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# FABRICATING AND PERFORMANCE EVALUATING OF AN EXPERIMENTAL PROTOTYPE OF DOWNDRAFT BIOMASS GASIFIER

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**ABSTRACT:** Thermochemical conversion process by the gasification to convert the agricultural residues to gaseous fuel using the biomass partial oxidization theory is a very potential as a simple, clean and sustainable method for producing heat and power at rural and remote regions with less contamination compared to the fossil fuel. The biomass gasification process produced a mixture of gases called the producer gas, which contains of carbon dioxide ($CO_2$), carbon monoxide (CO), methane ($CH_4$), hydrogen ($H_2$) and nitrogen ($N_2$). Hence, the aim of this investigation is fabricating and evaluating the performance of a prototype fixed bed downdraft gasifier using corn stover pieces and air as a gasifying agent under different equivalence ratios (ER) of 0.18, 0.24 and 0.36, corn stover particle size (PS) of 1-5, 6-10 and 11-15 mm and working temperature (WT) after throat of 700, 800 and 900°C, takes into consideration the gas composition, temperature profile, the lower heating value, gas yield and gasification efficiency. According to the obtained results, it is recommended to operate the gasifier at ER of 0.24, PS of 1-5mm and working temperature of 900°C, obtained the highest concentration for CO (18.02%), $H_2$ (11.22%), $CH_4$ (3.317) and $C_nH_m$ (1.751%), gas lower heating value of 5.833 MJ/Nm$^3$ at gasification efficiency of 66.89% and gas yield of 1.70 Nm$^3$/kg.

**Key words:** Biomass gasification, downdraft gasifier, corn stover, producer gas, gasification efficiency.

## INTRODUCTION

Energy is the cornerstone for pushing the wheel of production and development in all countries of the world to achieve prosperity, welfare and civilization. Mostly the demand of energy is fulfilled from the conventional fossil fuels such as coal, petroleum and natural gasses. However, these energy sources will be depleted soon (Zainal *et al.,* 2001). Therefore, the concept of exploiting the renewable energy resources as a reliable, clean and sustainable route to produce heat, electricity, and power was appeared during last few decades. One of the most potential renewable sources of energy is biomass. Plant produced biomass continuously by the process of photosynthesis (Garcia-Pèrez *et al.*, 2002)

Biomass is a major energy resource for the rural population of Egypt, which includes the agricultural residues and dry animal dung cakes that are directly burn in primitive stoves and ovens to provide thermal energy to households for purposes of cooking, baking, and water and space heating (Abd Allah *et al.*, 2016).

Biomass gasification is a thermochemical conversion process to convert the solid and carbonaceous materials or wastes to combustible gas mixture called the Synthetic Gas or the producer gas. Gasification is the conversion of biomass into a combustible gas mixture by the partial oxidation of biomass at high temperatures, typically in the range 800–900 °C (McKendry, 2002).

In a downdraft gasifier, both the feedstock and product have concurrent flow gas moves downward and the product exits from the bottom at a higher temperature (*i.e.,* around 800°C). In this case, most of the forming tars are cracked due to the gas flows through a high temperature zone (Kumar *et al.*, 2009).

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Bhavanam and Sastry (2011) mentioned that, there exist mainly two designs for downdraft gasifiers: Throated gasifier and the open core gasifier.

The throated downdraft gasifiers are suitable to handle biomass fuel having ash and moisture content less than 5% and 20%, respectively (Pathak *et al.*, 2008).

Fixed bed gasification is the most common technology for the energy use of biomass and solid municipal wastes (Yang *et al.*, 2004).

Sometimes, this type of gasifiers may be called as the moving bed gasifier. Fixed bed gasifiers can be constructed inexpensively in small sizes, which are one of their major advantages (Basu, 2010).

The producer gas from downdraft gasifier has lesser tar-oils (<1 %), higher temperature (around 700°C) and more particulate matter than that from an updraft gasifier (Reed *et al.*, 1999). Downdraft gasifier is capable of generating producer gas with low tar content for engine applications (Chawdhury and Mahkamov, 2010). To achieve a high carbon conversion of the biomass and a low tar content, a high operating temperature (>800°C) in the gasifier is desirable (Hanping *et al.*, 2008).

García-Bacaicoa *et al.* (2008) stated that, the amount of air entered into downdraft fixed bed gasifiers controls the biomass consumption rate. On the other hand, Egyptian farms delivered annually huge quantity of agricultural crop wastes including straw, stalk, foliage, tree trimming in orchards. *etc.*, but unfortunately a little portion of these wastes had been utilized as animal feed, compost, litter at cattle / poultry farms and the rest would be remain as a source of contamination. Therefore, there is an urgent need to exploit these wastes for energy generating and avoiding the environmental pollution by the direct burn in field using the Biomass gasification technique.

Corn stover is one of the potential hydrocarbon feedstock for biomass gasification, where it contains large amounts of carbon (C) and small amounts of ash, sulfur (S) and chlorine (Cl) compared to the other agricultural crop wastes such as; rice straw or even cotton stalks. Despite, Egypt has a good potential for biomass resources, but very limited efforts executed to quantify this potential for energy generation by researchers, hence this work focused on fabricating and evaluating the performance of a local made, small-scale downdraft fixed bed gasifier as a prototype using the corn stover for producing Producer gas.

## MATERIALS AND METHODS

The fabrication of the prototype fixed bed downdraft gasifier was conducted at private workshop at Zagazig city, and the practical experiments were performed at Faculty of Agriculture farm, Zagazig University, Sharkia Governorate, Egypt.

### Corn Stover Pieces Characteristics

In this work, the corn stover (CS) was obtained from a private farm at Mashtool El-Souk Destrict, Sharkia Governorate, Egypt, to be used as biomass feedstock. The CS was chopped in form of pieces with length varied from 1 - 15 mm by using local chopping machine. The proximate, ultimate analysis and chemical analysis were conducted to determine the gross and elemental compositions of the corn stover pieces (CSP), as seen in Table 1. The moisture content of CSP was determined in three replicates by drying the samples in an oven furnace at temperature of 105°C for 24 hours.

### Experimental Setup

Fig. 1 illustrate a prototype biomass gasification unit that mainly consists of a fixed bed downdraft gasifier and air supply system. The gasifier was laid on a tri-leg stand with total height of 1795.90 mm and has three main parts namely: top, middle and bottom part.

#### Top part (fuel chamber)

The top part consists of three concentric steel cylinders that made of 3mm in thickness and 673.1mm in length for each. The outer diameter for these cylinders is 254, 381 and 508mm, respectively. The thermal ceramic layer of 25mm in thickness was packed between the middle and the outer cylinders as a thermal insulator. The fuel chamber contained the drying and pyrolysis zones. The cylinders were connected to the middle part by flange provided with eight peripheral bolts and thermal gasket, while the feeding gate was 150mm in diameter provided with a restricted lid that facilitates the gasifier loading of the feedstock.

**Table 1. Proximate, ultimate and chemical analysis of CSP**

| Proximate analysis (wt %db*) | | Ultimate analysis (wt % db) | | Chemical analysis (wt %db) | |
|---|---|---|---|---|---|
| Moisture content (MC) | 10.77- 22% | Carbon | 35.18 | Hemicellulose | 27.61 |
| Total solids (TS) | 89.23 | Nitrogen | 1.22 | Cellulose | 39.21 |
| Volatile matter (VM) | 82.04 | Hydrogen | 8.16 | Lignin | 17.6 |
| Ash (A) | 7.19 | Oxygen | 47.46 | $HHV^{1}_{biomass}$(kJ/kg) | 16898 |
| Fixed carbon (FC) | 11.78 | Sulfur | 0.79 | $LHV^{2}_{biomass}$ (kJ/kg) | 14824 |

*(wt % db) = weight percentage dry basis 1-$HHV_{biomass}$ = higher heating value of biomass
2-$LHV_{biomass}$ = lower heating value of biomass

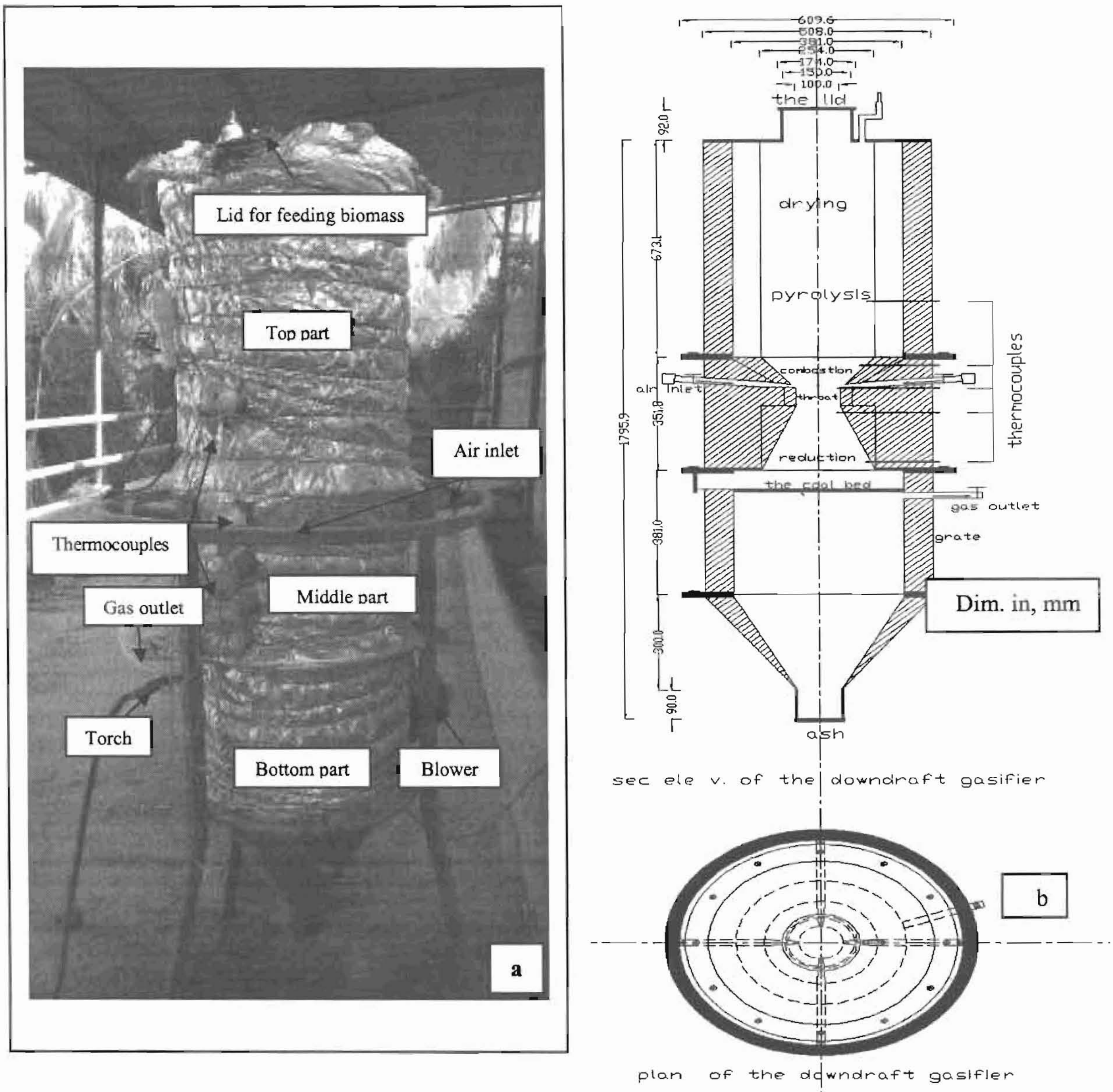


**Fig. 1. The gasification unit: a) the prototype fixed bed downdraft gasifier, b) cross sectional and plan views of the gasifier**

**Middle part (Reactions chamber)**

The middle part is the core of gasifier where the producer gas is produced through two main zones namely: the combustion/oxidation and reduction zone. This part mainly consists of three concentric steel provided with ceramic insulation around the throated area. The outer layer is a cylinder, which made of 3mm in thickness, 508mm outer diameter and 351.8mm in length. The combustion/oxidation zone provided with a throated area to push the incoming gas from pyrolysis zone entire a tiny route downwards and impact the injected oxidation agent (Air in this study), so it considered the hottest zone of the gasifier, then, the combusted gases would pass to the reduction zone/ gasification zone.

**Bottom part (ash chamber)**

This part has the grate, which the coal and feedstock are rested at the top, while the producer gas outlet pipe is located beneath the grate. It is the conical insulated part of the gasifier, which collects the remained ash resulting from the gasification process. Moreover, the accumulated ash can be rejected by a control valve at the lower end of this chamber.

**Air supply system**

This system has been connected to a radial distribution manifold, which is attached to the outer surface of the gasifier .The manifold, is received air stream from air blower through controlled valve and fed it above the throat directly. Air was supplied to the air distributed from a variable speed centrifugal fan (Model: SAVT-100L, 220V) with nominal speed 3000 rpm, maximum air volume 0.065 $m^3$/sec.

## Experimental Procedure

For each treatment, the gasifier was started up by adding considerable amount of coal to the grate at level near the throat. Afterwards, the coal was wetted with kerosene to initiate the ignition using a torch through a side hole and the top lid was closed strictly, then the blower is turned on to inject air into the gasifier to ignite the coal. This process was extended until the throat temperature reached the gasification level and consequently, the lid of top part is opened to feed the gasifier with the CSP, after that, the lid is closed strictly.

At combustion zone, the oxidation of charcoal and tar would generate heat for the rest of zones and the gasification process would take place at the reduction zone to form the producer gas.

The velocity of the entered air (m/sec.) to gasifier was measured using Hot-Wire Air Velocity meter (model TM-4002) to calculate airflow rate ($m^3$/hr.). Moreover, the gasifier is providing with 5 calibrated K-type thermocouples sensors with temperature range of -100 to1300°C at different height from grate along the vertical axis to investigate the temperature profile for monitoring the temperature variation at the different zones in addition to, the temperature of producer gas using a multi-channels digital data logging thermometer (Model TENMARS TM-747DU-4 Channel).

The quantity of producer gas was determined using a gas flow meter (model SENSUS, Egypt) with 0.001 $m^3$ of resolution, and 0.025-4 $m^3$/hr of gas flow rate(less than 200mm bar of operating pressure). Every sample of producer gas was collected using rubber bladder and analyzed by Gas Chromatographer system (GC) to its composition ($H_2$, $N_2$, $CH_4$, CO, $CO_2$ and $C_nH_m$) at the Egyptian Petroleum Research Institute (EPRI), Cairo, Egypt.

## Measurements

In this investigation, the performance of the gasifier was carried out under the following parameters:

1. Different equivalence ratios (ER) of 0.18, 0.24 and 0.36 corresponding to varied biomass feed rates of 4, 3 and 2 kg/hr., respectively at constant airflow rate of 0.000583$m^3$/sec.
2. Three levels of working temperatures (WT) at combustion zone of 700, 800 and 900°C.
3. Three ranges of corn stover particle size (PS) of 1-5, 6-10 and 11-15mm.

**Biomass moisture content**

All the practical experiments were conducted at constant moisture content of 10.77% for the CSP on wet basis (w.b%) according to the following relationship given by (Basu, 2010):

$$MC = (M_w - M_d)/ (M_w) \quad (1)$$

Where:

MC = moisture content of sample (%).

$M_w$ = sample mass before drying, g.

$M_d$ = mass of dried sample, g.

The performance of gasifier can be determined using the Equations [2-7] given by (Gai and Dong, 2012).

### The equivalence ratio (ER)

For each treatment was calculated using the equation :

$ER= [\varphi_m \text{ oxygen} / \varphi_m \text{ fuel (daf*)}]_{Actual} / [\varphi_m \text{ oxygen} / \varphi_m \text{ fuel (daf)}]_{stoich}$ (2)

$[\varphi_m \text{ oxygen} / \varphi_m \text{ fuel (daf)}]_{stoich} = 1/0.21[(1.866V_{C.daf}/100)+ (0.7V_{S.daf}/100)+ (5.55V_{H.daf}/100) - (0.7V_{O.daf}/100)] = 3.73 \text{ kg}_{air}/\text{kg}_{Biomass}$. (3)

Where:

$\varphi_m$ oxygen = air flow rate, kg/hr

$\varphi_m$ fuel (daf) = biomass consumption rate, kg/hr

$V_C$, $V_S$, $V_H$ and $V_O$ are the percentages of carbon, sulfur, hydrogen and oxygen, respectively on ultimate analysis dry basis.

#### The lower heating value (LHV)

The lower heating value (LHV) of the gas can be estimated by Eq. (4):

$Q_g = 0.126 \times CO + 0.108 \times H_2 + 0.358 \times CH_4 + 0.665 \times C_nH_m$ [MJ/Nm$^3$] (4)

Where:

*dry ash free

CO, $H_2$, $CH_4$ and $C_nH_m$ ($C_nH_m = C_2H_2 + C_2H_4 + C_2H_6$) are percentages of the volume fraction carbon monoxide, hydrogen and hydrocarbons in the product gas.

While, the lower heating value (LHV) of the feedstock is calculated in Eq. (5):

$Q_b = 0.339 \times C + 1.029 \times H + 0.109 \times S - 0.112 \times O - 0.025 \times MC$ [MJ/kg] (5)

Where:

C, H, S, O and MC are percentages of the mass fraction carbon, hydrogen, sulphur, oxygen and moisture content in the dry biomass.

#### The gas yield (GY)

The gas yield (GY) is calculated as the ratio of gas produced to the quantity of the dry biomass.

$GY = V_g/M_b$ [Nm$^3$/kg$_{Biomass}$] (6)

Where:

$V_g$ = the volume of the gas, Nm$^3$/hr.

$M_b$ = the quantity of the dry biomass, kg/hr.

#### The gasification efficiency ($\eta_g$)

The gasification efficiency ($\eta_g$) is defined by the ratio of the total amount of LHV of the gas to the LHV of the feedstock as depicted in Eq. (7):

$\eta_g = [(Q_g \times GY)/Q_b] \times 100$ [%] (7)

Where:

$Q_g$ = the LHV of the gas, MJ/Nm$^3$.

GY = the gas yield, Nm$^3$/kg$_{biomass}$.

$Q_b$ = the LHV of the feedstock, MJ/kg.

## RESULTS AND DISCUSSION

The obtained results were discussed under the following topics:

### Effect of the ER on Gas Composition Using Different Working Temperatures and Particle Size Ranges

The producer gas is mixture of gases that mainly consists of $H_2$, $N_2$, $CH_4$, CO, $CO_2$ and $C_nH_m$ gases with different mole fraction depending up on the operating conditions. Fig. 2 illustrate that, the effect of the ER on gas composition using PS range of 1-5mm at different WT. It was observed that, the WT has a highly effect on the Producer gas composition. The obtained results show that, the increasing in WT from 700 to 900°C caused rapid increasing the heating rate of the feedstock, which leads to more gas and lower tar production. At lower temperature, a large amount of charcoal (carbon) will not convert to fuel gas at the reduction zone. This may be due to the decrease in the oxidization process at combustion zone, but when the temperature increased, carbon will convert to carbon monoxide according to the Boudouard reaction in reduction zone as follows:

$C + O_2 \rightarrow CO_2$ (8)

$C + CO_2 \rightarrow 2CO$ (9)

Simultaneously, $H_2$ is produced by the water gas reaction and methane reforming reaction as follows:

$C + H_2O \leftrightarrow CO + H_2$ (10)

$CH_4 + H_2O \leftrightarrow CO + 3H_2$ (11)

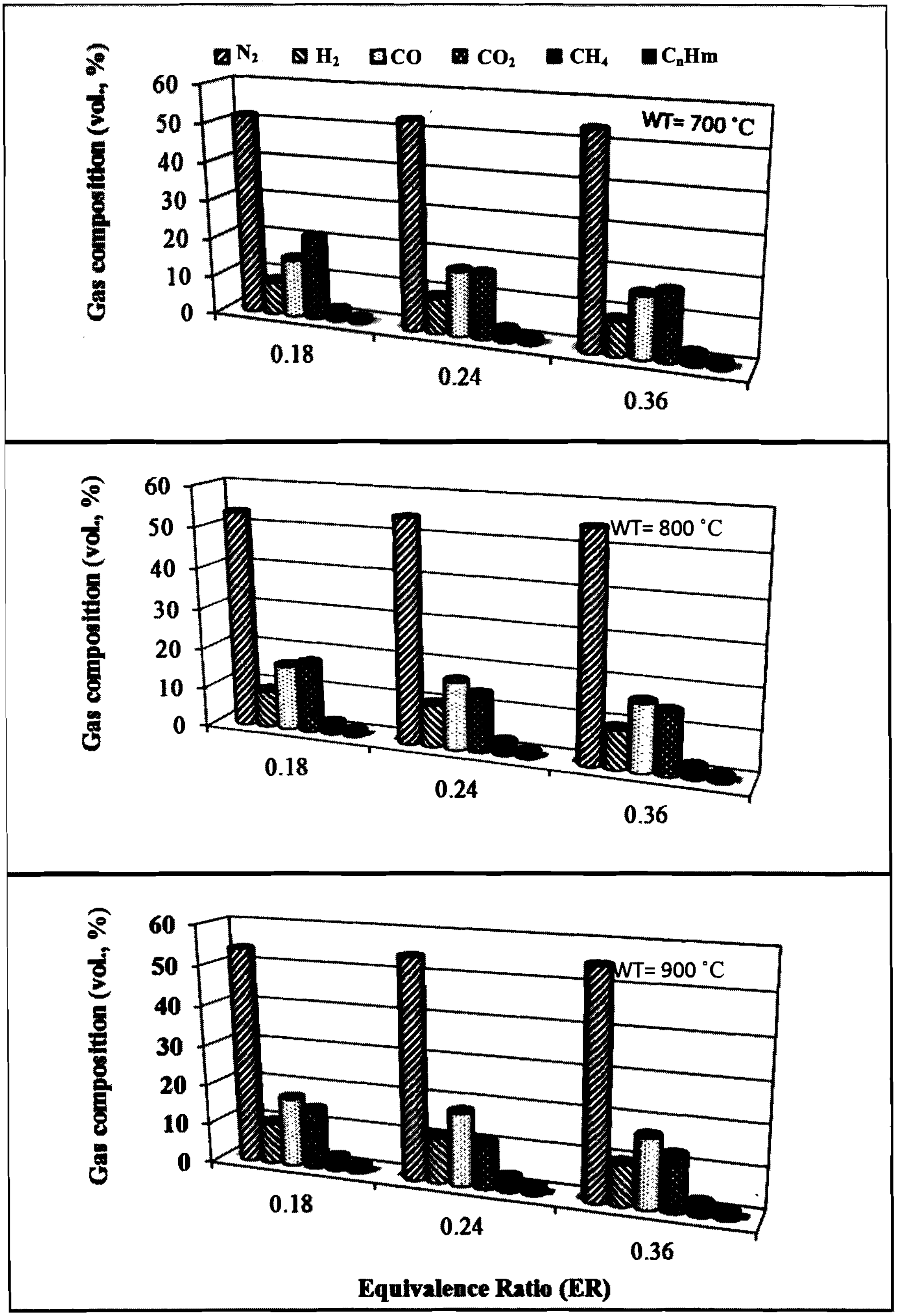


**Fig. 2. Effect of the ER on gas composition using different working temperatures at particle size range of 1-5mm**

Hence, the rise of WT from700 to 900°C within the gasifier will improve the production of CO and $H_2$ gases on the account of $CO_2$ gas, so the concentration of $H_2$, $CH_4$, CO and $C_nH_m$ gases will increase while, the concentration of $CO_2$ gas will decrease. Besides, the concentration of $N_2$ gas always increased relatively by increasing the WT.

It is obvious that, the WT of 900 °C gave the highest concentration of the fuel gases represented in $H_2$, $CH_4$, CO.

Regarding the temperature profile, the temperature variation at the pyrolysis, combustion and reduction zones was measured during the gasification process using five thermocouples along the vertical axis of the gasifier that located at different heights from the grate. As seen in Fig. 3 the temperature increased gradually through the pyrolysis to reach the peak temperature at combustion zone, afterwards it tends to decreases in reduction zone, particularly above the grate. The measurements indicated that, start of the partial oxidization for the CSP took place before the throat and extended after throat to reached the peak temperature inside the gasifier as exothermic process, so it considered the hottest zone inside the gasifier and would give the heat to the endothermic processes of both the pyrolysis and reduction. Since, the high temperature after throat is desirable to obtain high conversion of carbon with low tar, thus the selecting the optimum value of ER is strongly important because the low or high ER will degrade the performance of the gasifier.

Since, heat transfer into particle is elegant in the smaller particle size (PS) of biomass feedstock causes an enhancement in carbon conversion rate; hence, the reduction of particle size will lead to a sharp increase in the concentration of the fuel gases. On the other hand, the concentration of $CO_2$ gas was fixed bed decreased gradually at the same trend of PS. The optimum results for the best performance of the fixed bed downdraft gasifier were obtained by using the PS range of 1-5 mm for the CSP.

Foremost, the ER is considering the most important parameter affecting the performance of the gasifier due to its glorious impact on producer gas composition. The obtained results reveled that, the amount of $N_2$ gas is represented approximately 50% of the producer gas total volume. The concentration of $N_2$ always increased steadily by increasing the ER from 0.18 to 0.36 under all studied parameters of this investigation.

Since the $N_2$ is a main constitute of air, this increase could be due to the increase of air amount that entered the gasifier compared to the feeding rate of biomass feedstock. The obtained results showed that, the increasing of ER from 0.18 to 0.24 was followed by an increase in the concentration of $H_2$, CO, $CH_4$ and $C_nH_m$ gases by using constant particle size range. Whereas, the increasing of equivalence ratio up to 0.36 the mentioned concentration would decrease at the same conditions of the experiment. Whilst, the concentration of $CO_2$ gas decreasing and then increases with the increasing of the ER at the same conditions of experiment.

At the optimum WT of 900°C and PS range of 1-5mm, the increasing of ER from 0.18 to 0.24 was followed by apparent increase in the concentration of $H_2$, CO, $CH_4$ and $C_nH_m$ gases by about 11, 5.82, 13.48 and 23.57%, respectively. Whereas, the increasing of equivalence ratio up to 0.36 the mentioned concentration would decrease by about 9.85, 5.13, 11.55 and 17.88%, respectively at the same conditions of the experiment. Moreover, the concentration of $CO_2$ gas was decreased rabidly by about 23.32% and then increases by about 18.46% at the same conditions of experiment.

## Effect of the ER on Lower Heating Value (LHV) of Producer Gas Using Different Particle Size Ranges at Different Working Temperatures

The LHV is sharply affected by concentration of the combustible gases in the produce Producer gas represents in CO, $H_2$, $CH_4$ and $C_nH_m$ according to Equation (4). Therefore, the fluctuation of the LHV is confined with the concentration of the combustible mentioned gases. The obtained results indicated that, the LHV decreases as the concentration $N_2$ increase with the increase of the ER. Fig. 4 displayed the effect of the ER on LHV of producer gas using different PS ranges of the biomass feedstock at different WT. The obtained results indicated that, the minimum LHV of 5.225 $MJ/Nm^3$ was recorded at ER of 0.18 using PS range

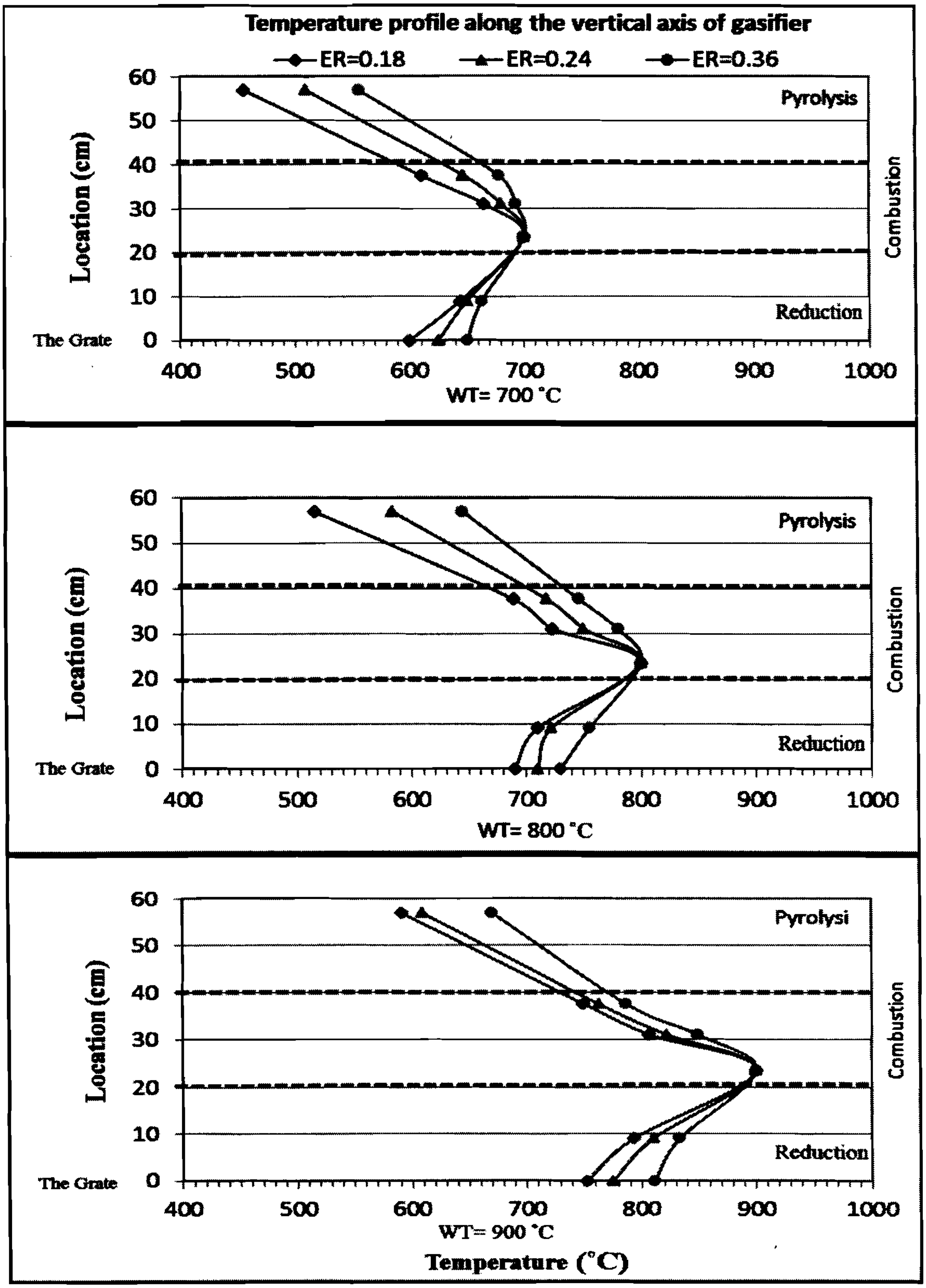


**Fig. 3. Effect of the ER on temperature profile using different working temperatures at particle size range of 1-5mm**

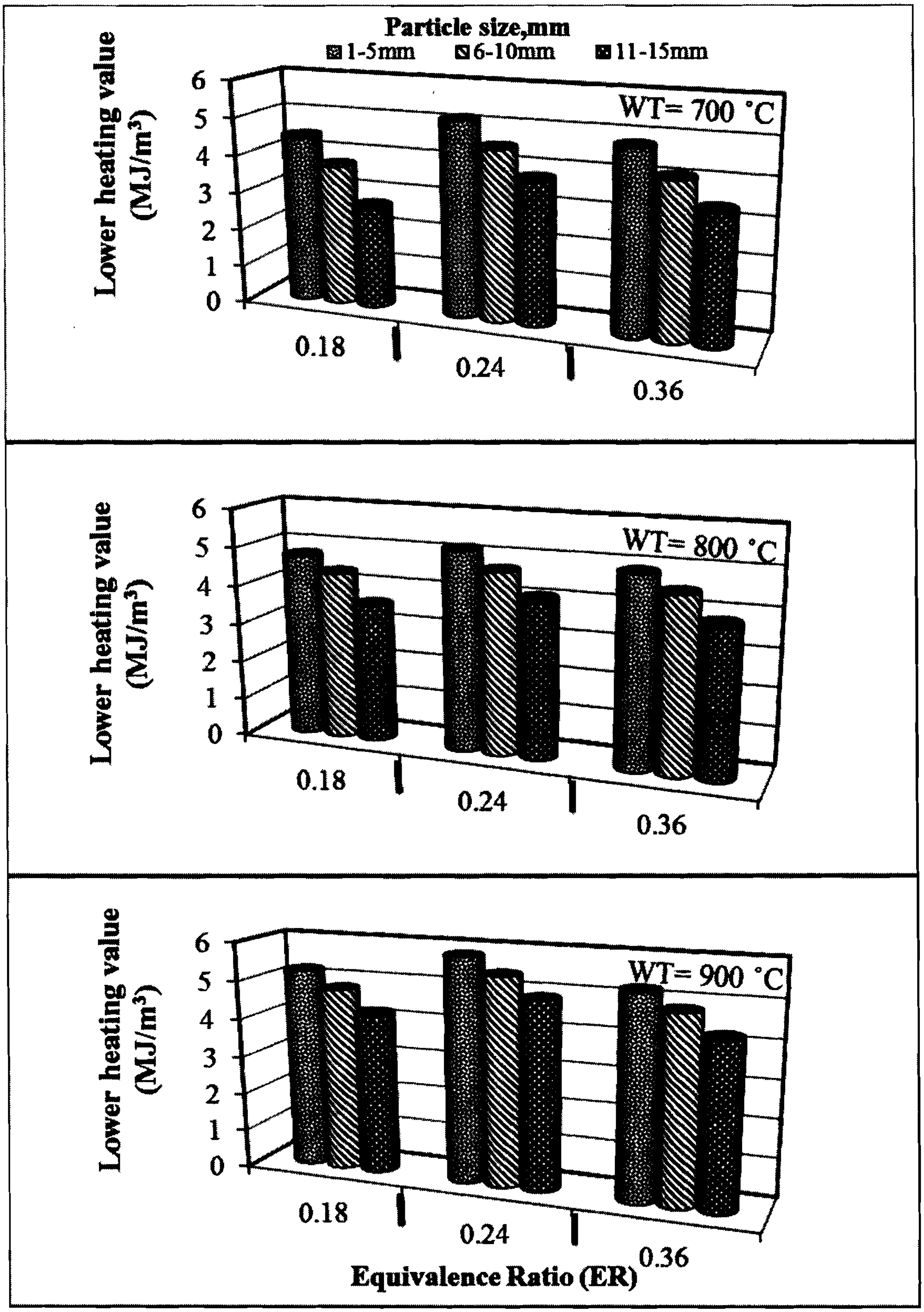


**Fig. 4. Effect of the ER on lower heating value of producer gas using different particle size ranges at different working temperatures**

of 1-5mm. However, the LHV reached the peak value of 5.833 MJ/Nm$^3$ by increasing of ER up to 0.24 and then the trend declined to 5.252 MJ/Nm$^3$ at ER of 0.36. Nevertheless, the increase PS from 1-5 to 11-15mm at constant ER of 0.24, the LHV was decreased linearly from 5.833 to 4.88 MJ/Nm$^3$ due to the decrease of gasification rate and the formation of the combustible gases. In addition, the decrease of LHV can be attributed to the increase $N_2$ concentration due to the high amount of air at the higher values of ER.

## Effect of the ER on Gas Yield (GY) and Gasification Efficiency ($\eta_g$) Using Different Particle Size Ranges at Different Working Temperatures

Fig. 5 show the effect of ER on the GY per unit weight of CSP as biomass feedstock using different PS at different working temperatures. It is obvious that, the increase in the ER from 0.18 to 0.36, was followed by remarkable increase in GY from 1.36 to 2.08 Nm$^3$/kg at optimal PS range of 1-5mm. Higher ER meant that, the airflow rate is higher than the biomass consumption rate and consequently more tar cracking, especially at the smaller sizes of feedstock resulting in high GY, but the LHV of the producer gas would decrease due to the increase of $N_2$ and $CO_2$ on the account of the combustible gases. Wherever, the increase of the PS from 1-5 to 11-15mm the GY decreases from 2.08 to 1.79 Nm$^3$/kg at ER of 0.36.

The gasification efficiency ($\eta$g) is a crucial indicator for the gasifier performance. It can be defined as the energy ratio of the producer gas per the mass unit to the LHV of the feedstock. Therefore, the gasification efficiency is depending on the LHV of the producer gas and the GY. Fig. 6 show the effect of ER on the gasification efficiency for the CSP as biomass feedstock using different PS ranges at different working temperatures. It was noticed that, the increase of ER from 0.18 to 0.36 was accompanied with a clear increase in the gasification efficiency from 47.94 to 73.69% at PS range of 1-5 mm, in spite of the decrease of LHV. Despite, the high ER of 0.36 degrades relatively the calorific value of the producer gas, the GY increased markedly due to the tar cracking and can relatively compensate the reduction in the amount of the combustible gases, especially at the smaller size of feedstock and then the gasification efficiency would increase. Whilst, the gasification efficiency was decreased from 73.69 to 51.40%, by increasing the PS range from 1-5 to 11-15mm at ER of 0.36.

## Conclusion

The obtained results in this study concluded that:

Increasing of ER from 0.18 to 0.24, the concentration of $CO_2$ gas decreases, but the concentration of CO, $H_2$, $CH_4$ and $C_nH_m$ gases were increased. At higher values of ER up to 0.36, they decrease. In addition, the concentration of $N_2$ increases with any increase in ER.

Decreasing of particle size and increasing of working temperature, the concentration of CO, $H_2$, $CH_4$, $N_2$ and $C_nH_m$ gases were increased. On the other hand, the concentration of $CO_2$ decreases.

Increasing of both, ER and working temperature, the gas yield (GY) and gasification efficiency ($\eta_g$) continuously increases.

The lower heating value (LHV) of producer gas increases at a peak value with an increasing both the ER and working temperature and then tends to decrease. However, it decreases with an increasing of particle size. At ER of 0.24, working temperature of 900°C particle size of 1-5mm, the highest LHV of the producer gas of 5.833 MJ/m$^3$ was recorded at gasification efficiency of 66.89%.

It is recommended to operate the gasifier at ER of 0.24, working temperature of 900°C and particle size of 1-5mm for a good performance of the fixed bed downdraft gasifier using the corn stover pieces.

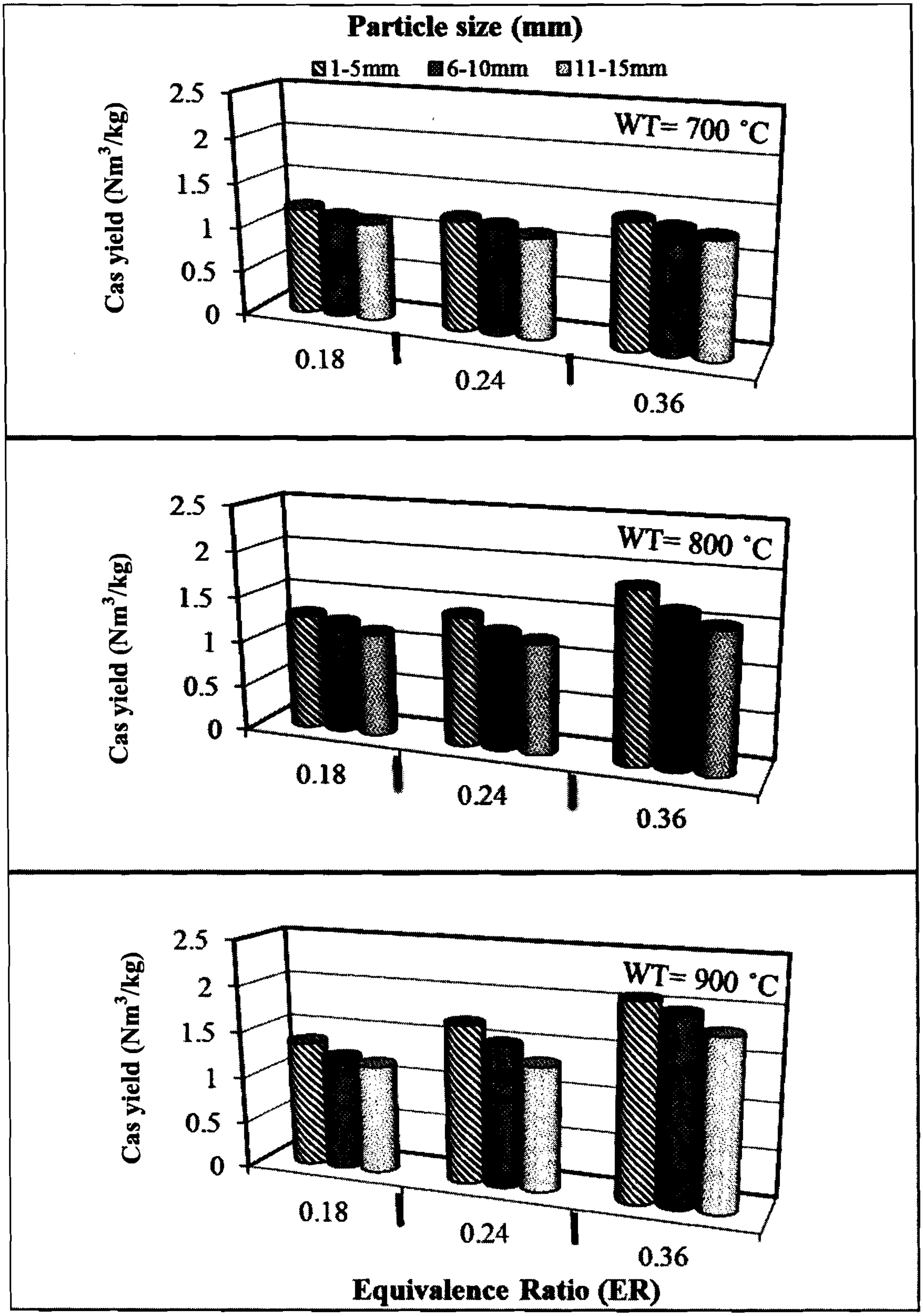


Fig. 5. Effect of the ER on gas yield using different particle size ranges at different working temperatures

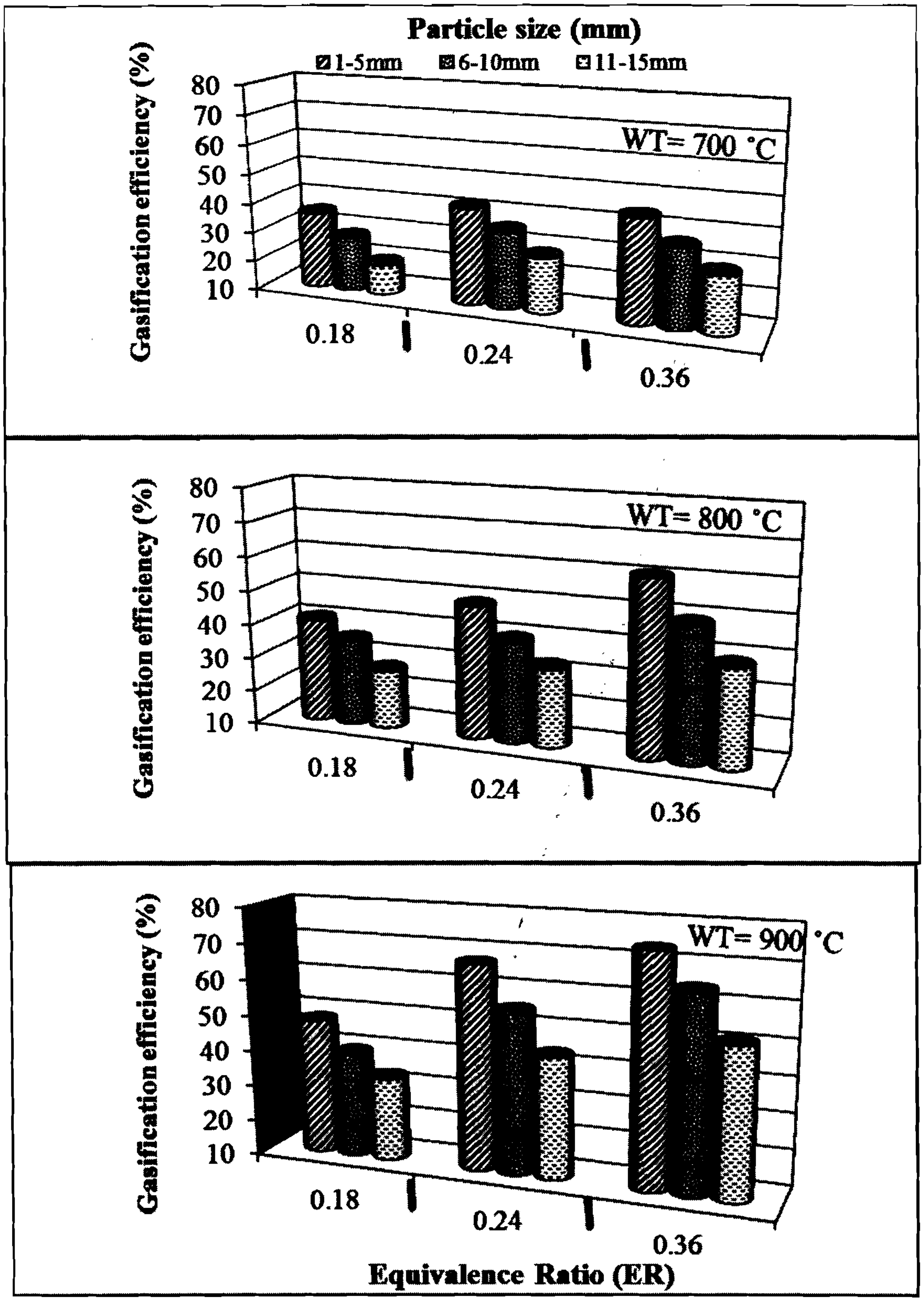


**Fig. 6. Effect of the equivalence ratio on gasification efficiency using different particle size ranges at different working temperatures**

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# تصنيـــع وتقييـــم أداء نمـــوذج تجـــريبـــي للمغـــوز ذو التيـــار الهـــابـط

**عطية عزت عطية ـ محمد محمد مراد ـ محمد على توفيق ـ كمال إبراهيم وصفي**

قسم الهندسة الزراعية ـ كلية الزراعة ـ جامعة الزقازيق ـ مصر

عملية التحويل الثرموكيميائية بواسطة عملية التغويز لتحويل المخلفات الزراعية إلى وقود غازى بإستخدام نظرية الأكسدة الجزئية للكتلة الحيوية هى وسيلة بسيطة واعدة ومستديمة لإنتاج الحرارة والطاقة فى المناطق الريفية والنائية مع أقل تلوث مقارنة بالوقود الأحفورى، تنتج عملية التغويز للكتلة الحيوية خليط من الغازات يسمى الغاز الصناعى، والتى تحتوى على ثانى أكسيد الكربون($CO_2$)، أول أكسيد الكربون ($CO$)، الميثان ($CH_4$)، الهيدروجين ($H_2$) والنيتروجين ($N_2$)، وبالتالى فإن الهدف من هذه الدراسة هو تصنيع وتقييم أداء نموذج مصغر للمغوز ذو المرقد الثابت والتيار الهابط باستخدام قطع من حطب الذرة والهواء كعامل محفز تحت نسب تكافؤ مختلفة (٠,١٨ ، ٠,٢٤، ٠,٣٦) وحجم جزيئات حطب الذرة (١-٥، ٦-١٠، ١١-١٥مم) ودرجة حرارة التشغيل بعد الاختناق (٧٠٠، ٨٠٠، ٩٠٠°م)، مع الأخذ فى الاعتبار تقييم مكونات الغاز، التوزيع الحرارى داخل المغوز، القيمة الحرارة المنخفضة، حجم الغاز الناتج وكذلك كفاءة عملية التغويز، وفقاً للنتائج التى تم الحصول عليها، فإنه يوصى بتشغيل المغوز ذو المرقد الثابت والتيار الهابط عند نسبة تكافؤ ٠,٢٤، حجم جزيئات حطب الذرة ١-٥مم ودرجة حرارة التشغيل ٩٠٠°م، للحصول على أعلى تركيز لغازات أول أكسيد الكربون (١٨,٠٢%)، الميثان (٣,٣١٧%)، الهيدروجين (١١,٢٢%) والهيدروكربونات (١,٧٥١%)، وأعلى قيمة حرارية منخفضة ٥,٨٣٣ ميجا جول/م٣، كفاءة عملية التغويز ٦٦,٨٩% وحجم الغاز الناتج ١,٧٠ م٣/ كجم كتلة حيوية.

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