UK Fluids Network Short Researcher Visit Report

Dr Liang Li

School of Engineering and Technology

University of Hertfordshire

A short research visit from University of Hertfordshire to University of South Wales took place on the 17th – 22nd September 2018. In this visit, Dr Liang Li was hosted by Prof Yunting Ge of Sustainable Environment Research Centre of University of South Wales. Dr Liang Li also met with the academic, research staff and PhD students of University of South Wales and visited the experimental facilities and laboratories. The purpose of this visit was to apply advanced measured and simulative methods to investigate the heat transfer characteristic of a shell-and-tube heat exchanger in biomass-CO_2 power generation system.

It is highly desirable to promote the use of localised renewable energies, such as industrial waste heat and biomass fuels with optimised CHP system engineering designs. Integrating biomass boilers with Organic Rankine Cycles (ORCs) is a well-developed technology and an applicable option. However, there is an obligation to select environmentally friendly working fluids and to improve the thermal efficiency of the Biomass ORC system. It is expected that a biomass-CO_2 power generation system based on supercritical or transcritical Brayton cycles can achieve these targets. However, the gas heater (shell-and-tube heat exchanger) with highest temperature and pressure of the system will significantly affect the system thermal and exergy efficiencies.

In this research visit, various possible solutions to the measured methods of the shell and tube heat exchanger in biomass-CO_2 power generation system were discussed. Ideas were exchanged on further development of the existing models for CO_2 power generation system (Fig.1), biomass boiler (Fig. 2) and data logging system. During the visit, the above system with shell and tube heat exchanger has been investigated by the activities of experiment and modelling in order to implement scale-up for practical applications. Both energy and exergy analyses by the modelling have be carried out to evaluate and optimise the heat exchanger performance and system design. The gas heater heating capacity decreases slightly with higher gas heater CO_2 outlet pressure due to the resultant CO_2 mass flow rate reduction. However, the higher biomass fumes temperature can greatly increase the gas heater heating capacity due to the heat transfer enhancement of the heat exchanger at higher biomass fumes temperature. Correspondingly, the biomass fumes temperature at the gas heater outlet increases with higher gas heater CO_2 outlet pressure due to the consequent heating capacity decrease. The detailed results of the modelling will be described in a paper at near future, which is founded by the short research visit. The visit was very useful and provided an excellent opportunity to enhance the research network and promote research knowledge exchange between different universities in UK.

Fig.1 CO_2 Power system

Fig.2 Biomass Unit