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Research and application progress of deep ocean water industry in the United States

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Abstract. Firstly, Hawaii as the main source of water exploitation for deep ocean water (DOW) in the United States was described. And the main methods of collecting DOW were also introduced. Then, the development of DOW in the US from the stage of direct utilization to that of multistep utilization was discussed. Finally, the industry, products and market scale of DOW in the US were explained. The DOW industry in the United States had achieved very good economic benefits. In the future, with people's deep understanding of the deep sea and the continuous progress of technology, the development of DOW would be more diversified.

1. Source of DOW

The deep sea was the largest unknown area on the planet, containing various strategic resources and energy needed for the future development of human society, and was known as the strategic territory for sustainable human development in the 21st century. In addition to the commercial development of deep-sea oil and gas fields and mineral resources, deep-sea water as a clean and green new resource was receiving more and more attention and attention [1, 2].

The United States was the first country to develop and utilize deep ocean water. In 1974, the United States established Natural Energy Laboratory of Hawaii Authority (NELHA) in Hawaii, which theoretically began to explore the use of deep seawater. In 1979, NELHA successfully used the temperature difference between deep ocean water and surface water to generate electricity.

The deep ocean water of Hawaii was drawn by the Hawaii Institute of Natural Energy of the United States from more than 3,000 feet (915 meters) deep in the Pacific Ocean off the coast of Kona on the Big Island of Hawaii [3]. The water came from icebergs in the waters off Greenland more than 2,000 years ago. Due to the low temperature in the Polar Regions, the density of the water increased and sank into the depths of the ocean. This high-density, mineral-rich deep ocean water traveled along the North American continental shelf edge in the Atlantic Ocean [4-6]. It flowed through the coasts of Australia and New Zealand. After a 2,000-year journey, it eventually rose in the North Pacific near the Hawaiian Islands. This submarine current was called the global ocean cycle.

2. Acquisition of DOW

When the use and development of deep ocean water just started, NELHA set up a fixed 1.4 m diameter and 2.7 km long huge water pipe at the promontory of Hawaii Island to extract deep ocean water.



However, since 2007, NELHA has chosen to use boats to fetch water. The location of the water collection was 4 nautical miles off the Shore of Oahu Island. The water pipe was put down from the ship, and the deep water was pumped up through the pump at the lower end of the water pipe. The method of collecting water from deep ocean water with this movable ship was completely different from the conventional fixed installation method on land, and you can freely choose the location to collect water. Currently, NELHA has a buoy about 4 nautical miles off the coast of Oahu, which drew deep water at a monthly frequency [7-10]. The pumped deep ocean water first removed the salt immediately, and then it was poured into a special water storage tank, which was installed in a container and can store about 20,000 liters of water, and then the deep water was transported to all parts of the world, and its water quality will not change. At present, NELHA has the world's advanced deep-sea water extraction equipment.

3. Development and utilization of DOW

NELHA extracted 2000-3000 feet of deep ocean water and provided them to third-party companies for industrial development, including deep ocean water raw water, deep ocean water desalinated water and deep ocean water packaged water. American Koyo Company, Destiny deep ocean Water Company and American Kona deep company all used the deep ocean water for reprocessing to make deep ocean water drinks [11, 12]. Sephora, Wishtrade and other cosmetic companies also accepted Hawaiian DOW as raw materials for cosmetic production. Companies such as Rainboii utilized the deep water of Hawaiian to make salt [13].

Destiny Company rely on the most advanced purification system to treat the deep ocean water. Destiny first filtered the water twice using a purification system. Subsequently, the purified seawater was desalinated, and the salt in the seawater was removed to make the water suitable for drinking. Then, the hardness of the quoted water was adjusted according to the customer's preference. It was then sterilized. Finally, the processed water was bottled, labeled and packaged. Koyo is the world's largest bottled deep sea water company, and can currently fill 1 million bottles of water per day.

NELHA used DOW to carry out energy development, fish farming, vegetable, fruit cultivation and fish preservation research, and has obtained considerable economic benefits in developing the commercial use value of deep ocean water. In recent years, the export volume of NELHA's DOW has been increasing [14-16]. DOW has become an important product of the state of Hawaii, and it was also a pillar industry for exports.

4. Market of DOW

In 2008, Kona Deep started producing packaged drinking water. At that time, the company focused on Asia, a region with a more mature deep ocean water market. In mid-2014, Kona Deep Water began to form a North American operations team. The deep ocean water of Kona began to spread in Hawaii and the continental United States. The retailer priced a half-liter package between \$1.29 and \$1.49, and a one-liter package at \$2.29. Kona DOW is currently sold in Hawaii grocery and convenience stores, as well as Amazon.com.

Koyo USA has passed strict benchmarks and inspections by the U.S. Food and Drug Administration (FDA) and the Hawaii State Insurance Regulatory Agency (DOH). It was the first bottled beverage in the United States that has been approved for the manufacture and sale of deep ocean water. Although Koyo USA produced more than 200,000 bottles of deep ocean water every day, it still cannot meet the needs of the Japanese market, where it sold 1.5L MaHaLo bottled water for about US\$4 to US\$6 per bottle.

5. Conclusion Market of DOW

In the field of deep ocean water development and application, the United States has a geographical advantage. It has mature mining technology, scientific research system, standard production specifications and perfect market operation. It has an excellent international position in the health industry.

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