Abstract

[Research Title]

Demonstration of Heat Discharging Process of Thermal Energy Storage and Transport System for Recovering Unused Heat from Waste Incineration Plant in Vicinal Industries

Project Period (FY) :	2021-2023
Principal Investigator :	Fujii Shoma
(PI ORCID) :	ORCID0000-0001-6440-3819
Principal Institution :	Institute for Future Initiatives, The University of Tokyo 7-3-1 Hongo, Bunkyo-ku, Tokyo, JAPAN Tel: +81-3-5841-7937 E-mail: shoma.fujii@ifi.u-tokyo.ac.jp
Cooperated by :	
Keywords :	Renewable energy, Regional energy system, Unused heat, Waste incineration, Regional Circular and ecological economy

[Abstract]

Unutilized local resources from biomass residues and waste incineration should be efficiently utilized within the region. Currently, power generation using waste is being actively conducted, but due to the variety of heating value of fuels, the efficiency of power generation is low and a large amount of unused heat is generated. On the other hand, other industries in the vicinal area often use heat from burning fossil resources. In order to efficiently circulate local resources, it is necessary to develop and apply technologies for recovering and distributing unused heat. The gap in time and space between the generation of unused heat and the demand for fossil fuels needs to be resolved, and it is necessary to establish a thermal energy storage and transport system. The objective of this project is to propose a system for transporting unused heat to neighboring industries using zeolite, a heat charging material, to make waste treatment facilities a stable energy generation base for the region, and to conduct small-scale demonstration tests and system evaluation of an original heat discharging system that can continuously generate pressurized steam for industrial use. A small-scale demonstration test rig of a "zeolite boiler" employing a moving bed indirect heat exchange system capable of continuously generating pressurized steam using zeolite was constructed and installed in a cleaning factory on Tanegashima where a fossil fuel boiler was installed. The demonstration test was conducted on a scale of 15 kg/h zeolite flow rate, and it was demonstrated that the use of the heat charging material has the effect of increasing the heat of steam. In addition, a numerical analysis model coupled with heat/mass conservation equations was constructed to simulate the demonstration test, and its validity was confirmed. Using the numerical model that was validated through demonstration tests, a conceptual design of a commercial-scale equipment was conducted, and system evaluations such as life cycle assessment, cost analysis, and input-output analysis were conducted on a commercial scale (zeolite flow rate: 0.1-2.0 t/h), and the dominant factors of the thermal energy storage and transport system that circulates local resources were identified, and to confirm the possibility of providing feedback for further technological development.

[References]

Fujii, S., Nakagaki, T., Kanematsu, Y., Kikuchi, Y., (2022) 'Prospective life cycle assessment for designing mobile thermal energy storage system utilizing zeolite', Journal of Cleaner Production, 365, 132592, https://doi.org/10.1016/j.jclepro.2022.132592

Fujii, S., Kanematsu, Y., Kikuchi, Y., (2022) 'Integration of experimental study and computer-aided design: A case study in thermal energy storage', Computer Aided Chemical Engineering, 49, 2095-2100, https://doi.org/10.1016/B978-0-323-85159-6.50349-3

This research was funded by the Environment Research and Technology Development Fund (ERTDF).