this process, is easily available in China. The German side is strongly interested that CAREX is successfully applied in China, since this will be a reference also for possible users in other countries.

In the discussions with UNDP staff the proposal was made to organize a meeting in China if the pilot plant experiments turn out to be successful. By this means informations about this process will be available also for other companies or users.