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УДК 66.081

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STUDY THE INFLUENCE OF SORBENT (CAO) ON HYDROGEN PRODUCTION FROM BIOMASS GASIFICATION IN DIFFERENT CONDITIONS: USING ASPEN PLUS

Abstract. *This work models and simulates in Aspen plus the effect of influence CaO on the production of hydrogen from wood chips gasification under various operating circumstances such as temperature and equivalent ratio. The suggested quasi-steady state model, based on available experimental data, includes pyrolysis, tar cracking, and char conversion. The prediction of the resulting model is validated. The greatest H2 mole fraction with CaO is roughly 35% at temperatures close to 900 K.*

Keywords*: Steam Gasification, Biomass, Hydrogen production, Effect of CaO,* CO_2 *Capture*

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ИЗУЧИТЬ ВЛИЯНИЕ СОРБЕНТА (САО) НА ПРОИЗВОДСТВО ВОДОРОДА ИЗ БИОМАССЫ В РАЗЛИЧНЫХ УСЛОВИЯХ: С ИСПОЛЬЗОВАНИЕМ ASPEN PLUS

Аннотация*. Эта работа моделирует в Аспене, изучают эффект влияния CaO на производство водорода при газификации древесной щепы при различных рабочих условиях, таких как температура(T), и эквивалентное соотношение (ER). Предложенная модель квазистационарного состояния, основанная на имеющихся экспериментальных данных, включает пиролиз, крекинг смолы и конверсию полукокса. Прогноз полученной модели подтверждается. Наибольшая мольная доля H2 с CaO составляет примерно 35% при температуре, близкой к 900 К*

Ключевые слова*: паровая газификация, биомасса, производство водорода, влияние CaO, улавливание* CO_2*.*

I. Introduction

Nowadays, conventional fuels provide the majority of industrial and home energy needs. As these with rising energy needs, energy sources are diminishing at a quicker rate; future energy may come from renewable sources. After fossil fuels, biomass has been designated as the world's greatest major energy source [1, 2]. Many studies have provided an overview of conversion strategies for generating energy from biomass. In comparison to the biological approach, thermo-chemical gasification appears to be more advantageous for energy extraction as syngas [3]. Hydrogen, one of the major elements of syngas, has been receiving more attention as a potential energy carrier, being a clean fuel with higher energy density on mass basis Researchers have successfully simulated processes such fluidized bed combustion , coal gasification , integrated coal gasification, and solid oxide fuel cells system using the process modeling program ASPEN Plus Simulator. It makes it possible to individually model and simulate each part of an integrated system; Sreejth et al [2, 3]. Developed a Gibb's free energy minimization model for steam gasification of biomass. The model did not take into account tar, and the char conversion was assumed to be 100%. At a temperature of 973 K and a steam to biomass ratio of unity, a maximumhydrogen concentration of 59.3% was projected. Table1, content Proximate and ultimate analyses result of wood chips.

TABLE I

Proximate and Ultimate analysis of wood chips

Proximate analysis	Wt.%	*Ultimate analysis*	Wt.%
Volatile matter	75.5	C	46.99
Fixated carbon	17.59	H	5.75
Moisture	3.56	O	39.51
Ash	3.34	N	0.39
		S	0.01

II. MODELIG PROCEDURE

Using the ASPEN Plus process simulator, a nonstoichiometric quasi-steady state model is created to mimic the air-steam gasification of biomass. The impact of CaO sorbent for in-situ CO_2 collection will be examined using the model. Fig.1. Process flow sheet for air–steam gasification. The model's underlying presumptions are as follows:

- A gasifier is a steady-state system with constant pressure and temperature.
- Dilute gases include all gases other than H_2, CO, CO_2, CH_4, and N_2.
- At a superheated state of 1 bar and 200 °C, steam is delivered.
- Carbon considered graphitic is char.

$CO (g) + H_2O (g) = CO_2 (g) + H_2 (g)$ exothermic ……………………. (1)

Carbonation reaction $CaO (s) + CO_2(g) = CaCO_3 (s)$ exothermic… ….(2)

Calcinations reaction $CaCO_3 (s) = CaO(s) + CO (g)$ endothermic ……..(3)

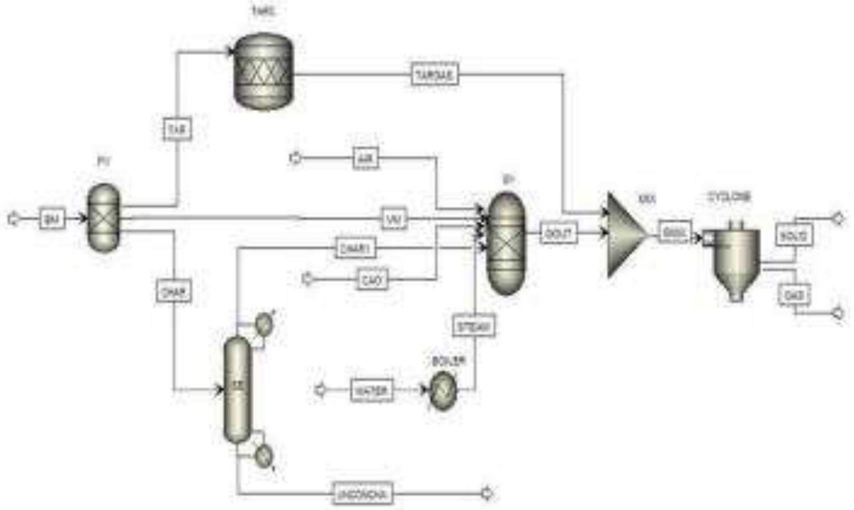


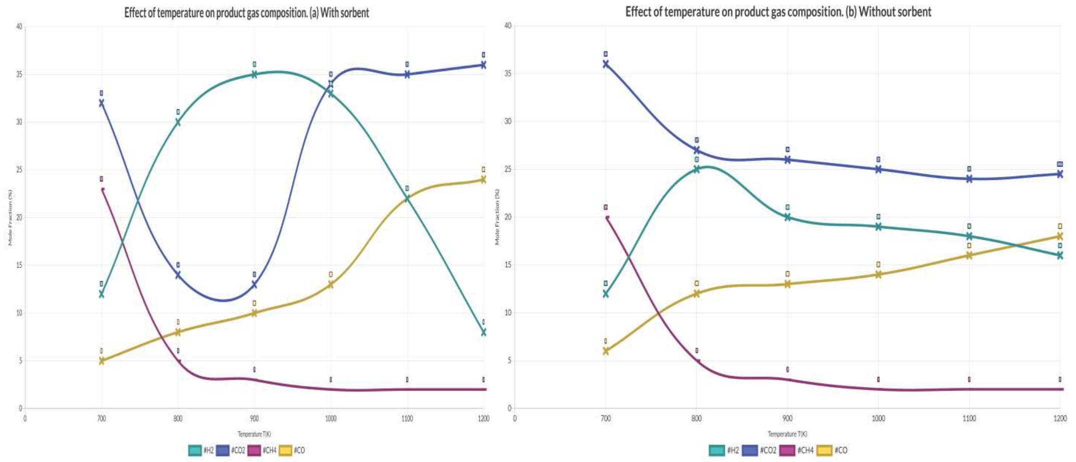
Fig. 1 - Process flow sheet for air–steam gasification

III. RESULTS AND DISCUSSION

The modeling output of several factors and how they interact with one another, for instance, how temperature affects the gas composition product with and without CaO sorbent in Fig 2a,b. According to the reversal of the water gas shift reaction, the H_2 concentration is seen to grow to a maximum value in both circumstances and then decrease with an increase in temperature. Effect of (ER) “Equivalent Ratio” on the make-up of the product gas demonstrates the impact of ER on the mole fraction of the ingredients in product gas with and without CaO. With the exception of CO_2, all gas components generally decrease with ER. This is because the method has changed to focus on combustion at higher ER levels. In Fig. 3a,b, the rise in CO_2 moles with ER is depicted. A maximum H_2 concentration of 35% is attained at a gasification temperature of 900 K in sorbent-enabled gasification for CO_2 capture. When compared to that without CO_2 sorbent, it is discovered that the maximum mole fraction of H_2 has increased by 25.1%. In contrast, CO_2 concentration remains nearly constant at 1000 K in gasification without sorbent whereas CO_2 concentration declines to a minimal value and subsequently grows in gasification supported by CaO. Beyond 1000 K, there is a trend reversal in the change of CO_2 concentration with temperature.

Without sorbent H_2 production diluted dependent on availability to air, although CO_2 production grew progressively as air rose.

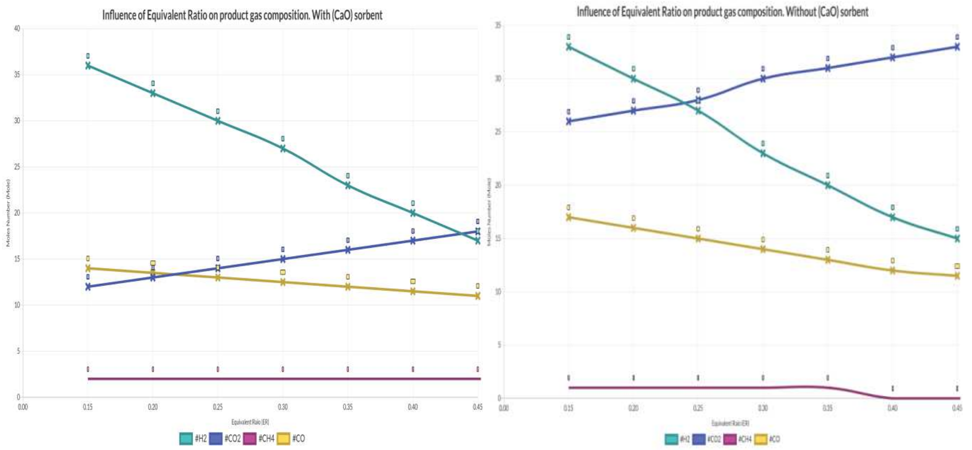
In Fig. 4 shows the higher H_2 production from biomass gasification with steam agent. In Fig. 5 compare them with experimental from literature.



(a) (b)

Fig. 2 - Studied effect of temperature on product gas composition. With (a) and without (b) sorbent (CaO)

Under conditions (STEAM = 1, AIR-STEAM = 1, AIR = 0.27



(a) (b)

Fig. 3 - Studied influence of Equivalent Ratio (ER) on product gas composition. With (a) and without (b) sorbent (CaO) under conditions (T= 1000K, STEAM = 1, AIR-STEAM = 1, AIR = 0.27).

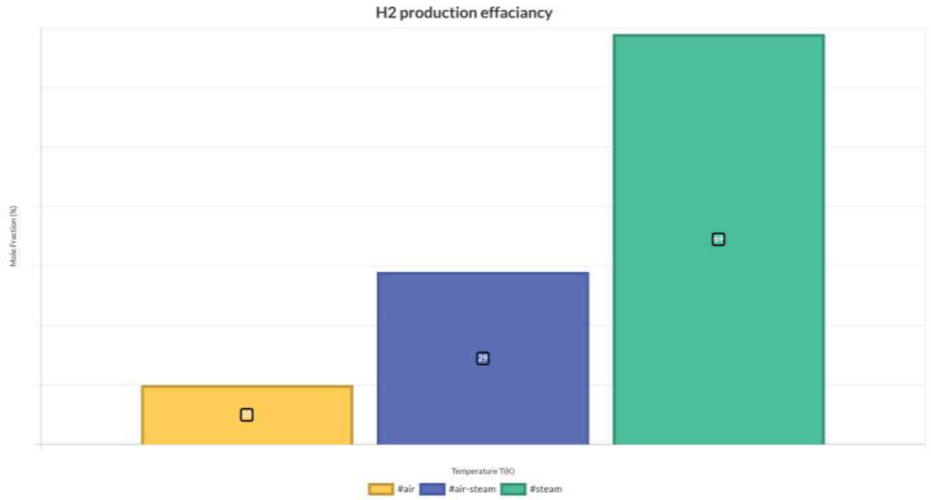


Fig. 4 - Effect of gratifying agents in product H_2

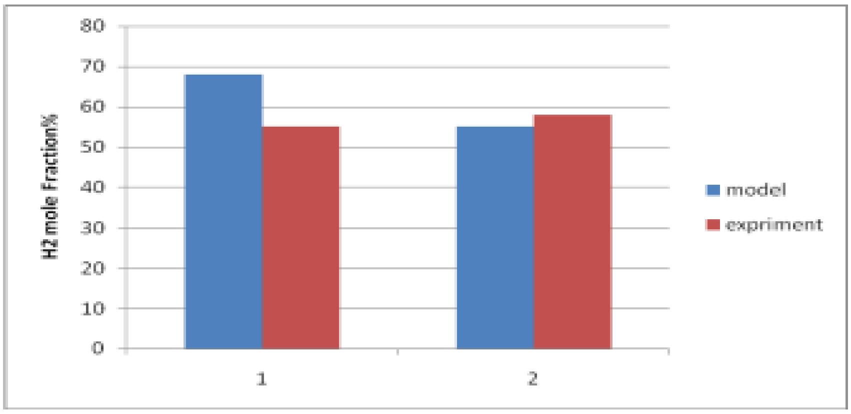


Fig. 5 - Comparison between model and experimental (T = 1000 K), with sorbent (steam = 1)

CONCLUSION

A quasi-steady state model was constructed in ASPEN Plus process simulator to examine the impact of critical operating parameters by adding sorbent (CaO) to air-steam gasification of wood chips. The effect of gasification temperature, Equivalent ratio ER, demonstrates the influence of CaO as a sorbent on raising the Hydrogen yield from air-steam biomass gasification by boosting the tar cracking rate mechanism and capturing CO_2.This technique was tested using a verified model. As a result, the maximal H_2 mole percentage is around 35% at temperatures close to 900K, which is higher than gasification without sorbent.

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УДК 621.316.721:723

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ПОВЫШЕНИЕ НАДЕЖНОСТИ СЕТЕЙ С КОМПЕНСАЦИЕЙ ЕМКОСТНОГО ТОКА

Аннотация. *Применение в сетях с компенсированной нейтралью 6-35кВ дугогасящего реактора не обеспечивает его эффективную работу и точную резонансную настройку в различных условиях эксплуатации в результате ряда причин, влияние которых будет сводиться к минимуму при использовании в таких сетях управляемого резистора с возможностью изменения активного сопротивления.*

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INCREASING RELIABILITY OF NETWORKS WITH CAPACITIVE CURRENT COMPENSATION

Abstract. *The use of an arc suppression reactor in 6-35 kV networks with compensated neutral does not ensure its efficient operation and accurate resonance tuning in various operating conditions due to a number of reasons, the influence of which will be minimized by the use in such networks of a controlled resistor with the possibility of changing the active resistance.*

ПУЭ регламентирует переход изолированного режима заземления нейтрали в компенсированный путем подключения дугогасящего реактора в распределительные сети 6-35 кВ с большими