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System Integration and Method for High-Efficiency Utilization of Solar Energy and Biomass Energy Thermochemically Based on Deep Learning

Manoen Kautish*

Universiti Teknologi MARA, Malaysia

**corresponding author*

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Abstract: As the excessive use of traditional energy has led to environmental pollution and energy crisis, solar energy, as a clean and renewable energy, has been widely used all over the world because of its renewability, non-polluting and widespread distribution focus on. Solar energy is an important energy source that can effectively replace traditional energy, but due to high volatility and other reasons, it needs to be combined with a heat storage system to achieve sustainable and stable applications. The purpose of this paper is to analyze the thermochemical complementary characteristics of solar energy and biomass energy based on deep learning based on the integration of systems and methods for efficient utilization of solar energy and biomass energy. The basic physical properties such as the calorific value of the biomass samples were determined by the rice straw and corn straw.

1. Introduction

Biomass is not suitable for direct utilization due to its scattered distribution and low energy density. It needs to be converted into liquid or solid fuel with high energy density in a certain way to be effectively utilized. Regarding the utilization form of biomass energy, high-temperature pyrolysis under the condition of isolating oxygen is the simplest and most efficient method to convert biomass into carbon-containing liquid fuel [1].

With the increasing demand for energy in our country, it has brought a series of serious environmental pollution problems. Lasmari We found that a distributed system power management system integrating distributed generation and distributed static compensation has several advantages, which are very different from today's EDS. An improved DG synthesis method is proposed in EDS based on solar photovoltaic panels. An objective function based on measuring the level of active energy loss in EDS is deployed to simultaneously find the optimal size and location of DG PV and

DSTATCOM in different study cases using different particle swarm optimization algorithms. Simulation results show that the TVA-PSO algorithm exhibits the highest power and efficiency in finding the best solution. A comparison of simulation results obtained from different study cases concluded that DG and DSTATCOM are simultaneously optimally distributed, resulting in significantly reduced power loss and enhanced voltage ripple [2]. The use of CSP as a high temperature heat source for biomass thermochemical synthesis at Bellouard Q is a promising prospect for syngas production. The solar process avoids partial combustion of the feedstock, thereby saving biomass resources and improving energy conversion efficiency, as the input of solar energy increases the calorific value of the feedstock and also reduces the need for downstream gasification and separation, as the gaseous product is not combusted. By-product contamination. A new concept of a solar bed reactor with continuous biomass injection has been proposed to enhance heat transfer in the reactor, increase gas velocity and gas production by providing continuously agitated particles, and improve continuous operation [3] .The lack of energy and even the energy crisis has become a major problem restricting social improvement.

This paper studies biomass energy and its characteristics, solar thermal utilization technology, and an overview of deep learning, convolution and long short-term memory networks. In the experiment, we mainly study the integration principles and ideas of solar energy and biomass thermochemical complementary utilization system, study the combination of syngas produced by the gasification of these two renewable energy complementary utilization processes, and analyze the thermodynamic characteristics of solar energy and biomass gasification. The efficient complementary utilization of solar energy and biomass provides a theoretical basis. The basic physical properties such as the calorific value of biomass samples were determined by experiments on cotton Wuxuan, wheat rice and corn stalks.

2. Research on Thermochemical Complementary Utilization System of Solar Energy and Biomass Energy Based on Deep Learning

2.1. Overview of Biomass Energy

There are many biomass resources, most of which are solids, and the energy utilization methods are various. Vigorously improving and utilizing biomass energy will be of great significance for ensuring my country's energy supply and reducing environmental pollution [4-5]. There are many technologies for the treatment, transformation and utilization of biomass prototypes. Among them, thermochemical transformation technology has improved rapidly due to its high efficiency. It can either solidify biomass, or liquefy it into liquid fuel, or gasify it into gaseous fuel. It can increase the utilization rate of biomass and facilitate the transportation and use of products. With the different energy and form demands, biomass utilization technology is still improving rapidly, and its broad prospects in the field of energy consumption are beyond doubt. High-moisture feedstocks such as algae, organic waste (food scraps), biosolids, and biosludge are processed into transportation fuels using liquefaction methods. The main products are bio-crude oil, coal coke, water-soluble substances and gases with high calorific value [6-7]. Such an industrial process has several characteristics, including mild process operating conditions, low cost material consumption, and less reliance on raw material transportation and product distribution. But the chemistry of liquefaction is complex and highly matrix-dependent. The industrial application of these processes faces various challenges due to harsh process conditions. Corrosion resistance requires the use of expensive alloys, and high working pressures place stringent requirements on process components such as feed pumps. To date, most research on liquefaction has been carried out on a laboratory or laboratory scale. The high investment cost is a major obstacle to commercialization [8].

2.2. Solar Photothermal Utilization Technology

Status Quo In the utilization of solar energy resources, photothermal regeneration technology is a relatively mature technology that has been improved at present. The solar radiation heat and light on the earth's surface are collected from the earth's surface, and the utilization of their thermal energy is called photothermal utilization technology [9]. It is classified according to the use temperature. Among them, the high-temperature thermal utilization technology of solar energy has higher efficiency in absorbing solar energy, which will become the improvement trend of comprehensive utilization of solar energy in the future. Concentrating solar collectors are typical equipment for medium and high temperature solar energy utilization. The working principle is that the solar radiation entering the aperture is refracted through optics such as mirrors into the receiver and converged together. In order to track more intensive solar radiation, a single-axis or dual-axis tracking device is usually used on the equipment rack [10]. Trough collectors, tower collectors and dish collectors are the three main types of concentrating collectors.

Due to the difference in the way of concentrating solar energy and the concentrating ratio, the corresponding temperature range of solar energy collection is quite different, resulting in different ways of utilizing solar energy. Among them, the temperature range of the dish type and tower type heat collector The higher the temperature, the better the matching degree with the temperature range required for biomass thermochemical utilization [11]. At present, the above-mentioned focused heat collection technology is mainly used in solar thermal power generation systems, and commercialized or technical demonstration solar thermal power plants have been built. The solar thermal power station uses the concentrating heat collection device to convert the radiant energy of sunlight into medium and high temperature heat energy, and then relies on different types of heat transfer media (such as molten salt, heat transfer oil, water, water vapor or air, etc.) The heat device is transferred to the heat exchanger, and finally heated by the heat exchanger and generates high temperature steam and other working medium to drive the thermodynamic cycle (Rankine cycle, Brayton cycle or Stirling cycle) to generate electricity [12].

2.3. Overview of Deep Learning

Deep learning is one of the most widely used main branches in the field of machine learning in recent years. It is based on the principle of biological brain neurobionics, and is based on a large number of sample training. It is a further improvement of artificial neural networks [13]. In recent years, with the advancement of GPU parallel computing technology, the computing power has been greatly improved. Coupled with the massive data accumulated by the Internet and the wave of big data, deep learning has ushered in unprecedented improvement. Deep learning gradually evolved from artificial neural networks. After fifty or sixty years of improvement, many classic network types have been formed and have been widely used in many fields [14-15]. Deep belief networks, automatic encoder-decoder networks, and generative adversarial networks fall into the category of unsupervised learning; recurrent neural networks are used to deal with time series forecasting problems.

(1) Brief description of convolutional layer

The convolutional layer is the core component of the entire network. It consists of several convolution kernels. Each convolution operation is the operation of convolution kernels on a certain region on the input feature map, and the entire region convolution is completed by sliding [16]. A convolution kernel generally extracts shallow features such as lines. Using multiple convolution kernels to extract simple features at the same time, the entire network can extract high-level abstract features, which can be used for visual tasks such as image recognition and target segmentation.

(2) Convolutional neural network structure and characteristics of each layer

As an important branch of neural network, convolutional neural network is a research hotspot in computer vision and deep learning in recent years. When studying the visual cortex of cats, it was found that the visual cortex is composed of a series of cells sensitive only to a small area in the receptive field, and these cells cover the entire receptive field [17]. From this, they proposed a convolutional neural network with a similar structure. Convolutional neural networks are mainly composed of convolutional layers, pooling layers, activation layers, batch normalization layers, dropout layers, fully connected layers and output layers.

(3) Long Short-Term Memory Network

Gradient disappearance or gradient explosion is a problem often encountered in the training and learning of recurrent neural networks. It is difficult to learn the dependencies between neurons with long time intervals, and only short-term dependencies can be effectively learned. For improvement, gating mechanisms are used to control the transmission of information, selectively transmitting information from previous moments and also selectively transmitting new input data [18].

3. System Integration and Method for High-Efficiency Utilization of Solar Energy and Biomass Energy Thermochemically Based on Deep Learning

3.1. Research Content

It mainly studies the integration principles and ideas of solar energy and biomass thermochemical complementary utilization systems, studies the combination of syngas generated by the gasification of the two renewable energy complementary utilization processes, and analyzes the thermodynamic characteristics of solar energy and biomass gasification. The efficient complementary utilization of materials provides a theoretical basis. Among them, cotton wuxuan, wheat daoqiao and corn stalk were taken from M area, and the basic physical properties such as calorific value of biomass samples were measured.

3.2. Deep Learning

As an operation in mathematics, convolution is often used for signal processing.Given an image $X \in R^{M\times N}$ and a filter $W \in R^{U\times V}$, generally $U \pi\pi N, V \pi\pi N$, where * denotes a two-dimensional convolution operation. Its convolution and the two-dimensional convolution of the input signal X and the filter W are respectively:

$$y_{ij} = \sum_{u=1}^{U}\sum_{v=1}^{V} \omega_{uv} x_{i-u+1,j-v+1} \tag{1}$$

$$Y = W * X \tag{2}$$

4. System Integration and Method for High-Efficiency Utilization of Solar Energy and Biomass Energy Thermochemical complementary

Cotton rice straw is selected as the biomass for subsequent complementary utilization with solar energy. In addition, considering the resources and geographical distribution characteristics of biomass resources in my country, it will also be the basis for the abundant biomass of wheat rice straw and corn rice straw. Characteristics and complementary use characteristics for analysis. Because the gasification reaction temperature is directly related to the complementary solar energy collection characteristics and the reaction characteristics of the biomass itself, the cotton rice straw is an example, and the variation characteristics of the synthesis gas combination with the gasification reaction temperature are calculated based on the Gibbs free energy minimum principle. 1 and Table 1:

Table 1. Gas components of cotton straw

Gasification reaction temperature / k	Gas component /%				
	Carbon monoxide	Carbon dioxide	Water	Hydrogen	Formaldehyde
750	0.51	32.7	36.1	7.16	35.4
850	13.6	30.6	31.6	28.1	30.6
950	26.4	18.6	20.4	46.7	11.7

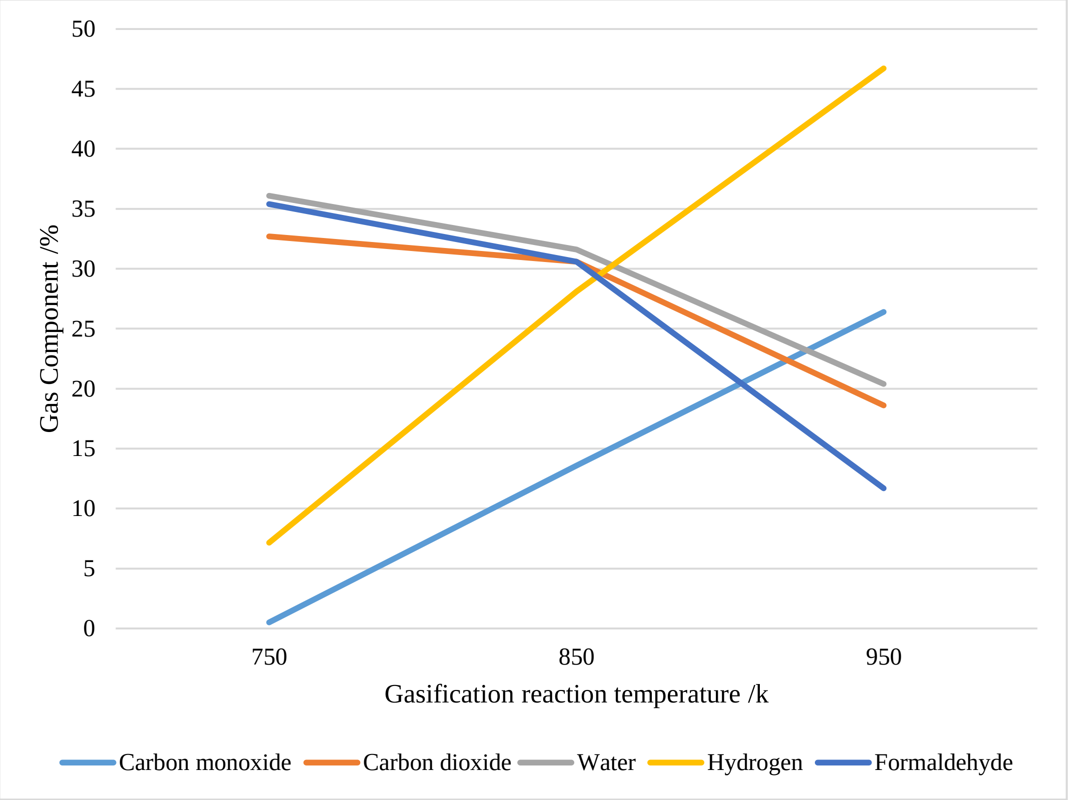

Figure 1. Characteristics of cotton straw syngas components changing with the reaction temperature

When the gasification reaction temperature is increased, the content of hydrogen and carbon monoxide in the syngas will increase, which is mainly due to the gasification reaction of biomass semi-coke with steam and semi-coke with carbon dioxide in the off-temperature section. When using syngas to produce clean liquid fuels such as methanol and diformic acid, the carbon-to-ammonia molar ratio of hydrogen and carbon monoxide in the syngas has an important impact on the reaction process, as shown in Table 2 and Figure 2:

Table 2. Sample changes of corn straw, wheat straw and cotton straw

Gasification reaction temperature / k	Maize straw	Wheat straw	Cotton straw
750	8.61	8.59	8.54
850	4.12	4.03	3.91
950	3.15	3.01	2.93

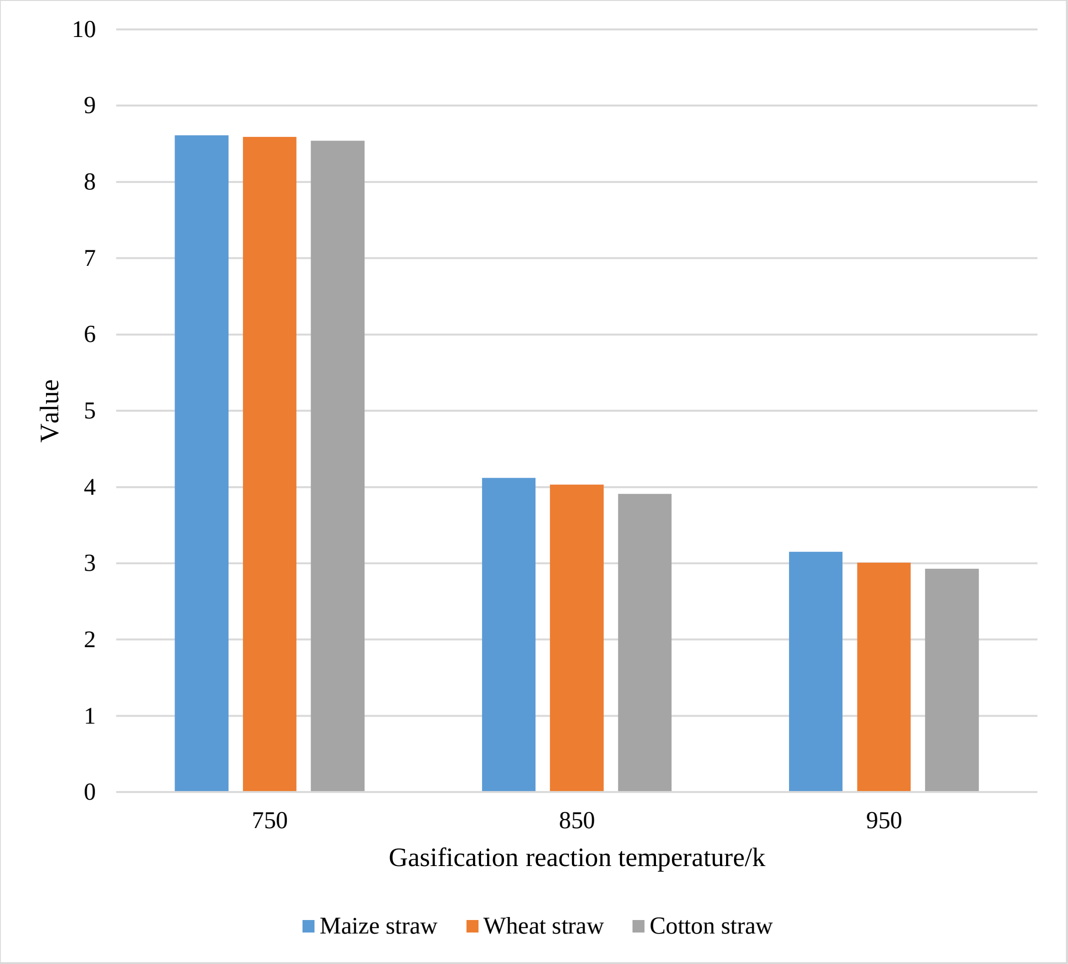

Figure 2. Characteristics of the carbamemolar ratio of the three samples varying with the reaction temperature

Combined with the measured basic physical properties of cotton straw, wheat straw and corn straw, the equilibrium water vapor gasification characteristics of these three samples were analyzed and studied. When the gasification reaction temperature is set to 1100K, the equilibrium syngas composition is shown in Figure 3:

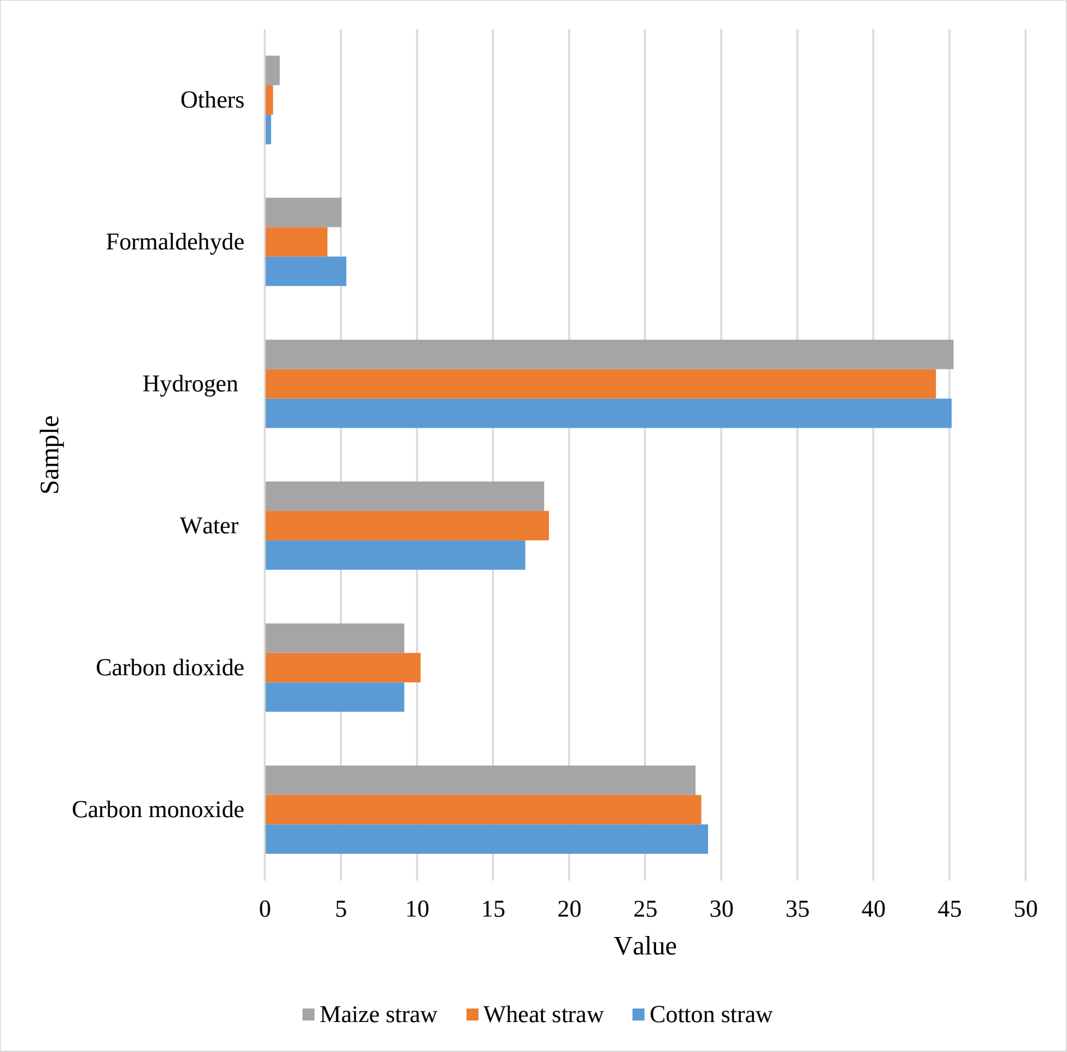

Figure 3. Syngas components generated from balanced solar-biomass gasification

The variation characteristics of CO/CO of the three biomass samples at different gasification reaction temperatures were compared. Since the CO content in the syngas increased rapidly with the increase of the reaction temperature, the carbon-to-ammonia molar ratio of the syngas decreased sharply. However, the molar ratios of carbon and ammonia corresponding to the three biomass samples tended to be stable at a temperature of 1100K, which could basically meet the gas composition requirements for the production of methanol or dimethylacetate.

5. Conclusion

In order to achieve the national "dual carbon" goal and ease the pressure on the country's natural gas imports, the utilization of renewable energy represented by biomass gasification will flourish. But traditional biomass gasification plants that use fuel to provide the heat needed for gasification generate additional by-products and lose a lot of thermal energy. In contrast, solar gasifiers store solar energy into biomass syngas through thermochemical methods of heat transfer and gasification, which improves the energy quality of solar energy and saves fuel, which is a future research hotspot.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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