**Process design and economic analysis of a biomass-based integrated gasification combined cycle (BIGCC) system**

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**Highlights**

* A heat-integrated IGCC polygeneration plant using SCL is presented.
* The investing in BIGCC is superior to the conventional IGCC power plant.

**1. Introduction**

Recently, the IGCC power plants were combined with the clean coal technologies which were used to reduce CO2 emissions and remove other pollutant emissions such as sulfur dioxide (SO2) and nitrogen oxides (NOx). The oxy-fuel combustion with the aid of the air separation unit (ASU) could effectively reduce NOx and increase the concentration of CO2 in the flue gas, but the high cost and the high energy penalty of ASU would obviously enhance the levelized cost of electricity (LCOE) [1]. To improve the overall efficiency of the IGCC system, an elevated-pressure ASU had significant potential option [2]. Regarding the reduction of energy penalty of ASU, a new technology based on coal gasification integrated with the syngas chemical looping (SCL) was validated to reduce the energy penalty as well as the capital cost of the cryogenic air separation unit (CASU). This work show a few results (i) a heat-integrated IGCC polygeneration plant using SCL is presented, (ii) the SCL contributes to generate electricity, H2, and CO2-rich gas, (iii) the net energy efficiency of the proposed design can achieve about 60% if ASU and CCS are removed, (iv) the BIGCC using 20% biomass in place of coal can reduce the yields of hydrogen and methanol by 8.3% and 10.7%, respectively.

**2. Methods**

The proposed BIGCC power plant connecting the syngas chemical-looping (SCL) shown in Fig. 1 is carried out the process simulations in the Aspen Plus environment.

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**Figure 1.** Schematic of BIGCC power plant connecting the syngas chemical-looping (SCL)

**3. Results and discussion**

This study is emphasized on the reactor design in the chemical looping, where the fast fluidized bed reactor and the moving bed reactor can be validated by some experiments. Through the system integration, the new polygeneration processes with biomass gasification is proposed and its performance in terms of hydrogen yield, hydrogen thermal efficiency, net power efficiency, and the overall system efficiency is evaluated. Based on the prescribed economic model with different scenarios and conditions, the economic indicators such as the levelized cost of electricity, net present value, and internal rate of return carry out the complete economic assessment. Finally, it is expected that the BIGCC has a few economic benefits. In the research, the integration of Aspen Plus® and Matlab® is used to execute the simulation task.

**4. Conclusions**

To remove the high energy duty of the air separation unit such as CASU are investigated, the BIGCC polygeneration plant connecting can increase the net energy efficiency output since it connects the syngas chemical looping to generate electricity and hydrogen simultaneously. The corresponding net efficiency would be up to 60% if the heating values of fuels of hydrogen and methanol are taken into account.

**References**

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