A review on "The Potential of Energy Generation through Poultry Waste Litter"

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***Abstract*- The poultry industry is one of the biggest and quickest developing agro-based businesses on the planet. This can be credited to an expanding interest for poultry meat and egg items. Be that as it may, a noteworthy issue confronting the poultry industry is the vast scale gathering of squanders including compost and litter which may posture transfer and contamination issues except if naturally and monetarily reasonable administration innovations are advanced.**
The aim of this paper is to prepare a review about the techno-financial examination of the little scale incorporated gasification of poultry litter to offer ascent to both biochar and vitality items.

Index Terms- Poultry waste, litter, gasification, Economic Analysis, Energy potential etc.

I. INTRODUCTION

1.1 Background of the study

Gasification is a chemical procedure that believers carbonaceous materials like biomass into helpful advantageous vaporous powers or chemical feedstock. Pyrolysis, halfway oxidation, and hydrogenation are connected procedures. Combustion additionally changes over carbonaceous materials into item gases, however there are some essential contrasts. For example, combustion product gas does not have useful heating value, but product gas from gasification does. Gasification packs energy into chemical bonds while combustion releases it. Gasification takes place in reducing (oxygen-deficient) environments requiring heat; combustion takes place in an oxidizing environment giving off heat.

Biomass is formed from living species like plants and animals—that is, any-thing that is now alive or was a short time ago It is shaped when a seed grows or a life form is conceived. Not at all like fossil fuel, biomass does not take a large number of years to create. Plants use sunlight through photosynthesis to metabolize atmospheric carbon dioxide and grow. Animals grow by taking in food from biomass. Fossil fuels don't repeat while biomass does, and, thus, is viewed as inexhaustible. This is one of its real attractions as a wellspring of energy or chemicals .Poultry litter is characterized as a heterogeneous compound produced after a poultry production cycle, being the sum of the material used as bedding in association with the animal waste, dead skin, feed scraps, water, feathers and the resulting microbiota. The expansion of poultry production around the world has resulted in elevated generation of this residue. Over the years its use has been restricted to organic fertilizer or simply as a waste to be eliminated and disposed of in the environment. However, this mechanism has caused environmental and social damages due to its indiscriminate use. Because of the energetic and biological properties of poultry litter, its sustainable use as energy can be obtained via thermochemical processes such as anaerobic digestion and through combustion, gasification, pyrolysis or power co-generation systems, in which there is a combination of one or more processes. As a result, there is the potential for generating heat, electricity, fuel gas and biochar with low emission of pollutants. However, it is emphasized that there is no standard with regards to its composition and the source material type, where efforts are more focused on the contents of moisture and inorganic compounds. In this manner, forms that look to utilize poultry litter as fuel biomass ought to be all around controlled and effective for fruitful energy generation1

1.2 Biomass Conversion

The bulky and inconvenient form of biomass is a major barrier to a rapid shift from fossil to biomass fuels. Unlike gas or liquid, biomass cannot be handled, stored, or transported easily, especially in its use for transportation. This provides a major motivation for the conversion of solid biomass into liquid and gaseous fuels, which can be achieved through one of two major paths

(1) biochemical (fermentation) and

(2) thermochemical (pyrolysis, gasification).

Biochemical conversion is perhaps the most old-fashioned techniques for biomass gasification. India made methane gas for neighborhood vitality needs by anaerobic microbial assimilation of animal misuses. In present day times, a large portion of the ethanol for car fuels is created from corn utilizing maturation.

1.2.1 Biochemical Conversion

In biochemical conversion, biomass molecules are broken down into smaller molecules by bacteria or enzymes. This process is much slower than thermochemical conversion but does not require much external energy. The three principal routes for biochemical conversion are:

- Digestion (anaerobic and aerobic)
- Fermentation
- Enzymatic or acid hydrolysis

The main products of anaerobic digestion are methane and carbon dioxide in addition to a solid residue Bacteria get to oxygen from the biomass itself rather than from surrounding air. Vigorous assimilation, or fertilizing the soil, is additionally a biochemical breakdown of biomass, with the exception of that it happens within the sight of oxygen. It utilizes diverse kinds of microorganisms that entrance oxygen from the air, delivering carbon dioxide, warm, and a strong digestateIn fermentation, part of the biomass is converted into sugars using acid or enzymes. The sugar is then converted into ethanol or other chemicals with the help of yeasts. The lignin is not converted and is left either for combustion or for thermochemical conversion into chemicals. Unlike in anaerobic digestion, the product of fermentation is liquid.

1.2.2 Thermo-chemical Conversion

In thermochemical conversion, the entire biomass is converted into gases, which are then synthesized into the desired chemicals or used directly. The Fischer-Tropsch combination of syngas into fluid transport fuels is a case of thermochemical conversion. Generation of warm energy is the principle driver for this conversion course that has four wide pathways:

- Combustion
- Pyrolysis
- Gasification
- Liquefaction

Combustion includes high-temperature conversion of biomass in overabundance air into carbon dioxide and steam. Gasification, then again, includes a substance response in an oxygen-insufficient environment. Pyrolysis takes place at a relatively low temperature in the total absence of oxygen. In liquefaction, the large feedstock molecules are decomposed into liquids having smaller molecules. This occurs in the presence of a catalyst and at a still lower temperature. The biochemical course for ethanol generation is more financially created than the thermochemical course, yet the previous requires sugar or starch for feedstock; it can't utilize ligno-cellulosic stuff. As a result, a larger fraction of the available biomass is not converted into ethano In the thermochemical course, the biomass is first changed over into syngas, which is then changed over into ethanol through union or some different means

Gasification

Gasification changes over fossil or non-non-renewable energy sources (strong, fluid, or vaporous) into helpful gases and synthetic concoctions. It requires a medium for response, which can be gas or supercritical water (not to be mistaken for customary water at subcritical condition). Gaseous mediums incorporate air, oxygen, subcritical steam, or a blend of these.

By and by, gasification of fossil fuels is more typical than that of non-fossil fuels like biomass for generation of engineered gases. It basically changes over a potential fuel starting with one shape then onto the next. There are three noteworthy inspirations for such a change:

- To increment the warming estimation of the fuel by dismissing non-combustible parts like nitrogen and water.
- To remove sulphur and nitrogen such that when burnt the gasified fuel does not release them into the atmosphere.

- To reduce the carbon-to-hydrogen (C/H) mass ratio in the fuel.

In general, the higher the hydrogen content of a fuel, the lower the vaporization temperature and the higher the probability of the fuel being in a gaseous state Gasification or pyrolysis builds the relative hydrogen content (H/C proportion) in the item through one the followings implies:

Coordinate: Direct presentation to hydrogen at high weight.

Backhanded: Exposure to steam at high temperature and weight, where hydrogen, a middle item, is added to the item. This procedure likewise incorporates steam improving.

Pyrolysis: Reduction of carbon by rejecting it through solid char or CO_2 gas.

Gasification of biomass also involves removal of oxygen from the fuel to increase its energy density For instance, an average biomass has around 40 to 60% oxygen by weight, yet a helpful fuel gas contains just a little level of oxygen. The oxygen is expelled from the biomass by either parchedness or decarboxylation. The latter process, which rejects the oxygen through CO_2, increases the H/C ratio of the fuel so that it emits less greenhouse gas when combusted.

Biomass can convey about everything that fossil fuels give, regardless of whether fuel or compound feedstock. Furthermore, it gives two vital advantages that make it a reasonable feedstock for syngas creation .First, it does not make any net contribution to the atmosphere when burnt; second, its use reduces dependence on non-renewable and often imported fossil fuel.

For these reasons, biomass gasification into CO and H_2 provides a good base for production of liquid transportation fuels, such as gasoline, and synthetic chemicals, such as methanol. It also produces methane, which can be burned directly for energy production. Gasification is carried out generally in one of the three major types of gasifiers:

- Moving bed (also called fixed bed)
- Fluidized bed
- Entrained flow

Downdraft and updraft are two normal kinds of moving-bed gasifier. A study of gasifiers in Europe, the United States, and Canada demonstrates that downdraft gasifiers are the most widely recognized. It demonstrates that 75% are downdraft, 20% are fluidized beds, 2.5% are updraft, and 2.5% are of different outlines

1.3 Poultry litter

Poultry litter alludes to the material utilized by the poultry for bedding amid the generation cycle. The litter material is commonly sawdust, wood shavings, wheat straw, shelled nut bodies, or rice structures. During broiler production, the accumulating manure is mixed with the litter. To clean out the poultry manure, one must necessarily remove the litter also. Thus, poultry litter commonly denotes the mixture of bedding material and manure. Many management, environmental and physiological factors may influence poultry litter production and composition at a particular time and location. Content of the litter varied with the number of flocks grown on the same litter and, to a lesser degree, on the bedding material used. Production of litter is influenced by

(1) Age and breed of chickens,
(2) Density of confinement,
(3) feed conversion rate,
(4) Feed ration,
(5) Type and amount of bedding material,
(6) Moisture content of bedding material,
(7) Type of floor,
(8) Climatic conditions during litter accumulation, and
(9) Organic matter and N losses.

Significant variation of the constituent contents is possible, but a definitive study linking the various influential factors to litter production and quality has not been reported. The only reliable method for litter quality determination is thus by analysing the litter. The best wy of utilizing energy from Poultry litter is shown in figure 1.1

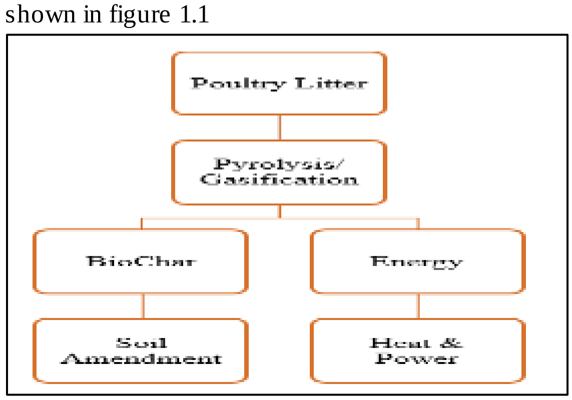

Figure 1.1 Products from Poultry Litter

II- LITERATURE REVIEW

Agrarian and forestry build ups are typically handled as squanders; else, they can be recouped to deliver electrical and warm energy through procedures of thermochemical conversion, such us torrefaction, pyrolysis and gasification. At present, the gasification of remaining biomass for delivering neutral CO2 fuel for energy creation is being developed stage.

Given the high volume generated by broiler poultry and due to shortage of energy sources and the high price of conventional sources, the use of poultry litter as biomass energy is becoming attractive and therefore it may become both technically and economically feasible.

Available literature on the use of poultry litter as biomass energy in industrial production units is still incipient. Recent studies indicate the efficiency of heat and energy production from poultry litter in locations near the waste-generating units.

The production of broiler chickens has been significantly growing throughout the world, and therefore the high generation of waste becomes a concern for the agricultural sector that increasingly seeks sustainable alternatives for the use of generated wastes. According to *P. Abelha et al; 2003*, poultry waste may be used for sustainable renewable energy generation, and methods should be explored due to its potential as a fuel and not simply as a waste to be eliminated, since its heterogeneous character may cause problems when indiscriminately disposed of in the environment. In this sense, it is necessary to seek measures for proper use of poultry litter for energetic purposes. The use of poultry litter as a sustainable fuel has been studied by various researchers some of them are discussed further.

some years for use in thermochemical conversions such as direct *A. Gaglianoa et al 2017* proposes an equilibrium-based model, developed by the commercial software Aspen Plus, of a co-current gasifier fuelled with agriculture residual, which allows estimating the chemical composition and the heating value of the syngas produced.

Poultry farm is not the best type of industry due to polluted wastes generated and foul smell emissions in various countries. However a 800,000 chicken egg-delivering ranch in the last bastion of cultivating land in Singapore called Lim Chu Kang has developed to defeat the space limitations, ecological administrative, supportability requests, generation efficiencies and environmentally friendly power energy push in bringing down the carbon impression. This organization has been the principal effective ranch in Singapore to change over chicken squanders into biogas as fuel to produce power. In doing as such, it has decreased the contaminated squanders and change it into energy toward independence, recouping waste warmth from the turbine deplete for drying of chicken feed. The power produced is up to 1 MW while the waste water in the oxygen consuming digester is dealt with and extricated the slime into dried cake for rural manures

The biogas is utilized to create warmth and power control the ranch's framework, including its new co-generation feed dryer. The digester alcohol is dealt with and treated water is reused for the underlying weakening of excrement to improve the absorption procedure. Slop experiences a belt press to isolate solids and fluid bringing about bio strong cake utilized for making manures. This coordinated framework guarantees that side-effects can be reused, limiting waste and diminishing discharge of ozone harming substances by adjusting biogas for green power creation. [Dr Liew Kian Heng; 2017]

The real worry about the generation of mechanical waste is identified with its effects on human wellbeing and nature. World poultry generation has had a quickened development as of late, thus did the waste created by this chain. Felipe Santos Dalolio et al; 2017 break down the qualities of poultry litter as fuel, talk about the fundamental thermochemical forms for its enthusiastic conversion and propose measures to enhance its execution as a supportable biomass. Agmar Ferreira et al 2017 give a diagram of the poultry butcher's present practices and the primary types of butcher waste transfer and preparing, and also to audit the writing on the legitimate part of the transfer strategy, subsequently thinking of conceivable energy distributions for this waste which increases the value of the chain's last item

Ismail Cem Kantarli et al; 2016 studied, conversion of wastes from poultry farming and industry into bio-char and bio-oil via thermochemical processes was investigated. Fuel attributes and substance structure of bio-burns and bio-oils have been examined utilizing standard fuel investigation and spectroscopic strategies Bio-roasts were made from poultry litter through both watery carbonization (sub-basic water, 175– 250°C) and pyrolysis over a temperature extend in the vicinity of 250 and 500°C. In contrast with aqueous carbonization, pyrolysis at bring down temperatures delivered biochar with more prominent energy yield because of the higher mass yield. Biochars procured by the two methods were equivalent to coal. Watery liquefaction of poultry devour at different temperatures (200– 325°C) was driven and stood out from update its methodology conditions. Higher temperatures favoured the formation of bio-crude oil, with a maximum yield of 35 wt. % at 300°C. The higher heating values of bio-oils showed that bio-oil could be a potential source of synthetic fuels.

The specialized, natural and monetary examination of creating power or potentially warm together with bio-scorch from poultry litter (PL) squander is the subject of this investigation. For this analysis, *Y. Huang et al 2014* utilize the process simulation software ECLIPSE. Modelling and simulation have been conducted over the configuration: combined updraft gasification and pyrolysis process integrated with an Organic Rankine Cycle (ORC). The office will at first be equipped for preparing 1500 kg of PL squander at 30% dampness content each hour The expansion plans of the facility are underway to deal with 3000 kg of PL waste per hour. Based on the results achieved, the key technical and environmental issues have been examined. Finally, an economic evaluation of the system is performed. The ECLIPSE multiplication shows that the yield of biochar conveyed in the updraft gasifier is around 415kg consistently and the creator gas is around 2052m3/hour with a calorific estimation of 4.45MJ/Nm3. Gross electric power generated by the ORC system is 391kWhe.Recovered low grade heat for space heating is estimated at 1822kWhth.

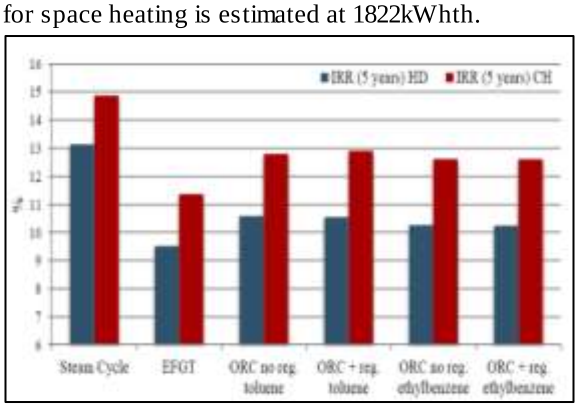

Figure 2.1 5-years Internal Rate of Return results for the selected CHP technologies (reported by Prof. Ssa Anna Stoppato 2015)

III. CONCLUSION

Poultry litter refers to the material used by the poultry for bedding during the production cycle. The litter material is typically sawdust, wood shavings, wheat straw, peanut hulls, or rice hulls. During broiler production, the accumulating manure is mixed with the litter. To clean out the poultry manure, one must necessarily remove the litter also. Thus, poultry litter commonly denotes the mixture of bedding material and manure. The following conclusion can be made on the basis of previous research

1. As the steam to biomass ratio increases CO increases, CO_2 and CH_4 decreases.
2. If consider the average efficiency of Electricity generation is about 45% then the total energy that can be generated after Syn gas combustion in a boiler is 954812 KWh appr energy can be generated by the waste which is higher than the need of the plant.

The various work has been carried out for the biomass gasification process for the poultry litter waste, there could be alternative way like hybrid generation, fuel cell etc, that can also be studied.

REFERENCES

[1] Gaglianoa, F. Noceraa, M. Brunoa, G. Cardilloa, 2017, “Development of an equilibrium-based model of gasification of biomass by Aspen Plus” Energy Procedia 111 (2017) 1010 – 1019

[2] Agmar Ferreira, Sheila S. Kunh, Paulo A. Cremonez, Jonathan Dieter, Joel G. Teleken, Silvio C. Sampaio, Peterson D. Kunh; 2017,“Brazilian poultry activity waste: Destinations and energetic potential”, Renewable and Sustainable Energy Reviews

[3] Billen P, Costa J, Van Der AaL, Caneghem JV, Vandecasteele C. “Electricity from poultry manure: a cleaner alternative to direct land application”. J Clean Prod 2015; 96:467–75.

[4] Dr Liew Kian Heng, “Bio Gas Plant Green Energy from Poultry Wastes In Singapore” World Engineers Summit – Applied Energy Symposium & Forum: Low Carbon Cities &

Urban Energy Joint Conference, WES-CUE 2017, 19–21 July 2017, Singapore

[5] D. R. Edwards & T. C. Daniel; 1992, "Environmental Impacts of On-Farm Poultry Waste Disposal a Review", Bio resource Technology 41 (1992) 9-33

[6] Felipe Santos Dalólio, Jadir Nogueira da Silvaa, Angélica Cássia Carneiro de Oliveirab, Ilda de Fátima Ferreira Tinôcoa, Rúben Christiam Barbosaa, Michael de Oliveira Resendea, Luiz Fernando Teixeira Albinoc, Suani Teixeira Coelhod, 2017, "Poultry litter as biomass energy: A review and future perspectives", Renewable and Sustainable Energy Reviews 76 (2017) 941–949

[7] Huang Y, Anderson M, Lyons GA, McRoberts WC, Wang Y, McLleveen-Wright DR, et al. Techno-economic analysis of biochar production and energy generation from poultry litter waste. Energy Proc 2014; 61:714–7.

[8] Ismail Cem Kantarli , Arzu Kabadayi , Suat Ucar, Jale Yanik ; 2016, "Conversion of poultry wastes into energy feed stocks", Waste Management 56 (2016) 530–539

[9] Jamison Watsona, Yuanhui Zhang, Buchun Sia, Wan-Ting Chena, Raquel de Souza, 2018, "Gasification of biowaste: A critical review and outlooks", Renewable and Sustainable Energy Reviews 83 (2018) 1–17

[10] Lynch D, Henihan AM, Bowen B, Lynch D, Mcdonnell K, Kwapinski W, et al. "Utilization of poultry litter as an energy feedstock. Biomass Bioenergy" 2013; 49:197–204.

[11] Mahsa Baniasadi, Alessandro Tugnoli , Roberto Conti , Cristian Torri , Daniele Fabbri , Valerio Cozzani; 2016, "Waste to energy valorisation of poultry litter by slow pyrolysis", Renewable Energy 90 (2016) 458-468

[12] Muhammad Arshad, Ijaz Bano, Nasrullah Khan, Mirza Imran Shahzad, Muhammad Younus,Mazhar Abbas, Munawar Iqbal, 2018, "Electricity generation from biogas of poultry waste: An assessment of potential and feasibility in Pakistan", Renewable and Sustainable Energy Reviews 81 (2018) 1241–1246

[13] N.S. Bolan, A.A. Szogi, T. Chuasavathi, B. Seshadri,M.J. Rothrock Jr.And P. Panneerselvam, 2010; "Uses and management of poultry litter", World's Poultry Science Association 2010

[14] P. Abelha, I. Gulyurtlu, D. Boavida, J. Seabra Barros, I. Cabrita,J. Leahy, B. Kelleher, M. Leahy, 2003, "Combustion of poultry litter in a fluidised bed combustor", Fuel 82 (2003) 687–692

[15] Pieter Billen, José Costa, Liza Van der Aa, Jo Van Caneghem, Carlo Vandecasteele; 2014, "Electricity from poultry manure: a cleaner alternative to direct land application" Journal of Cleaner Production