Decontamination System Development of Radioative Activated Carbon using Micro-bubbles

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1. Introduction

Technique utilizing micro-bubbles has been rapidly adopted in the field of environmentally friendly industry that minimizes a use of chemicals. This study was aimed to develop a decontamination system by applying such technical characteristics that minimizes a generation of secondary wastes while decontaminating radiation wastes. The radioactive activated carbon is removed from the end-of-life air cleaning filter in replacement or decommission of nuclear power plant or nuclear facility. By removing radioactive activated carbon, the filter would be classified as a low radioactive contaminant. And thus the amount of radioactive wastes and the treatment cost would be decreased.

We are in development of the activated carbon cleaning technique by utilizing micro-bubbles, which improve efficiency and minimize damage of activated carbon. The purpose of using micro-bubbles is to decontamination carbon micropore, which is difficult to access, by principle of cavitation phenomenon generated in collapse of micro-bubbles.

In order to improve an efficiency of the micro-bubble device, we have built the experimental system adding the auxiliary equipment, which could accelerate the reaction. The micro-bubble decontamination system consists of a micro-bubble generator, a cleaning tank with acid liquid tube, stirring device and motor controller, a filtering device that removes polluted materials from cleaning solution and a pH regulator of cleaning solution .

2. Development of micro-bubble decontamination system

2.1 Characteristics of micro-bubbles

The micro-bubble generating device in this study, a high speed circulating type, produces micro-bubbles by utilizing the vertical multistage pump offering the performances of flow rate 1.5 m^3/hr, total water head 90 m, 3450 rpm, and 2.2 kw. It produces micro-bubbles with a fluid speed of 20 L/min by injecting gases of lower than 2 L/min and subsequently being mixed with solution. Trac PC 2400D Laser Particle Counter used to confirm the micro bubble size generated. Flotation process evaluation method was to determine the size distribution of bubbles. As shown in Fig. 1, 93% of the bubble generation generated in the range of 1-10 μm.

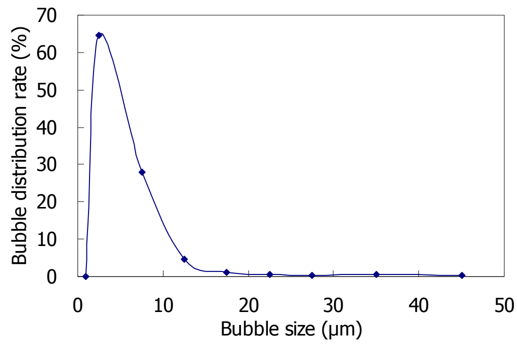

Fig. 1. Bubble size distribution.

2.2 Characteristics of micro-bubbles according to a change of pHs

Maintaining times of the micro-bubbles that were being generated by injecting air with speed of 1 L/min into the solution in the micro-bubble generation device were measured according to temperature changes. And collapse times of the micro-bubbles were measured by receiving micro-bubble decontaminating solution into 500 ml mess cylinder. Maintaining times of bubbles according to change of temperatures are decreased as the temperature is increased at room temperatures as shown in Fig. 2. For the case that a maintaining time of bubbles becomes lengthened is suitable to decontaminate an object pursuant to situation that bubbles take a longer time to arrive in an object. For the case that a maintaining time of bubbles is short, it can expect a better efficiency of decontamination causing by that bubbles produce much energies during a short period.

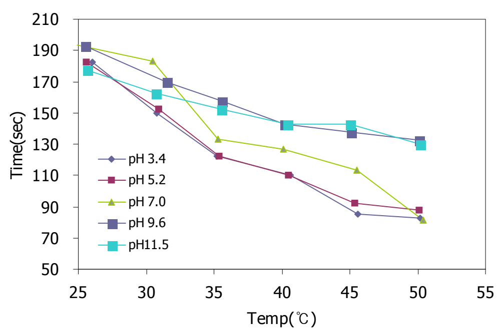

Fig. 2. Maintaining times of the bubbles according to change of pHs of solution and change of temperatures in solution.

It shows a tendency that the maintaining time becomes lengthened as pH gets higher by comparing the maintaining times of bubbles while change of pHs. There are some deviations caused by differences of measured temperatures and maintaining times of bubbles but there are not much variability in the maintaining times of bubbles according to a change of pHs, as shown in Fig. 2.

By arranging the data in Fig. 2 with changes of decontamination solution temperatures and pHs, it has confirmed that a maintaining time of bubbles is shorter at low pHs as a temperature of the decontamination solution is higher and a maintaining time of bubbles is shorter as pH is lower.

2.3 Development of micro-bubble decontamination system

The decontamination system was configured with micro-bubble generator, cleaning tank and cleaning solution cooler. The micro-bubble generating part and the cleaning solution circulating part were installed on the surrounding of the cleaning tank with capacity 300 L and material 316 SUS. The chemical injecting tack was attached on the upper part of the micro-bubble generating part to adjust a pH of cleaning solution. The cleaning solution circulating part was built with a circulating pump with capacity 250 L/min, mixed resin, and micro filters to purify foreign materials while circulating a cleaning solution and to be operated simultaneously with the micro-bubble generating part.

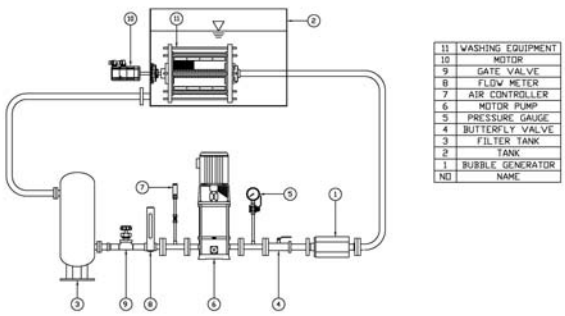

Fig. 3. Schematic diagram of the micro-bubble decontamination system.

Fig. 4. Manufactured micro-bubble decontamination system.

Physical force was strengthened on the surface of activated carbon to improve the decontamination performance activated carbon. Existing systems were installed to rotate the vessel in cleaning tank in a manner which simply circulate the bubbles in cleaning tank. We also added the device that bubble can react with the activated carbon in various directions by rotating at a constant speed when activated carbon insert into the vessel. This program that controls the motor controller can decontaminate under the optimum condition by adjusting decontamination time, rotational speed and direction.

Fig. 5. Build a stirring device. (stirring vessel, motor controller, circulation pump and control program. Clockwise , from top left)

3. Conclusions

In this study, we introduced the micro-bubble decontamination system developed to decontaminate activated carbon.

For further researches, we will determine carbon weight change and the decontamination rate under the experimental conditions such as temperature and pH.

Also, we will continue to research new technologies, such as water electrolysis or using ozone, to connect to the micro-bubble system And so develop the improved system .

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