Sterilizing system of ballast water using an arc discharge

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Abstract

The inadvertent transfer of harmful aquatic organisms and pathogens in the ballast water of ships has been determined to cause a significant adverse impact to all around the world coastal regions. Recently, in order to solve this issue, a number of technologies have been developed and commercialized. Most of the treatment technologies are barely used independently. In addition, there are several combined methods to treat the ballast water. The overall aim of this study is to suggest on of the best way of sterilization of ballast water using DAB Charging and high voltage pulsed arc discharge.

Keywords: Sterilization System,Ballast Water,DAB.

1. Introduction

Ballast water from ships has been established as a potential vector for transference of various species around the world. The shifts will have negative impacts on the environment through factors such as competition for food, altered substrate or ambient temperature and light availability [1]. The International Maritime Organization(IMO) has estimated that every year the world's fleet moves ten billion tons of ballast water around the world and that on average more than 3000 species of plants and animals are being transported daily around the world. Once these are introduced to local environment,it is virtually impossible to get rid of them. This could have a permanent effect on the environment, which could bring catastrophic effect on local fisheries. It is therefore imperative that introduction of harmful aquatic organisms is prevented rather than cured afterwards. In Process of loading and discharging the ballast water, we apply our arc discharge technologies to the object species that is not effectively disinfected chemically or filtered physically.

2. The sterilization of ballast water

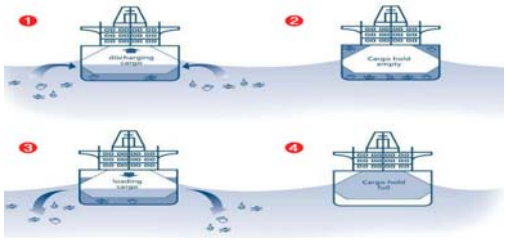

Fig.1 The schematics of ballast water.

As shown in Fig. 1, an introduction of harmful aquatic organisms is prevented rather than cured afterwards. Especially the processes for the balance of the large ship, many kinds of the harmful aquatic organisms are moved to the different ocean by this ballast water. Because of this problem,IMO declared the importance of sterilization. In the processes of loading and unloading the ballast water, it is very important to eliminate many

3. Experimental processes

Arc discharge generates under the certain condition like some distance between electrodes or voltages applied. In this study, the distance between the seawater surface and electrode edge was an important factor. To make the constant discharge during the sterilization experiments, we have to keep that distance within 1cm between the seawater surface and the needle electrode

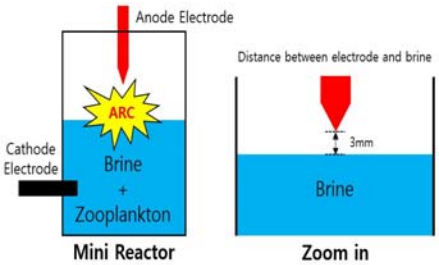

Fig. 2. The electrode edge and the seawater surface.

However the oxidation and combustion of needle electrode is inevitable during arc discharge. Therefore, the distance between the electrode edge and the seawater surface increased as the electrode edge was worn out, the discharge was not lasted more over.In this process, we want to keep the certain distance between the electrode edge and the seawater surface using a motor control.

Fig. 3. The boosting circuit for 20KVDV arc discharge.

For the first active experiments of sterilizing organisms with high voltage arc discharge treatment system, we have made the high voltage circuit that can cause reasonable arc discharge. The first circuit in this picture can make 2kV with 20kHz from 12VDC Input. A MC34063 for boost topology, IR2153 and 2:340 turn ratio transformer were used for fly-back topology. After that, this output connected to the Cockcroft Walton voltage multiplier circuit that can boost from 2kVAC to more than 20kVDC. To make the active arc discharge, the voltage more than 5kV is needed. But in this case,as the applied arcing voltage between the seawater and the electrode edge is needed more than between metal electrodes.

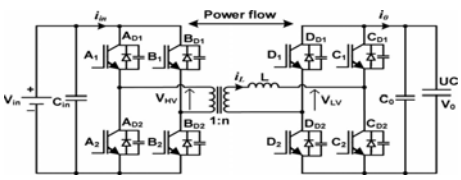

Fig. 4. DAB converter

Shown Fig.4, we use DAB to charge a capacitor. The DAB is a bidirectional converter having characteristic of Phase shift, Buck+Boost biderection, not needing additional snuber and high efficiency and ZVS.

If use this circuit we can Quicker Charging.

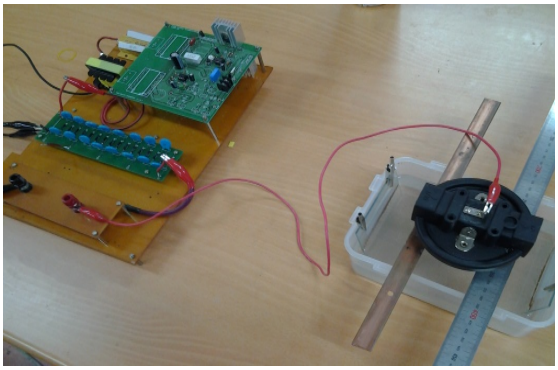

Fig. 5. Arc discharge experiment to Artemia cysts.

To confirm the sterilizing effect of this arc discharge treatment system, we bred artemia cysts that is the kind of brine shrimp causing harmful effects to non-native coastal region. The cysts hatch after 48hours in salt water illuminated light source.

In the arc discharge experiment, the 20kVDC output from the circuit generating high voltage was applied to between the seawater surface and the needle electrode. Saltwater same as salinity of seawater of 500ml is used in this experiment to spread the hatched cysts in this salt water.

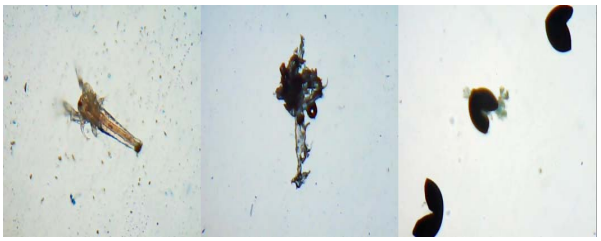

Fig. 6. Artemia cysts and their eggs before and after the experiments.

After arc discharge about 10minutes, most of them were sterilized. They were sterilized and melted by the ozone and OH radical produced from arc discharge. However the fixed needle electrode was shortened by the oxidation and combustion for discharge process. As increasing the distance between needle electrode and saltwater, the discharge processes were stopped. Originally sharpened needle electrode was shortened and flattened after many trials of discharging experiments.

4. Conclusion

Our studies show that arc discharge treatment system is potentially effective to adopt the technology for ballast water management. Species which cannot easily dis-infected chemically or filtered physically are subject to sterilized by pulsed power and electrical energy during arc discharge experiment. As the arc phenomenon by the pulsed power, it is more cost effective than the other treatment methods. This study also showed that oxidized and flattened electrodes by the arc discharge need to be controlled by motor control to increase the efficiency of stabilizing processes, the distance between electrode and seawater has to keep the certain distance. In this part, the control system can move automatically to sustain a constant rate by the speed of shortening needle. Further research has to be needed from these basic ideas and active experimental results.

Reference

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