

# Process Simulation of CO<sub>2</sub> Chemical Absorption Based on Self-Heat Recuperation Technology for Pre-Combustion Process

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The pre-combustion capture is widely applied in hydrogen production which consists of gasification/reform process with H<sub>2</sub>/CO<sub>2</sub> separation process, and the H<sub>2</sub>/CO<sub>2</sub> separation process is applied to integrated coal gasification combined cycle power plant (IGCC). IGCC can achieve higher power generation efficiency than conventional power plant. However, CO<sub>2</sub> capture process reduces this efficiency. This is because CO<sub>2</sub> separation from gas mixtures requires huge amount of energy. In this study, we analyzed the pre-combustion process combined CO<sub>2</sub> separation process based on self-heat recuperation technology (SHR). The electric generation efficiency can be improved by SHR compared with conventional IGCC.

## 1. Introduction

Nowadays, the effects of global warming are becoming more obvious due to increased energy consumption in over the world. Thus, there has been a great discussion about the mitigated global warming. Anthropogenic emissions of greenhouse gases (GHGs) are factor in a causation of global warming. One of the anthropogenic emissions is carbon dioxide (CO<sub>2</sub>). CO<sub>2</sub> results from the combustion of fossil fuels. Coal has been performed important role as the primary energy source since industrial era in the fifteenth century. Coal could be supplied as a stable energy in the fossil-fuels, because the reserves-to-production ratio (P/R) is longer than others. Total recoverable reserves of coal around the world and current reserves-to-production ratio are estimated at 909 billion tons and 129 years, respectively (U.S.IEA website, 2010). The term is longer than other fossil fuels. However, global demand of coal has expanded more and more. To use the coal effectively, many researchers have paid more attention about IGCC (Madzivhandila et al. 2009).

IGCC has achieved fuel efficiency rate to 43.5 percent (LHV) (Decamps et al. 2007). IGCC consists of gasification/reform process and power generation process. Recently, IGCC is integrated also H<sub>2</sub> and CO<sub>2</sub> separation processes to reduce CO<sub>2</sub> emission. However, the fuel efficiency rate is approximately reduced 10% by counting H<sub>2</sub>/CO<sub>2</sub> separation processes (Decamps et al. 2007, Davison et al. 2007, Riemer et al. 1995).

Recently, an innovative exergy recuperation technology has been developed for industrial processes: gasification process based on exergy recuperative gasification (Tsutsumi, 2006), heating and cooling thermal process based on self-heat recuperation (Kansha et al. 2009), distillation process based on self-heat recuperation (Kansha et al. 2010(a), 2010(b)). For example, the modularity based on self-heat recuperation for the distillation process was found to reduce the required energy more than 75% in comparison with conventional distillation processes (Kansha et al. 2010(b)). By using the self-heat recuperation technology, the energy requirement of thermal process was drastically reduced (1/3-1/22). Recently, Matsuda et al. (2010) reported that the hydro-desulfurization process with self-heat recuperation technology can reduce the energy input and the exergy input to 46% and 20%.

In this paper, we applied the exergy recuperation technology to CO<sub>2</sub> chemical absorption process for the pre-combustion CO<sub>2</sub> capture. The process modularity of CO<sub>2</sub> gas chemical absorption and stripping processes based on exergy recuperation technology can achieve a considerable reduction in energy consumption. The process simulation of exergy recuperative CO<sub>2</sub> gas separation in pre-combustion capture was conducted by using a process simulator PRO/II (Invensys plc.) to calculate the energy input in comparison with the conventional CO<sub>2</sub> gas separation process based on exergy recuperation.

## 2. Description of the IGCC with pre-combustion CO<sub>2</sub> separation

Figure 1 shows the conventional IGCC with pre-combustion CO<sub>2</sub> separation. Coal is gasified using the air or O<sub>2</sub> rich gas. The O<sub>2</sub> rich gas is produced from cryogenic air separation process (ASU).

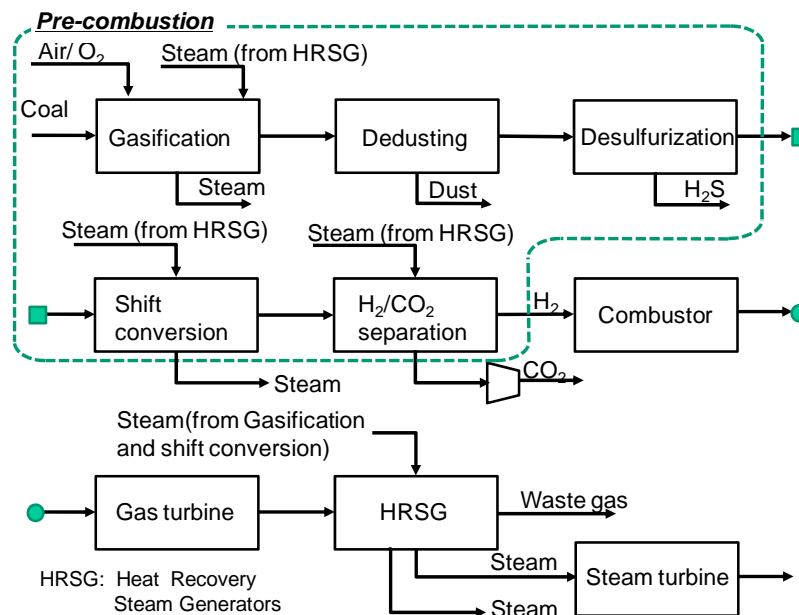


Figure 1: IGCC plant with pre-combustion CO<sub>2</sub> separation







