FINAL REPORT

FACULTY RESEARCH FUND

A Study of Retrofit Engineering Design for Existing Small and Medium Size Gas Turbine Power Cycle into a Combined Cycle Power Plant

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1. Original Plan

The objective of this research was to develop an engineering design tool to retrofit the existing single small/medium sized gas turbine power plant with steam power cycle into a combined cycle power plant. The PI developed a computer program to yield engineering cycles of combined cycle power plants by integrating thermodynamics, fluid mechanics and heat/mass transfer, etc. The scope of this research was to develop; 1) system level design on power ratio, overall mass flow rate and power output, 2) first level design on sub-system optimization.

2. Scholarly Activities

2.1 Software Development

All of the research deliverables were accomplished. A computer program was developed to solve all of major governing equations derived for 1st law, 2nd law, and economic analysis for a combined cycle power plant using MATLAB R2010a. The program was facilitated with fundamental databases to accurately compute thermo-physical properties of substances required to simulate. Input deck of the software accepts main data from operation or design conditions. And output deck is automatically built up for gas and water side variables as well as overall performance parameters. The cost optimization in design and operation was added to the program. To optimize low cost design, the PI surveyed feasibility of the equipment currently available in the United States markets and reviewed possible options in foreign equipment markets. An article has been prepared to submit for a journal publication based on the modeling.

2.2 Scholarly Disseminations and Activities

In regard to this award, the PI conducted scholarly disseminations as follows:

[1] Jeong, K., “Thermodynamic and economic analysis for retrofitting existing small size simple gas turbine power cycle into combined cycle power plant”, In Preparation, 2015.

[2] Jeong, K., “Thermal Impact of Cyclic Operations on Small/Medium Size Combined Cycle Power Plants at Low Load Factor”, IMECE2014-40067, Montreal, Canada, 11/2014.

[3] Jeong, K., “Sec. 3.3 Cooling of natural gas combustion and combined cycle power plants” in “Thermal Power Plant Cooling: Context and Engineering”, ASME 860250, ISBN: 9780791860250, 2014.

[4] Jeong, K., “Sec. 3.4 Extraction of water from power plant exhaust gas” in “Thermal Power Plant Cooling: Context and Engineering”, ASME 860250, ISBN: 9780791860250, 2014.

[5] Jeong, K., “Method and System of Increasing Water and Acid Condensation from Flue Gas”, US Provisional Patent Pending, No. 62/134,427, 2015.

[6] Technical Trip with 25 Students to Entergy 1.7GW Coal-Fired Power Plant, Newark, AR, Apr 1, 2015.

[7] Elected as Chair for Technical Committee on Renewable Energy and Energy Conversion (TC-REEC), ASME, 2014-2015.

[8] Served as Track Organizer for 2-16 Low/Zero Emission Power Plants and Carbon Sequestration, 2015 ASME Power & Energy Conference: Energy Solutions for a Sustainable Future, San Diego, CA, 2015.

[9] Served as Chair for Industrial Relations Committee, College of Engineering, ASU, 2014-Present.

[10] Served as Track Co-Organizer for Combined Energy Cycles, CHP & CCHP, ASME Energy Sustainability Conference, Boston, MA, 2014.

[11] Served as Session Co-Organizer for Combined Energy Cycles, CHP & CCHP, IMECE, Montreal, Canada, 2014.

3. Outcomes

The project provided cross-disciplinary research experiences, enhancing their competitiveness in the field of engineering. To aggressively extend the research results to existing power plant technology, the PI applied for a funding opportunity in power industry and received a total of $1.2M for software development projects, as follows:

[1] ASU - DHI, Predictive Modeling for Transient Ash Deposition in Post-Boiler Heat Exchangers, 2015-2019, PI, To Be Contracted, On-Going.

[2] ASU - DHI, Predictive Modeling for Transient Ash Fouling on Superheater and Reheater in Boiler, 2015-2018, PI, To Be Contracted, On-Going.

4. Future Plans

The research results can be applied to commercialization and technology transfer for power markets. The research would be helpful in offering preliminary design and cost data to power and engineering companies interesting in power-upgrading through reverse engineering of existing single small and medium size gas turbine plants. To continue further developing the software and enhancing the modeling accuracy, the PI will apply for federal funds in collaboration with regional or local power industry.

5. Acknowledgement

The PI appreciates for the Faculty Research Awards Committee and the Office of Research and Technology Transfer for their supports.