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Development Perspectives for Biogas Production from Animal Manure in Iraq

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Abstract: Both the developing and developed worlds have witnessed the rapidly increasing in energy demand since the energy crisis in the beginning of 1970s. Since then many countries, which do not have large reserve of crude oil or natural gas have put much effort into utilizing renewable energy as an alternative. Agricultural operations and livestock production are among the important economic activities in the world. But the great majority of energy demand of the agricultural enterprises is still supplied by conventional energy sources. One of the main renewable energy resources is biomass which has been utilizing by people for over 200 years. The main uses of biogas are for cooking, lighting homes, manure and as fuel for cars. This study aims to investigate the biogas potentials which can be produced by the waste of livestock and poultry in Iraq. Also, giving reliable information to both decision makers and industry developers is another goal for this research. In this study, the amount of animal manures, have been analyzed. Then, the amount of energy that can be generated from this resource has been calculated based on their availability in certain geographical areas.

Keywords: Biogas production, Animal manure, Green environment

Energy demand has been increasing in the last five decades which was the catalyst to push other countries to take giant steps in utilizing renewable energy. Climate change, the main cause of green gas emissions, is another reason of pushing up sustainable development. In addition to that, the increasing in oil price, the possibility of oil depletion, and the exponentially growth of the world pollution have further accelerated the utilization of renewable energy (Alhelal 2015). There is increasing consensus in both the scientific and political communities that significant reductions in greenhouse gas (GHG) emissions are necessary to limit the magnitude and extent of climate change. Renewable energy systems already reduce GHG emissions from the energy sector, although on a modest scale. Most long-term energy projections show that renewable energy will play a major role in the global energy supply in the second half of the century, with capacity increasing gradually in the first three decades (Bilen et al 2008)

Biomass, which is defined as organic materials derived from plants and animals that can be renewed over time (Energy 2005), is amongst the available renewable energy resources. This type of energy is the product of photosynthesis process in which plants utilizes solar energy to breakdown carbon dioxide, release oxygen, and store carbon in the mass. Animal manure can also be considered as a biomass as well. The environment friendly biogas production which reduces the production costs in agricultural enterprises, is becoming more and more important. Animal manure, energy plants and agricultural organic wastes can be used as sources of biogas in the farms (Ayhan 2015).

With the case of Iraq, biomass resources are available in most regions. These resources are agricultural residues, urban wastes, animal manures, and forests residues and by products. Discussed that there are different sources of renewable energy in Iraq which includes on-shore and off-shore wind power, solar power, and biomass. With regards to biomass resources, also addressed the possibility of producing bio-ethanol from dates, sugar cane, and corn (Chaichan 2012). As an initial investigation, it is worth noting that a portion of the data used in this paper has been collected from the literatures published in the areas of agriculture resources, crops production, animal manure, forests residues, and domestic and industrial waste (Jaradat 2002, FAO 2014, Magid 2003, Spencer and Schnittker 2009, Annepu 2015). Methane (CH_4), Carbon dioxide (CO_2), some other minor constituents like nitrogen, ammonia (NH_3), sulfur dioxide (SO_2), hydrogen sulfide (H_2S) and hydrogen are the main components of biogas. The more methane percentage in biogas means more useful energy can be produced. Various parameters have a major influence on methane formation such as moisture content, percentage of organic matter, pH and temperature. This means a good quality gas for energy generation can be obtained by controlling these characteristics (Wright and Overend 2007).

MATERIAL AND METHODS

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biomass resources are available in most regions (Chaichan 2012). These resources are agricultural residues, urban wastes, animal manures, and forests residues and by products. As an initial investigation, it is worth noting that a portion of the data used in this paper has been collected from the literatures published in the areas of animal manure (Jaradat 2002, FAO 2014, Magid 2003, Spencer and Schnittker 2009, Annepu 2015).

Livestock is one of the major features and has always been an important source of income for the traditional farmers in Iraq, as a result of that many animal farms have been set up all over Iraq since the ancient time. However, the number of animals stock have showed a downward trend since the second golf war in 1990. In further details, the number of camels, chickens and buffalos has fallen significantly by almost 87%, 72% and 57%, respectively. While the number of other type of castles such as horses, asses, mules, goats and sheep have also gradually decreased (Magid 2003). There are several factors which affect the amount of waste and biogas obtainable during livestock operations. These factors include the type and age of animal, body weight, type of breeding, total solids ratio, volatile solids ratio and the availability of waste and biogas yields (Antonia et al 2013).

Calculation method: In order to obtain the amount of biogas and the other products that can be produced from animal manure, the related data and conversion coefficients have been used. These data are the number of cattle, sheep, goats, camels, horses, chicken, asses, buffaloes, and mules. To calculate the potential biogas that can be produced from animal manures, various conversion coefficients, which are listed below, were employed.

Cattle/horse/camel: 3.6 t unit^{-1} year^{-1}; sheep/goat: 0.7 t unit^{-1}year^{-1}; poultry: 0.022 t unit^{-1}year^{-1}; donkey 2.9 t unit^{-1}year^{-1} (adopted from Tatlidil et al 2009).

To convert animal manure to biogas, the coefficients of 33 m^3 year^{-1} t^{-1} for cattle/horse/camel, 58 m^3 year^{-1} t^{-1} for sheep/goat, 78 m^3 year^{-1} t^{-1} for poultry, and 26 m^3 year^{-1} t^{-1} for donkey were used as conversion coefficients (adopted from Tatlidil et al 2009).

The following coefficients were used for calculation of biogas equivalents (adopted from Tatlidil et al 2009) gas oil: 0.62 L, charcoal: 1.46 kg, wood: 3.47 kg, butane: 0.43 kg, dry cow manure: 12.3 kg, electricity: 4.7 kWh, diesel fuel:0.66l, fuel: 0.75l, and propane: 0.25m^3

Table 2 shows the numbers of animals in Iraq and the equivalent amount of electricity that may be produced from the manure. It is worthy of mentioning that, Table 2 has been calculated based on several reliable assumptions, which has been utilized by many researchers (Tatlidil 2009).

RESULTS AND DISCUSSION

There are various advantages of utilizing animal manures such as producing biogas, organic fertilizer which can then be used to enrich soil composition, socio-economic impact, and environmental impact. Based on the tables above, about 892,263,400 m^3 of biogas can be produced in compliance with the number of livestock and poultry waste. Cattle and sheep manures have the biggest proportion in the potential of biogas production. Then, poultry and goats follow this, recording 65,208,000 and 64,960,000 m^3 of biogas, respectively.

As shown in Table 2, biogas coefficients such as gas oil, butane, diesel fuel, fuel, and propane have been calculated based on the conversion coefficients which adopted from (Tatlidil et al 2009). Thus, 553203308l of gas oil, 383673262 kg of butane, 588893844l of diesel fuel, 669197550l of fuel, and 223065850 kg of propane can be obtained from biogas using conversion coefficients. For electricity sector,

Table 1. Biogas production potentials

Animal type	Population (head^{-1})	Manure ton year^{-1} (head^{-1})	Animal manure (ton year^{-1})	Coefficient of biogas (ton m^{-3})	Biogas m^3	Electricity KWh
Cattle	2780000	3.6	10008000	33	330,264,000	1552240800
Sheep	8250000	0.7	5775000	58	334,950,000	1574265000
Goats	1600000	0.7	1120000	58	64,960,000	305312000
Camels	65000	3.6	234000	33	7,722,000	36293400
Horses	52000	3.6	187200	33	6,177,600	29034720
Asses & Mules	391500	3.6	1409400	33	46,510,200	218597940
Poultry	38000000	0.022	836000	78	65,208,000	306477600
Buffaloes	307000	3.6	1105200	33	36,471,600	171416520
Total					892,263,400	4193637980

Table 2. Biogas equivalents (Ozturk 2005) addressed that each 1 m^3 of biogas can be lighten lamb for 6 hours, to cook three meal for a family, to start an engine for 6 h, and to generate 1.25 KWh electricity

Animal type	Biogas m^3	Gas oil (l)	Butane (kg)	Diesel fuel (l)	Fuel (l)	Propane (kg)
Cattle	330,264,000	204763680	142013520	217974240	247698000	82566000
Sheep	334,950,000	207669000	144028500	221067000	251212500	83737500
Goats	64,960,000	40275200	27932800	42873600	48720000	16240000
Camels	7,722,000	4787640	3320460	5096520	5791500	1930500
Horses	6,177,600	3830112	2656368	4077216	4633200	1544400
Asses	46,510,200	28836324	19999386	30696732	34882650	11627550
Poultry	65,208,000	40428960	28039440	43037280	48906000	16302000
Buffaloes	36,471,600	22612392	15682788	24071256	27353700	9117900
Total	892,263,400	553203308	383673262	588893844	669197550	223065850

According to the International Energy Agency (2012), electricity consumption in Iraq in 2010 was approximately 57 terawatt-hours and the demand is predicted to increase roughly three-fold in 2035, which noticeably shows a sharp upward trend during the first quarter of this century. The equivalent electricity which can be generated from the total amount of biogas production is 4.193 TWh. This means that utilizing the total amount of animal manures can cover about 6.9% of the total electricity consumption in Iraq.

Socio-economic impact: The utilisation of biomass resources will certainly attract both domestic and foreign investments to the country. As a result, this will help Iraq increasing its job opportunities and reducing the national unemployment rate, which is currently 15.01% (Iraq Unemployment Rate n.d). Furthermore, Iraq's dependency on foreign energy sources can be reduced once a local biomass to energy production takes place. Moreover, utilizing biomass resources in rural areas could have positive impacts on rural regions development as well as boosting the agricultural development which has not received much investment since 1990. This development may include utilising new technologies in agriculture as well as improving the farmer's life quality. In addition to that, the general public may also access biofuels, which has been proven to produce less emission compared to fossil fuels. On the other hand, despite the fact that there are a various advantages of having a diversity of biomass resources, the increasing of this development could affect adversely on countryside societies. According to (Milbrandt 2009) quoting from World watch institute study, plantations, which have poor wages and working conditions, have had most jobs. Also, local people who live in extensive monoculture plantations could also be affected due to rarity of the wood and food resources.

Environmental impact: It is undeniable that many environmental benefits can be achieved from the use of the biomass resources such as offset greenhouse gases emissions, utilize the waste, and control the erosion. (Overend 2011) stated that roughly 1.6 ton of CO_2, which causes global warming and increases its concentration in the atmosphere, can be displaced for every MWh of biomass power. Therefore, if the use of the biomass resources was under a proper management, that would have a great role in reducing CO_2 emissions. It is worthy of mentioning that, Iraq has witnessed an increasing in the amount of CO_2 emissions recently. Figure 11 shows how the amount of CO_2 emissions has been increasing since the beginning of the twenty-first century. The graph shows an upward trend from 1980 to 2012. Also, the amount of CO_2 emissions is sharply increased during the period from 2000 and 2012.

On the other hand, using improper managed biomass resources could also lead to the negative environmental influences such as deforestation, biodiversity limitation, and soil erosion. Reverse greenhouse gas emissions can be effected by clearing the land from the crops (deforestation), which is usually done by burning and logging. The burning process releases the CO_2 which is the principal cause of global warming. Also, after the land being removed, crops and trees will no longer contribute in carbon storage. Furthermore, deforestation contributes in both soil erosion and reduces the biodiversity.

CONCLUSION

Although both bovine and hen rearing is developed province, the existing potential cannot be effectively used in terms of benefitting from biogas production capacity. Considering animal waste potential and agricultural land holding of Iraq, making biogas facilities widespread, especially in rural areas, will bring economic benefits for the farmers. The results show a promising opportunity to utilize this type of clean energy. Unfortunately, Iraq still gives a back-seat for renewable energy due to its dependency on

fossil fuel plants. The chief job for this study was to shed the light on the possibility of utilizing animal manure in producing biogas and its equivalents. Also, various advantages can be obtained in several sectors such as agricultural, socio-economic and environmental sectors.

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