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Transition of Wave Power Generators in Japan

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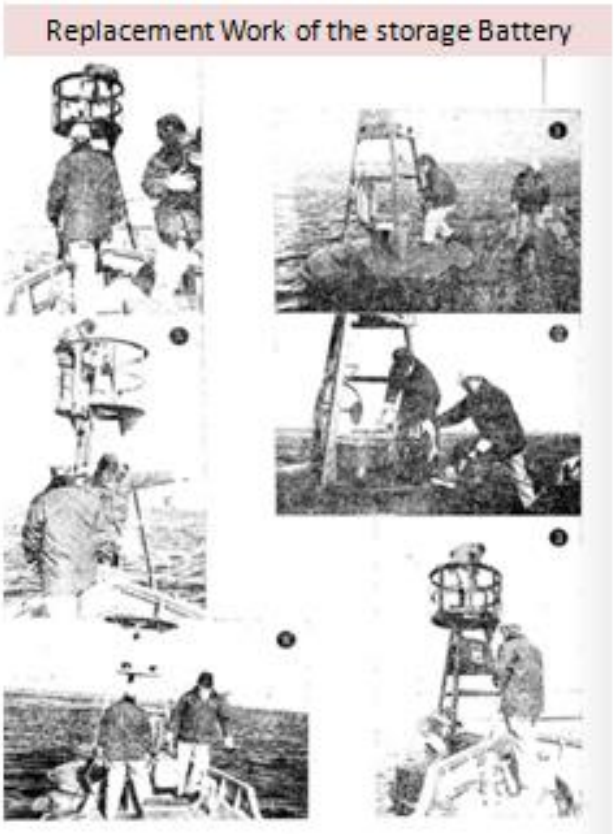
The securing of stable electric power, which is supplied for offshore "aids to navigation" (referred to as AtoN hereafter), has been an important issue since the past through to the present day.
Nowadays, the demand for further electric energy tends to increase year by year, because of the installation of an AIS AtoN, besides, some devices with advanced digital technology for transmitting oceanographic information on a tide, a wave and a wind, etc.

Lighted Buoy equipped with multifunctional devices

An efficient and sustainable power supply system is requested more and more in the field of floating AtoN.
A power supply for the floating AtoN was a battery long time ago for a while.
Hence, its cells had to be replaced periodically, which was a big issue that should be resolved. A new energy source was continued seeking in order to evade this heavy work, and as a result of it some systems have being developed.



From such a circumstances, new power systems have been studied and developed with technology that utilized the energy

of resources which are existing in the vicinity of AtoN, for example, the sun, the wind and the waves. These systems, namely a solar power generator, a wind power generator and a wave power generator, have been demonstrated and tested in the field for a practical use.

In Japan, the output of a solar power generator was uneven with the seasons and regions, due to the difference in sunshine hours, which is caused by the geographical features of Japan extending north and south, additionally the snowfall in the winter season is one of the big causes. However, it could be said that a solar power generator is considerably stable.

In the case of a wind power generator, it's output was uncertain throughout the year, because the wind surrounding Japan varies widely in strength depending on a seasonal wind, especially an unbelievable strong wind in a typhoon season brings damage to facilities and devices of the system and it would be very hard to maintain the generator.

While, the wave energy seemed to be relatively settled regardless of the seasons or day-time and night-time, so that the wave power was expected to become one of the steady energy sources. Therefore, the study on the wave power generator has been conducted together with the study on the solar and the wind systems in Japan.

The result of the latest status on the power supply system for AtoN must be first mentioned. The superiority in efficiency and sustainability of the solar power generator now became highly remarkable, compared with the wind power generator and the wave power generator, because of the technological innovation on a solar cell in late years. It was found from this situation that the future operation and development of the wind power generator and the wave power generator for AtoN could be unforeseeable at the moment.

Actually, the wave power generator for a floating buoy disappeared in Japan about 10 years ago, and remaining all of wave power systems which supplied an electric power to a lighthouse on a rock or on a breakwater have been removed last year also, which means that there are no wave power generators in the field of AtoN in Japan.

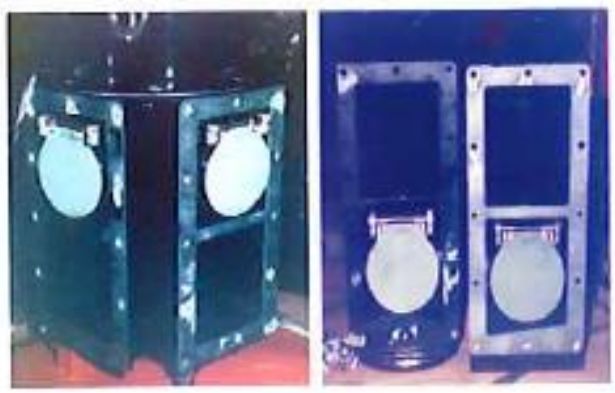
However, there are advantages and specific characteristics in the wave power generators, and they will surely play an important role under condition suitable for the use environment.

We are generous enough to unveil the techniques which have been accumulated to this day, if there is certain coastal water suitable for the wave power generator. The wave power generator is expected to be succeeded somewhere in the world.

This proposal and offer will be surely related to the safety of navigation, therefore the transition of wave power generators in Japan will be traced here.

A wave power generator described here refers to a method of converting the flow of air generated by vertical motion of a wave, which is generally called OWC (Oscillating Water Column), into rotational force to generate electric power. That is to say, energy is generated from the up and down of water caused by waves in the ocean.

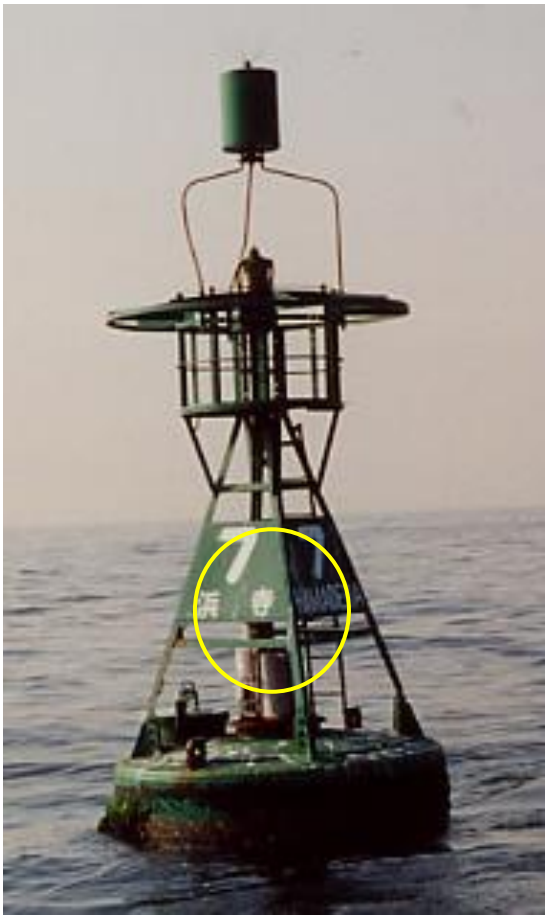
An early wave power generator used four air valves in order to make air flow in a one way direction and an impulse turbine to produce electricity. It rotates more than 2,000 rpm and produces a current of 3 amperes and an average output of 40 watts or more.



Valve box and 4 Valves

Impulse Turbine

In 1964, almost half a century ago, Japan Coast Guard, which was called Japan Maritime Safety Agency at that time, began to work on the wave power system for AtoN, and it was 1965 that the first one was adopted in a lighted buoy.
In 1987, after 23 years passed from the first installation of the wave power generator for AtoN, 436 lighted buoys equal to about 30% of their total number (1,395) were equipped with the wave power generator.



Lighted Buoy equipped with the Wave Power Generator

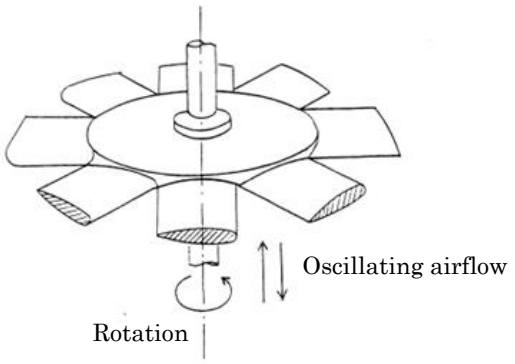
The device was structurally complicated using a valve mechanism, and it was large and heavy.

Wave Power Generator (TG-3)

At first the equipment was made with corrosion-proof casting-aluminum and steel plates. In order to solve these problems, weight reduction for materials of the equipment was achieved by using corrosion-proof aluminum alloy-casting only or by using plastic together.
However, the equipment did not reach the weight being easy to carry for people. The electrical specification of the wave power generator installed in a lighted buoy was 3-phase AC 12 V, 5,000 rpm, maximum output 100 W, and its total weight was about 60 kg.
(ref : 6 batteries of low discharge type 500 Ah were used in a floating buoy generally.)

After that, a single valve system was contrived to be simplified structure using only the exhaust flow instead of the four valves system using intake and exhaust.

On the other hand, as a revolutionary event, the principle of an air turbine was focused on. It always rotates in a certain direction, even if the air flow changes 180 degrees. This one was invented by Professor Wells of the Queen's University Belfast, UK, in the late 1970s, and subsequently in 1980 the Japanese company “Ryokuseisha” flew to the university to acquire its license for use. It has been called “Wells turbine”.



Wells Turbine

In 1983, according to the request of Japan Coast Guard, Japan Aids to Navigation Association (JANA) and “Ryokuseisha” jointly started study and experiment on use of the wave power generator with this

air turbine for a lighted buoy. After the basic data acquisition for 3 years, the practical model was made with the symmetrical airfoil of diameter 80 cm, and then several improvements were carried out to resolve a problem, such a poor starting torque, over several years.

In 1993, the first wave power generator which adopted Wells turbine was installed in the lighted buoy of Japan Coast Guard.
The output of this generator was 3 phase AC 12 V, 6,000 rpm, 100 W, and total weight was about 10 kg.

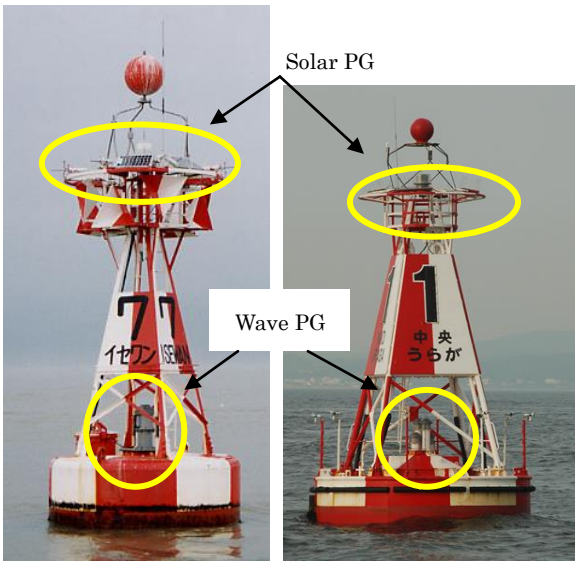
Wave Power Generator equipped with Wells Turbine

Lighted Buoy mounted Wave Power Generator

This wave power generator with the Wells turbine has been simplified structurally and the total weight became one-sixth which was light enough to carry, compared to the former wave power generator with an impulse turbine which provides the same scale output.

Wave Power Generator installed at a Large Buoy

Thereafter, the Wells turbine type wave power generator was sequentially installed at a lighted buoy, and the impulse turbine type was replaced one after another with this Wells turbine type. Furthermore, the power generator for offshore AtoN was shifted to a combined type with the solar and wave.



Installed Solar and Wave Power Generators

As mentioned before, the power generator ability of a solar cell has been improved rapidly with the times. And so, the superiority of the solar power generator became bigger and bigger than other power generators for AtoN. As a result, most of the lighted buoy became possible to support with a solar power generator, and then it was decided that the wave power generator would be disused sequentially in the five year plan from 2006. As of the end of 2006, 299 lighted buoys were equipped with the wave power generator and it was completely replaced with a solar cell in 2010.

Today, the establishment of AIS AtoN for a floating buoy demands future power consumption, even though there is no space to put the additional solar cell panel, especially for the small type of a lighted buoy.
In such a case, there is no choice but to upsize the body of a floating buoy for the solar panel or to install a mixed-type power generator. A wave power generator will be able to become one of the options.

The sea area of an acceptable utilization for a wave power generator is relatively calm and is about a depth of 10-90 meters, a wave cycle of 0-4 seconds and a wave height of 0-0.5 meters from experience.

It is seemed that the possibility of re-recognition of the wave power generator equipped with an enhanced Wells turbine surely came out in future. An examination into the state of increased power demand was seriously started these days.

JANA (Japan Aids to Navigation Association)