HSLU Hochschule Luzern

Technik & Architektur
Master of Science in Engineering
Energy & Environment

Master Thesis Master of Science in Engineering

CO_2 Separation from atmospheric Air

Development of a Lab Setup for CO_2 Separation from Air by means of Stripping and Vapour Compression

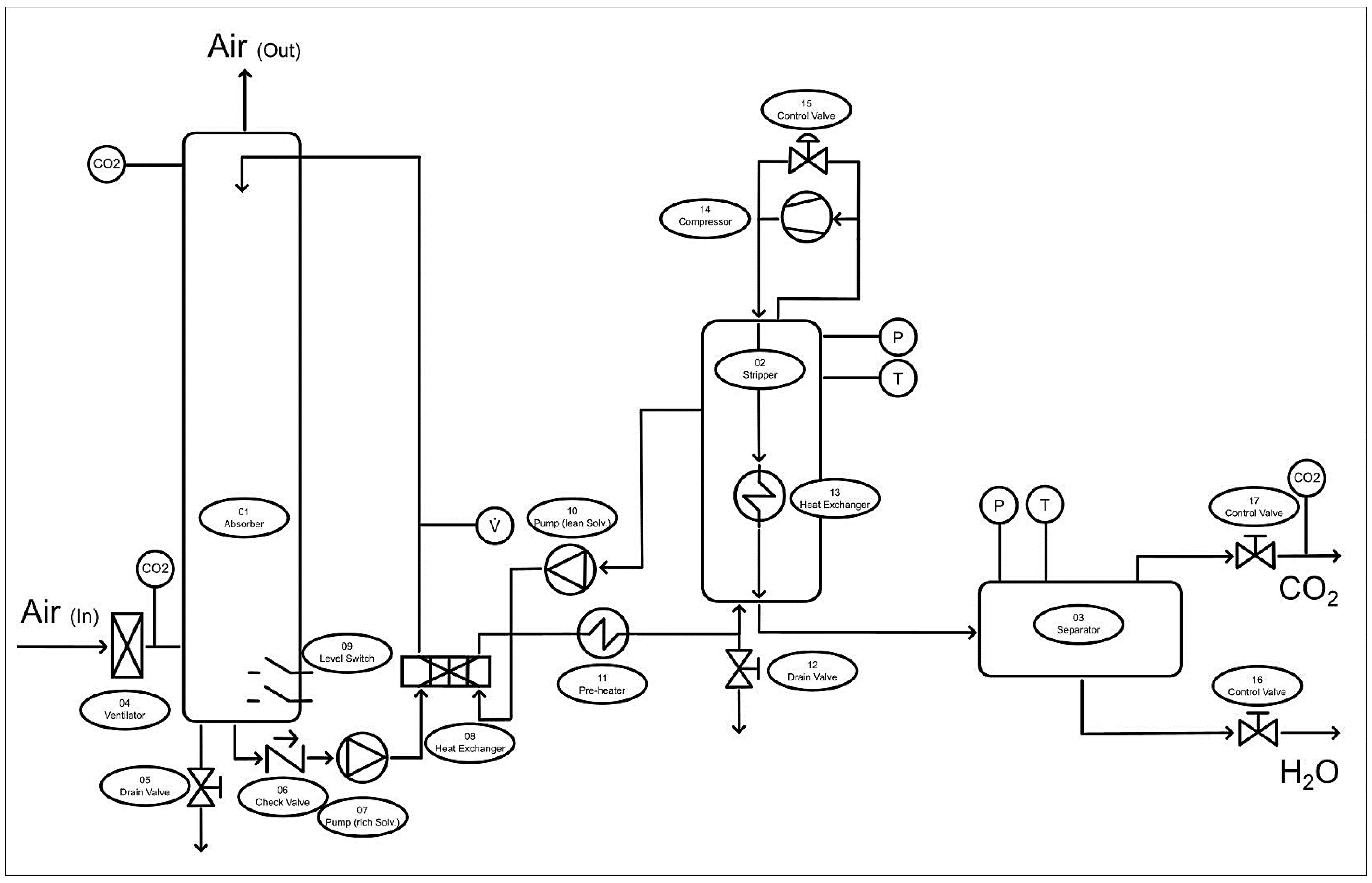

Fig 1: Process diagram of the plant

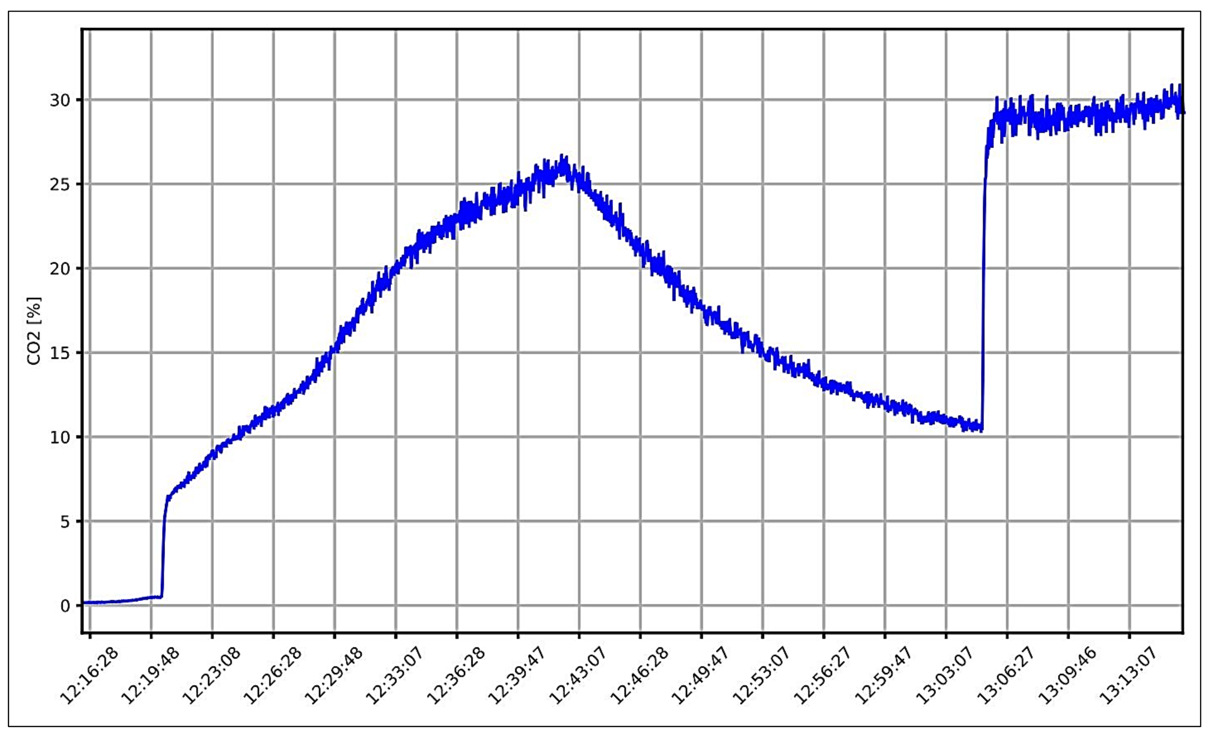

Fig 2: CO_2 reading at the outlet of the setup during testing

Fig 3: The developed setup in the lab

Problem Statement

This work is done at the Competence Center for Thermal Energy Systems and Process Engineering of the HSLU in collaboration with KSE Stalder Engineering. The objective is to prove the concept of carbon dioxide separation from atmospheric air by means of stripping and vapour compression. In order to prove the process, a laboratory setup must be developed. This includes detailing the concept and system design. The components must be evaluated, and the setup installed. Tests are then performed to validate functionality.

Solution Concept

The process is based on the concept of CO_2 capture technology using amine absorption and vapour compression. Figure 1 shows its process diagram. The main components are the absorber (01), the stripper (or desorber, 02) and the separator (03). The absorbent is a solution of water and diethanolamine (DEA). It is sprayed from above the absorber through a jet nozzle to increase the contact surface. That way, the CO_2 is absorbed by the DEA and the rich solution is collected at the bottom of the absorber. Then, it is pumped into the stripper. On the way there, it is preheated in two stages. Firstly, through a heat exchanger (08), which draws the heat from the lean solution. Then by an electric flow-type heater (11). Due to the extended temperature in the stripper, the carbon dioxide desorbs and becomes gaseous again. Furthermore, water evaporates. Vapour compression is used to heat the stripper. For this purpose, a compressor (14), sucks the vapour from the stripper and compresses it. Hence, the temperature increases, and the water liquidates. The hot stream flows into the separator (03), in which the water can be collected, and the gas is separated. The gas and the liquid are flowing out via the control valves (16 and 17). The lean solution of the stripper is then pumped (10) back to the absorber and is reused to capture carbon dioxide.

Results

A system was successfully developed, and it worked as expected, see figure 3. It is intended to enable tests that serve as a proof of concept for this process. This proof could only be partially provided. The absorption of carbon dioxide with DEA from atmospheric air, with the associated low concentration, could not be fully achieved. However, the absorption of carbon dioxide at higher concentrations worked and the subsequent desorption was successful. Figure 2 shows the CO_2 readings at the outlet during a test, where the absorber contained up to 18% carbon dioxide. For further activities in this project, the most important task is to improve the absorption.

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