

S1. Past, present and the future of resource applications of deep ocean water (DOW) in Japan

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1. Introduction

Resource applications of the deep ocean water (DOW) began by ocean thermal energy conversion (OTEC) using low temperature energy of DOW in France in the end of 19th century. Resource applications of DOW in Japan from the past to the future will be described here.

2. The past (before about 1985)

In 1957, Prof. Tadayoshi Sasaki firstly introduced OTEC to Japan. Profs. Michitaka Uda and Kenzo Takano described more in details later.

Technology development of OTEC began in about 1970 in Japan and it was incorporated the Ministry of International Trade and Industry in "Sunshine Program" after the first oil crisis of 1973. Prof. Haruo Uehara of Saga University constructed a 50kW experimental OTEC system in 1980. Private enterprises such as Tokyo Electric constructed a 100 kW OTEC in the Republic of Nauru by the support of Japanese Government, and continued operation for one year in 1981.

Following European countries, DOW was firstly paid attention its low temperature in Japan.

3. Present (from about 1985 to 2018)

Science and Technology Agency of Japan started "Aqua-marine Program" including the resource applications of DOW in 1985. Applications of a variety of resources not only the low temperature energy (OTEC is not included) but also inorganic nutrients, minerals, water were intended for the program. Two types platforms of the land based (Muroto, Kochi) and the ocean based (Toyama Bay) were constructed in 1989. The ocean platform performed experiments of the ocean fertilization using nutrients of DOW and finished in the early 90s. On the other hand, various applications were challenged in the land platform, and the products mainly on the eating and drinking were developed of which a part was marketed. Above all, drinking water and the cosmetics caused explosive popularity, and DOW industry came into existence. Then land based facilities of DOW were built in many locations from Hokkaido to Okinawa.

For the exchange of DOW information between the people concerned "Japan Association of Deep Ocean Water Applications (JADOWA)" was founded in 1997, and shifted to "Deep Ocean Water Applications Society (DOWAS)" in 2006.

Annual sales of the DOW industry is estimated approximately 65-100 billion yen in 2016. Resource applications of DOW mentioned above something like "hors d'oeuvres", and a large scale applications of low temperature energy, nutrients and water could support the "main dish".

4. The future (from 2018)

DOW, the single substance, contains many resources such as energy, metals, various nutrients and water. This is a few characteristics to fossil fuel and other underground resources being used so far. DOW could support more than 90% of resources which we need. Major problem of DOW was its low resource concentrations, but rapid accumulation of knowledge and technology development could overcome the problem.

In Kumejima, Okinawa, "Kumejima model" was proposed in 2013 to aim the island society supported by DOW resources, and became independent not the carry-on of resources from the outside such as oil. In the Kumejima model, it is essential to utilize various resources from energy in turn, in other word multi-step applications.

5. Conclusions

In the 20th century, the concentrated resources represented by fossil fuels and metal ooze were used. However, these causes environmental pollution as well as exhausting resources. This can be overcome by the non-concentrated resources such as DOW.

Takahashi, Mac Takahashi. 2000. DOW; Deep ocean water as our next natural resource. Terra Scientific Publ. Co., Tokyo, pp.99. (<http://www.terrapub.co.jp/e-library>)