The Improvement Method of Oxidation Furnace of Chemical Cleaning Liquid Waste Treatment System

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1. Introduction

The corrosion products flowing into the steam generator in the nuclear power plant might be deposited on secondary side of the steam generator and fixed in the form of sludge. These products could causes some kind of defect to effect the tube integrity and reduces the heat transfer efficiency of the steam generator tube. In order to remove the sludge adhered to the steam generator tube, the chemical cleaning with ethylenediaminetetraacetic acid (EDTA) is carried out. After the chemical cleaning, the chemical cleaning liquid waste containing EDTA is treated by the pyrolysis. The pyrolysis process generates air pollution matter such as NOx and SOx when the pyrolysis is firstiy performed at 850℃ in the electric furnace. In order to remove air pollution matter, it have burned around 500 to 900℃ once again in the oxidation furnace in the downstream of the electric furnace. In the oxidation furnace, zigzag type partition walls are settled in order to completely remove harmful gases such as NOx. However, due to the high temperature inside the oxidation furnace, the settled partition walls might be damaged such as decrease in thickness.

In this study, we have reviewed a method to prevent damage of the partition wall inside the oxidation furnace due to the high temperature in the chemical cleaning liquid waste pyrolysis treatment process.

2. Methodology

2.1 Pyrolysis process procedure

The chemical cleaning liquid waste treatment process pyrolyzes the liquid waste to about 850℃ while supplying a certain amount of liquid waste from the temporary tank storing the liquid waste to the electric furnace. At this time, due to the high temperature of the liquid waste, the sludge is accumulated on the bottom of the electric furnace, and the generated harmful gases are introduced into the oxidation furnace in the downstream of the electric furnace. The injected harmful gases are burned once again in the oxidation furnace, then removed through the catalytic device, condensed in a heat exchanger, and discharged into the environment with water and gas. Table 1 shows the permissible emission level.

Table 1. Permissible emission level of air Pollution Matter

Air Pollution Matter	Emission Facility	Permissible emission level (ppm)
NOx	Facility less than 2 tons per hour	90(12) or less
SOx	Facility less than 200 kilogram per hour	40(12) or less
CO	Facility less than 2 tons per hour	200(12) or less

※ ( ) is standard oxygen concentration (O_2 percentage)

2.2 Main function of pyrolysis plant

1) Pyrolysis furnace: An electric furnace with a heater at the top and bottom and pyrolyzing the liquid waste containing EDTA and ammonia at operating temperatures of 800 to 1000℃.

- Top heater (Bobbin): 380V, 4.5kW/unit(4unit).
- Bottom heater: 380V, 36kW/unit(4unit).
- Heating rate: 20℃/min.

2) Oxidation furnace: Air pollution matter such as NOx after pyrolysis in an electric furnace is oxidized at 500 to 900℃ using LPG burner.

3) Catalytic device: Conversion of air pollution matter such as CO and NOx from oxidation furnace to gas below permissible emission level through catalyst.

- SCR (Selective Catalytic Reduction) Catalyst: Reduce NOx to N_2 by injecting ammonia as a selective reduction catalyst.
- VOC (Volatile Organic Compounds) Catalyst: Remove CO and THC (Total Hydrocarbon) as

catalyst for removal of volatile organic compounds.

- NH_3 Catalyst: Ammonia removal catalyst.

4) Heat exchanger: An oxidation furnace, a catalytic device, and a device installed downstream of the HEPA filter to lower the temperature of the exhaust gas as required.

5) HEPA filter: Removal of particulate matter contained in the exhaust gas.

- Collection efficiency: 99.986%

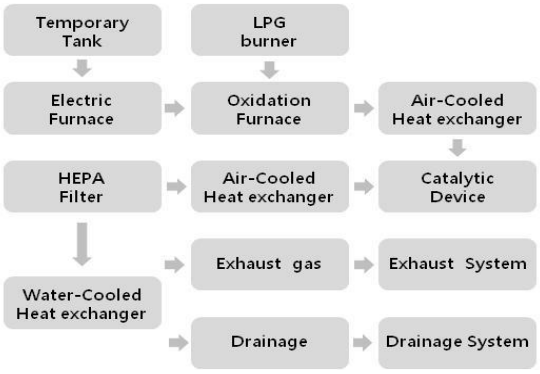

Fig. 1. Pyrolysis process flow diagram.

2.3 Secondary combustion in oxidation furnace

The secondary combustion of the oxidation furnace is intended to reduce the harmful gas by completely burning the harmful gas generated due to the incomplete combustion at the time of pyrolysis in the electric furnace. The harmful gases such as NOx are oxidized in the combustion process of high temperature when pyrolysis of waste liquid is regulated as air pollution matter. Therefore, in order to discharge the harmful gas generated during pyrolysis to the environment, it should be reduced according to the effluent quality standard, and the following points should be considered when burning.

- Maximum temperature reduction
- Reduced residence time of gas
- Reduced oxygen concentration

In an oxidation furnace using an LPG gas burner, it is very difficult to maintain a constant temperature and residence time while the secondary combustion is maintained at a constant temperature and the residence time of the gas is an important factor for reducing harmful gas. If the high temperature which is much higher than the proper temperature for removing the harmful gas is continuously maintained, there may be a problem that the partition walls are damaged inside the oxidation furnace. In order to solve such problems, it is desired to change the structure of the partition walls inside the oxidation furnace which is fixedly installed in advance so that the residence time of the gas can be adjusted, thereby securing the integrity of the oxidation furnace by secondary combustion.

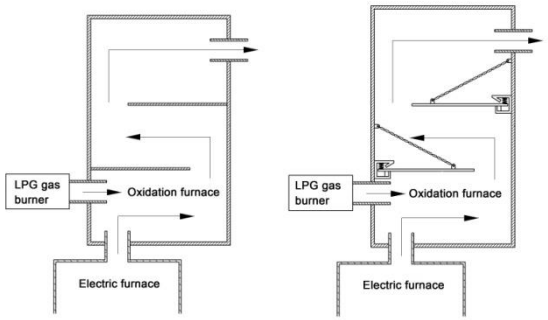

Fig. 2. Oxidation furnace design concept.

3. Conclusion

A function of the secondary combustion at the liquid waste treatment system is a method for reducing harmful gases such as NOx generated by pyrolysis during chemical cleaning liquid waste treatment containing EDTA. To maintain the constant temperature of the secondary combustion and to reduce the harmful gases such as NOx, the design of the partition walls were changed to secure the integrity of the oxidation furnace. Further studies such as gas flow according to the moving angle of the partition wall in the future should more effectively reduce the harmful gas and ensure the integrity of the oxidation furnace.

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