International Journal of Engineering Research
Volume No.7, Issue Special 4, pp : 546-549
ISSN:2319-6890 (online),2347-5013(print)
9,10 March 2018

Hybrid Electrical Supply System for Environmental Well Being

Praful Patidar, Shailendra Goswami
Electrical Department, Government Engineering College, Banswara, India

Abstract: In this Communication, authors have been used the rural agricultural waste to energy production and its effect on reduction of air pollution. In rural areas, wastage is available in form of rice husks, sugarcane bagasse (for biomass), animal dung (for biogas) etc. It can be utilized in form of renewable bio energy to produce electrical energy. Biomass producer gas can be used in a hybrid system along with diesel to fulfil the power need of rural area with less carbon emission. It can be standalone or grid connected system. Dual fuel generator with diesel and biogas/syngas is a favorable solution for emergency power backup, energy crisis and also to reduce pollution. The cost analysis is also presented based on load calculation and available waste case study.

Keywords: Environmental Pollution, Distributed generation, Diesel generator, Bio energy, Hybrid system.

I. Introduction

The increasing demand for energy, the continuous reduction in existent resources of fossil fuels and the growing concern regarding environmental pollution have compelled mankind to explore new production technologies for electrical energy using clean renewable sources such as biogas and biomass energy, solar energy, wind energy, etc.

Among the electric power technologies using renewable sources are clean, green, silent and reliable, with low maintenance costs. Along with these advantages, however, electric power production systems using as primary sources exclusively solar and wind energy pose technical problems due to uncontrollable wind speed fluctuations and to the day night and summer winter alternations. As a consequence, in continuous region, the power supply continuity of a local grid should be backed-up by other reliable and non- fluctuate sources of primary energy, such as diesel generator sets. Such systems, designed for the decentralized production of electric power using combined sources of primary energy, are called hybrid systems. Diesel generator sets also used for emergency region in conventional sources energy like nuclear plant. Diesel generator set used for feed power in isolate region as well as an emergency region. The increased interest in using of diesel generator sets as the main energy source in isolated areas or as an stand by source in the case of renewable-based power systems can be observed by the great number of papers and studies carried out in this area. The research conducted in this domain refers to aspects such as island operations of diesel generator sets [3], simulations of diesel/pv/wind hybrid power systems [4][5],etc.
The topic proposed in this paper refers to the development of numerical models for the simulation of the operation region of diesel generators integrated as a back-up energy source in hybrid power systems as back-up energy source. The dynamic analysis is completed by the help of Simulation tool.

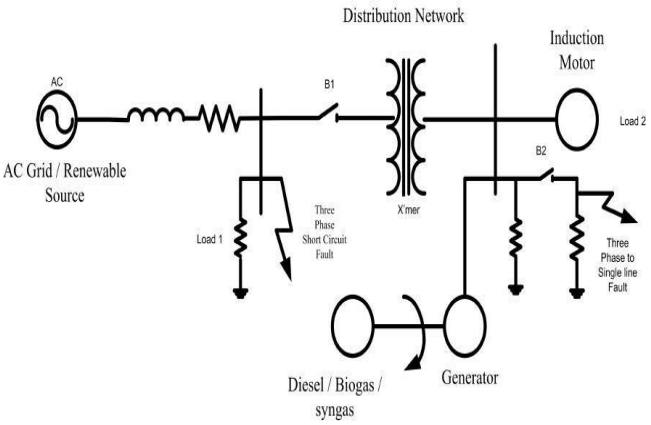

Figure 1.1: Schematic diagram of project work

II. Utilization of Biomass as Engine Fuel

As of 31 January 2014, India had an installed capacity of about 31.15 GW of non-conventional renewable technologies-based electricity, about 13.32 % of its total. Total Installed Capacity of Bio Energy as of 31,January 2014 is 4479.85 MW.

Table 2.1: Overview of biomass energy

Source	Type	Capacity
Biomass Power and Gasi cation	Grid-connected	1285.60 MW
Bagasse Cogeneration	Grid-connected	2512.88 MW
Non - Bagase Cogeneration	Off -grid	517.34 MW
Rural Biomass Gasi er	Off -grid	17.63 MW
Industrial Biomass Gasi er	Off -grid	146.40 MW

India produces about 600 million tonnes of agricultural residues (mainly rice husks, paddy straw, sugarcane waste, wheat residues and cotton stalks), of which 300 million tonnes

ISSN:2319-6890 (online),2347-5013(print)
9,10 March 2018

are unutilized and are disposed of by burning in open fields thus creating environmental hazards. Diesel engine is capable of successful running in duel fuel mode of operation with suitable biomass in gasifier. This study presents engine performance using rice husk, rice straw, cotton stalks and bagasse as biomass fuel in downdraft gasifier in dual fuel mode. Power Generation application on 100 % producer gas based system Rs. 15 lacs per 100 KW.

As the engine had to be fuelled with syngas or biogas, the unit was fed with laboratory blends contained in specific tanks for compressed gasses. In Table 2.2 and 2.3 the standard composition and lower heat content for a syngas and biogas (anaerobic process) are reported, both derived from standard biomass and with the percentage in volume of the different components[6].

Table 2.2: Standard composition for a biogas (Anaerobic) from Biomass

CH_4	CO_2	Others	L.H.C MJ=NM^3
62.0	35.0	3.0	23.0

Table 2.3: Standard composition for a syngas from biomass

CH_4	CO_2	H_2	CO	Others	L.H.C MJ=NM^3
7.0	41.0	23.0	20.0	9.0	13.0

2.1 Experimental work on engine

In biomass gasi er (5 kW, Kirloskar, single cylinder, four stroke engine with 1500 rpm), biomass was fed through feed door and stored in hopper (Fig.2.1). Throat (or hearth) ensures relatively clean and good quality gas production. Grate holds charcoal for reduction of partial combustion products while gas outlet is connected with engine via venturi scrubber, separator box cum ne filter and check filter with an air control valve to facilitate running of engine in dual-fuel mode[7].

Table 2.4: Characterization of fuels[4]

Biomass	Ash %	C %	H %	N %	O %	S %	Calorific value, MJ/kg
Cotton stalks	6.68	43.64	5.81	0	43.87	0	17.4
Bagasse	4.27	44.80	6.20	0.20	44.40	0.01	18.11
Rice husk	17.60	38.30	4.80	0.34	35.45	0.03	14.4
Rice straw	10.70	42.30	5.60	0.90	40.50	0.02	11.7
Wood Chips	3.20	48.60	5.56	0.60	41.46	0.03	17.4

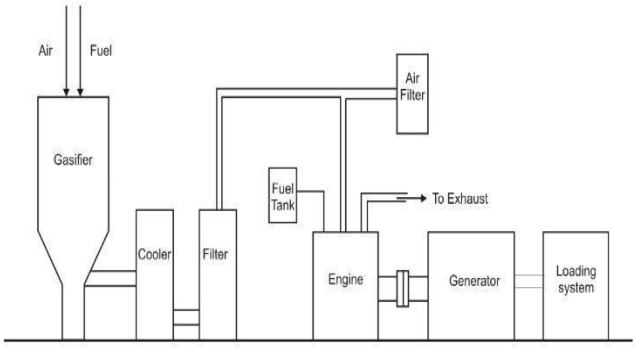

Figure 2.1: Schematic arrangement of experimental set up[4]

Dust particle of gas also removed by passing through gas lter. To contol of gas valves were provided in passage of gas and air ow. A single cylinder naturally aspirated direct injection four- stroke diesel engine coupled with generator was used for power generation. Dual fuel mode of operation was carried out by supplying gas to combustion chamber of engine through inlet manifold. Gas control valve is opened gradually to feed gas into engine. Also, engine governor control knob is closes to dual fuel position, to decrease amount of diesel when sound becomes normal. With rotation of gas valve, optimum adjustment of gas and diesel is made.

2.2 Result and analysis of energy cost

As producer gas is increased, there is a decrease in diesel consumption. Hence, higher diesel substitution in dual fuel mode of operation is achieved opening producer gas valve fully so that higher amount of producer gas flow will replace higher amount of diesel. Sugar cane bagasse fuel replaced maximum diesel (82 %) at 3 kW load followed by cotton stalks fuel (80 %). As gas flow is increased in cotton stalks fuel, diesel substitution varies from 60.58 - 79.79 %, maximum diesel substitution is obtained at full opening of gas flow valve. Wood also replaces a little more diesel (80-85%) as both fuels have same characterization properties. Sugar cane bagasse for producer gas generation in gasifier showed maximum diesel substitution (82.1 %) in dual fuel mode. As compared to cotton stalks and sugar cane bagasse, diesel displacement in case of rice husk as fuel is very less (33.36-59.74%), because presence of small quantities of C (38.3 %) and H (4.5%) and also very high ash content, which creates hindrance in producer gas generation. Rice straw gave minimum diesel replacement (47%), due to nitrogen present in rice straw that dilutes producer gas quality and also ash content being very high creating hindrance in production of producer gas. Energy costs (Fig. 2)to produce 1 kWh energy (at 3 kW load), cost associated with drying, collection, storage and transportation of biomass fuels is given as[4]

Energy cost (Rs/kWh) = (cost of diesel x diesel consumption) + (cost of biomass x producer gas consumption)
(2.1)

ISSN:2319-6890 (online),2347-5013(print)
9,10 March 2018

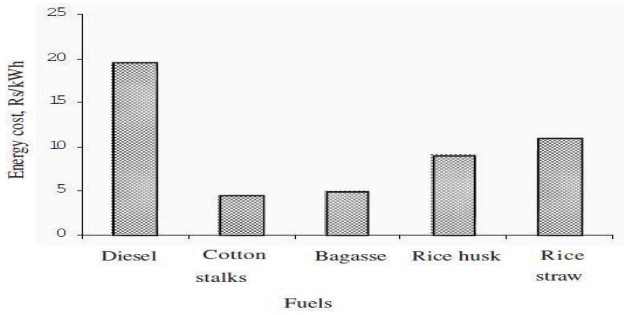

Figure 2.2: Energy cost of fuels[4]

Looking into energy costs, sugar cane bagasse is higher than cotton stalks but its diesel replacement is more than cotton stalks, because cost of bagasse is higher than cotton stalks. Diesel engine generator is capable of successful running in dual fuel mode of operation with suitable biomass in gasifier because of fuel is already available. To produce 1 kWh of energy, 630 ml diesel was used at Rs 19.55. Maximum diesel replacement in dual fuel mode of operation using cotton stalks in gasifier was 80 %. To produce 1 kWh of power energy, cost associated was Rs 4.46. Maximum diesel replacement in dual fuel mode of operation using sugar cane bagasse in gasifier was 82%. To produce 1 kWh of power energy, cost associated was Rs 4.82. Maximum diesel substitution in case of rice husk was 60% and to produce 1 kWh of power energy, cost associated was Rs 9.00. Maximum diesel replacement in case of rice straw was 47 % while to produce 1 kWh of power energy, cost associated was Rs 10.97. Hence, power generation cost while using biomass is cheaper than conventional power generation cost.

2.3 Energy cost analysis

Electricity can be generated using gasifiers either using DG set or using suitably modified natural gas engines/ producer gas engines. The energy cost(Rs/kWh) analysis of two types of mode in generator set are discussed below-

2.3.1 Dual fuel mode

In this the Gasifier is connected to a diesel generator and the generator is suitably modified. In this case up to 70 % diesel replacements are obtained. To generate 1 unit of electricity .08 -0.1 liter of diesel and 0.9 kg of wood or 1.4 kg of rice husk would be needed. Depending on the costs of these (wood chips, rice husk) the fuel cost of generation can be calculated. Savings obtained when a gasifier is coupled to a diesel genset is determined by this calculation.

The cost of 1 liter of diesel is Rs 55.15 and assumed the cost of 1 kg of wood or rice husk is Rs 5. One liter of diesel gives 3.5 units of electricity. Thus fuel cost of generation for 1 unit of electricity (with diesel alone) is around Rs 15.75. For generating a unit of power when the generator set is connected to the gasifier we need 0.08 -0.1 liter of diesel and 0.9 kg of wood or 1.4 kg of rice husk. If we considered the data(for rice husk) then using equation 2.1

Energy
cost(Rs/kWh)= (0.1 *
55.15) + (1.4 * 5)
Energy
cost(Rs/kWh)=
12.515

the fuel cost of generation for 1 unit of electricity is INR 12.515.

2.3.2 100% Producer gas mode

Here the Gasifier gets connected to a gas engine generator set(modi ed). Biomass produced gas(producer gas) is directly given as fuel to generator(no diesel) known as 100% producer gas engine. To generate 1 unit of electricity it required 1.3 kgs of wood or 1.8 kgs of rice husk. Savings obtained when a gasifier is coupled to a gas genset is determined by this calculation, using equation 2.1

Energy
cost(Rs/kWh)=
(1.3 * 5) + (1.8
* 5) Energy
cost(Rs/kWh) =
15.5

The cost of 1 kg of wood or rice husk is assumed around Rs 5. So, the cost of generate 1kWh energy is Rs 15.5. The cost of 1kWh energy of 100% Producer gas is high because of the cost of rice husk and wood is assumed equal to Rs 5. If the cost is less of rice husk and wood the cost of 1 kWh is also less.

2.4 Sustainability of modified gas engine

Where there is no possibility to connect to the grid (e.g. the electric energy supply of households, holiday houses, isolated objectives, equipment in industrial sites, electric installations for outdoor entertainment events, military equipment, telecommunications, etc.), or as emergency regime, as a reserve electric power source, in the event of electric power blackouts. In emergency regime the diesel generator sets usually supply only vital consumers, like re pumps, elevators, safety lighting installations, banks, hospitals, government buildings, offices, mobile towers, supermarkets and large restaurants, hotels, malls, stadiums, airports, fuel stations, private houses, and indus-trial sites where specific processes do not allow for blackouts, become uncontrollable or generate important losses without electric power, etc. Usually, in parallel with diesel generator sets, UPS systems are used, with a bu er, able to ensure for short periods the continuity of power supply for vital consumers, until the diesel generator sets are started-up. The minimum combined time necessary for the detection of a grid voltage drop, the start-up of internal combustion engine, reaching the stabilized regime of the generator (frequency and voltage) and the load connection is typically at least in few seconds. In the case of power systems based on renewable energies, given the fluctuate character of unconventional energy sources, diesel generator sets takes on particular importance, their role being to ensure the continuity of electric power for the local grid during periods when the renewable sources of energy become unavailable or insuffcient. Advantages of this modified gas engine[9] compair to diesel generator is-

ISSN:2319-6890 (online),2347-5013(print)
9,10 March 2018

- Social well being
- Economic well being
- Environmental well being
- Technology well being

III. Discussion

Diesel generator set is combination of prime mover, excitation system and generator so speed and voltage are required to maintain to operate system in stable condition.

ˆ Diesel generator set increases the reliability of the system with renewable sources in case of stand by operation and DG also used as primary source of supply electricity to vital load and it is reliable for continuous supply to vital load.

ˆ Normally DG rating are small hence they offer better system performance while connected in distributed manner.

ˆ This is especially suitable in remote areas and villages where power quality and reliability is a matter of concern.

IV. Future Scope

Diesel generator are used as backup supply system but

- Dual fuel type like diesel and gas (syngas) DG engine will impact less on environment and improves reliability of system.
- Use like bagasse, rice husk, wood chips, cotton stalks etc different type of fuel to replacement of diesel in DG set so per kWh energy cost also reduced.
- Involving power electronics system to further improve the performance of the system.

Bibliography

i. Robert J. Best, D. John Morrow, David J. McGowan and Peter A.Crossley,\Synchronous Islanded Operation of a diesel Generator", IEEE TRANSACTION OF POWER SYSTEM, VOL.22,NO.4,NOVEMBER 2007.

ii. S. Krishnamurthy, T.M. Jahns, and R.H. Lasseter,\The Operation of Diesel Gensets in a CERTS Microgrid", inConf. Proceed. of 2008 IEEE Power and Energy Society General Meeting - Conversion and Delivery of Electrical Energy in the 21st Centruy, pp. 1-8, July 2008.

iii. Tiberiu Tudorache, Cristian Roman,\The Numerical Modeling of Tran-

iv. sient Regimes of Diesel Generator Sets", Acta Polytechnica Hungarica. Vol.7,No.2,2010.

v. Ashish Malik, Lakhwinder Singh and Indraj Singh,\Utilization of biomass as en-gine fuel",Journal of Scienti c and Industrial Research. Vol. 68, October 2009,pp. 887-890.

vi. T. Theubou, R. Wamkeue and I. Kamwa.\Dynamic Model of Diesel Generator Set for Hybrid Wind-Diesel Small Grids Applications", IEEE Canadian Con-ference on Electrical and Computer Engineering(CCECE)2012: Montreal, QC, Canada.

vii. Yao lian-fu, Liu Qian, Li Shi and Zhang Zhen-yu.\Simulation and Dynamic Pro-cess Analysis of Nuclear Emergency Diesel Generators". International Conference on Informatics, Cybernetics, and Computer Engineering (ICCE2011) November 1920, 2011, Melbourne, AISC 112,pp 107-115.

viii. Aparna Pachori, Payal Suhane.\Design and Modelling of Standalone Hybrid Power System with Matlab/Simulink",International Journal of Scienti c Re-search and Management Studies(IJSRMS), ISSN:2349-3771.

ix. Aparna Pachori, Payal Suhane.\Design and Modelling of Standalone Hybrid Power System with Matlab/Simulink",International Journal of Scienti c Re-search and Management Studies(IJSRMS), ISSN:2349-3771.

x. Biomass Gasi cation Based Power Generation by Arashi Hi-Tech Bio- Power Private Limited.

xi. MNES Annual Report 2002-2003 (Ministry of Non-Conventional Energy Sources, Govt of India, New Del