Preliminary Design of CRP Carbon Capture Test Platform

Research on Compatibility Design of Carbon Capture Units

(Submitted to China Resources Power Haifeng Plant, under review)

REN Lihua[1], LIANG Xi[1], LUO Haizhong[2], WANG Li[1], LI Jia[1]

[1]UK-China (Guangdong) CCUS Centre, Guangdong, China

[2]Guangdong Electric Power Design Institute, China Energy Engineering Group

Abstract

This report is to discuss the compatibility design of the carbon capture units of the China Resources Power (CRP) Haifeng plant Carbon Capture Test Platform (CCTP) project.

As the first phase of the master project Guangdong Offshore CCUS (GOCCUS) Project, a large-scale integrated CCUS demonstration project with million tonne CO_2 capture and storage capacity, CRP Haifeng plant CCTP is designed to test different carbon capture technologies in parallel using real flue gas from the power plant, and aim to select the better suited technology for the GOCCUS project. CCTP will be the third international carbon capture technology test centre after the National Carbon Capture Centre in U.S. and CO_2 Technology Centre Mongstad in Norway; also, the first of its kind built in an ultra-supercritical coal-fired power plant.

The Pre-treatment Unit of CCTP is designed to further purify (reduce the concentration of the pollutants, such as NO_X, SO_2, dust, etc.) and cool down the flue gas, which helps optimising the capture efficiency in the capture units.

In Carbon Capture Units, the Shell CANSOLV amine-based carbon capture technology and MTR membrane separation technology are selected and applied to test their CO_2 capture performance.

The Amine Absorption Unit is designed based on the process package provided by Shell CANSOLV, but with flexibility to accommodate process variations due to the test of solvents with different properties. The key compatibility designs are:

1. The absorber and stripper are designed to cover a certain range of vapour and liquid flow rate turn-up and turndown.

2. The extra height is reserved respectively within the absorber and stripper for expending the height of the packing bed in the future. The solvent inlet nozzle is

installed above each packing bed, which provides different packing height options for testing the performance of the solvents with different properties and at different carbon dioxide concentration.

3. The stripper is designed with higher design pressure and temperature to allow some solvents to be regenerated at higher stripping pressure.

4. The absorber and stripper are equipped with sufficient gas and liquid sampling ports, gas analysis, temperature and pressure measurement instruments, which are distributed along the height of the packing bed, to obtain pressure and temperature profiles of absorption and desorption process, and other more test data.

5. The system can simulate the feed-in flue gas at different content concentration and temperature;

6. Field space is reserved for adding Mechanical Vapour Recompression (MVR) heat recovery system and amine thermal recovery unit in the future.

Membrane Separation Unit is designed to be compatible with different membrane products, and will be used to test other technologies of its kind. The core parts of the membrane separation unit are CO_2-selective membrane modules, which are designed to be easily replaceable with next-generation products of MTR or other similar membrane modules.

Bench-scale units and mobile units will be introduced to CCTP for testing other emerging carbon capture technologies. In the general layout, field spaces are reserved for the future small test units; and the specific interfaces at main flue gas duct and the pipelines of utilities supply facilities have been designed for the future capture units.