International Journal of ChemTech Research
CODEN(USA): IJCRGG ISSN : 0974-4290
Vol.5, No.2, pp 761-764, April-June 2013

ICGSEE-2013[14th – 16th March 2013]
International Conference on Global Scenario in Environment and Energy

Waste Water Treatment of Biomass based Power Plant

Lata Tripathi[1], Anil Kumar Dubey[2], Sandip Gangil[2] and P L Singh[3]

Agricultural Energy and Power division, Central Institute of Agricultural Engineering, Nabibagh, Berasia Road, Bhopal (India)-462038

Corres.author: dubey@ciae.res.in,

Abstract: The power generation from biomass requires the water to clean the producer gas for use in engines. The water used as cleaning agent gets contaminated with organic and inorganic compound and becomes highly polluted. The study was conducted to develop low cost water treatment plant to enhance water use efficiency by increasing the recycling duration. The charcoal received from gasifier was thermally treated for its activation and used to treat the waste water. The study reviled that 0.5 to 1.0 cm charcoal with 35 cm bed height was found effective for reduction in turbidity and COD present in the effluent water of biomass based power plant.
Keywords: *Activated charcoal; Biomass gasifier; COD; Phenolic compounds; Turbidity.*

1. Introduction

The producer gas generated from biomass gasifier use in engine for power generation. Wet scrubbing is often chosen to remove impurities present in gas like organic components (tars) and particulate matter and to cool the gas. The cooling and cleaning of producer gas results in the generation of waste water as an effluent[1]. The waste water from gasifier based power plant contains phenolic and terry materials. The disposal of this contaminated water creates environmental problems and needs adequate pretreatment before its discharge into natural stream. The byproducts of gasifier are ash, charcoal and terry materials. The quantity of ash depends on the raw material used for gasification and quantity of char depends on the design of gasifier and ash removal system. The waste (ash + char + tar) generated from power plant are varied from 5 to 20 % of fuel used. The highest amount of waste was found in rice husk gasifier and minimum in case of wood based gasifier[2,3]. Producer gas contains significant amount of tars, soot and ash. These contaminants must be removed from the producer gas before its use as fuel in internal combustion engines. The gas cleaning of biomass gasification plant (BGP) is performed indifferent systems, including water scrubbers and filters[3]. The water flow required for cleaning of gas varies from 600-1800 l/h. This, in turn, leads to the generation of tar, ash and contaminated water.

The wastewater generated from BGPs consists of organic component in the form of tar as well as inorganic compounds. The tar removed from gas considered as a mixture of several acidic, basic and neutral compounds. The acidic components include acids and phenols, basic include poly aromatic compounds (PAHs). The main component of inorganic residues is ammonia and small concentrations of H2S and chlorides[4,5]. The normal practice used in cleaning of gas is to recirculate the effluent water to minimize its requirement. The recirculation of water further increases the quantity of harmful contaminants. The water treated to make it pH neutral and to removal of suspended solids, total dissolved solids, alkalinity, ammonia, and

phenol[6,7]. Vrajesh at al. [8] treated tar-containing wastewater using lime and alum for the removal of in-organics, followed by adsorption on powdered activated carbon (PAC) for the removal of organics. Wastewater was also treated by several coagulators like ash, and granular activated carbon (CAC) in order to increase the treatment efficiency of power plant[9,10]. The present study was undertaken to develop the low cost treatment process to enhance the cleaning efficiency of recycled water and its safe disposal into natural stream.

2. Methodology

The study was done on biomass gasification based power plant of 22 kW coupled with water scrubber for treatment of producer gas. The effluent water of power plant was collected in water tank of 5000 liters capacity for recycling in the scrubber. The contaminated water collected from tank were analyzed and treated with charcoal. In contaminated water pH, total suspended solid (TSS), total dissolved solid (TDS), turbidity, alkalinity, COD were analysed before and after the treatment with charcoal. The study was carried out to use waste charcoal of different size and in different bed height.

An experimental setup to treat the tar-contaminated water with activated charcoal was prepared as shown in figure 1. Water collected from gasifier was passed through the cylindrical jar packed with charcoal from upper end and received from lower end then different parameters like pH, turbidity, colour, alkalinity and COD were determined before and after filtration. The charcoal partial size, bed height were optimized for treatment of water.

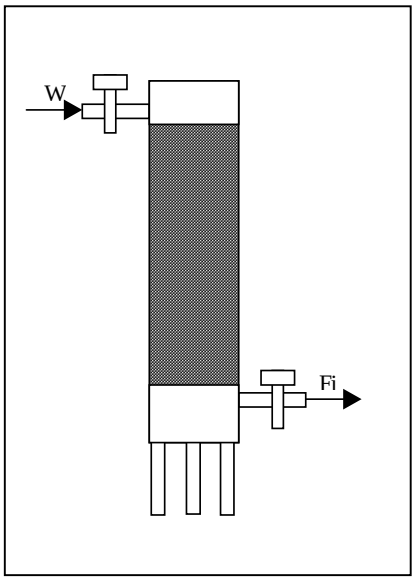

Figure1. Schematic Diagram of Experimental Setup for Filtration of Wastewater

The char received along with effluent of gasifier were cleaned and treated for its activation at different temperature. The activation level of charcoal is assessed by measuring the Iodine value. American standard test method (ASTM D4607-94) was used for determination of iodine number of activated carbon.

3. Results and Discussion

3.1 Physical Properties of Char

The char mixed with ash was washed to remove the ash from mixture. The physical properties of char like size, bulk density and true density was analysed. The size of received char varies from 0.1-3 cm length and diameter. The bulk density and true density of char were 280 mg/m^3 and 500 mg/m^3 respectively.

3.2 Effect of Charcoal Bed Height on Quality of Treated Water

The charcoal received from gasifier was cleaned to remove the ash and other contaminates. The charcoal bed height was optimized in an experimental filter. Three bed height 25 cm, 35 cm and 50 cm were selected for experiment. The effective bed height was found to be 35 cm. This bed height removes turbidity more effectively as compared to 25 cm and 50 cm bed height. The reduction in turbidity with change in charcoal bed height is shown in figure 2.

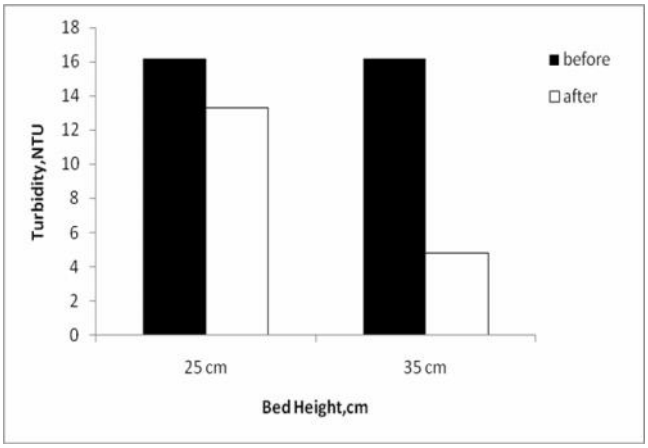

Figure 2. Effect of Bed Height on Turbidity

3.3 Effect of Charcoal Particle Size on Quality of Treated Water

The contaminated water was passed through treatment unit filled with different size of charcoal. The three different size of charcoal i.e. 0.5-1.0 cm,

1.0-1.5 cm, 1.5-2.0 cm were selected for treatment of waste water.

The charcoal bed height during the experiment was kept 35 cm. It was found that turbidity decreases 17.9% with charcoal size 1-1.5cm whereas reduction in turbidity was achieved 70.3% with charcoal size 0.5-1.0 cm.

The result indicates that turbidity reduces with decreasing charcoal particle size. The reduction in turbidity with change in particle size is shown in figure 3.

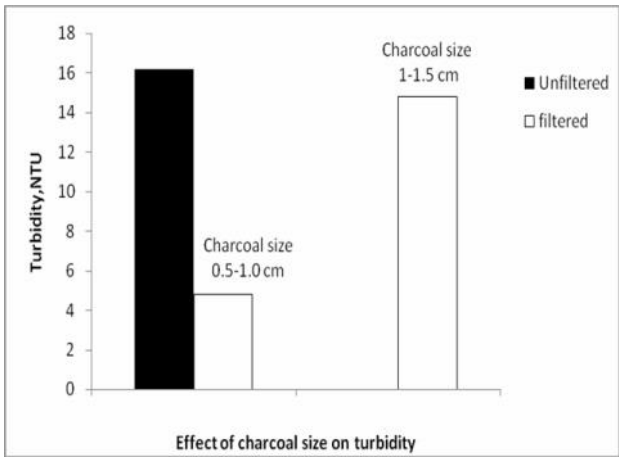

Figure 3. Effect of Charcoal size on Turbidity

3.4 Activation of Charcoal

The charcoal received from gasifier gets exposed at high temperature and observed to be activated as compared to charcoal generated from conventional method. The result of activation of charcoal is shown in figure 4. The iodine value of charcoal received from gasifier was 201mg/g, which was raised to 899 mg /g after activation. The gasifier charcoal could be activated up to 79% of activated commercial charcoal.

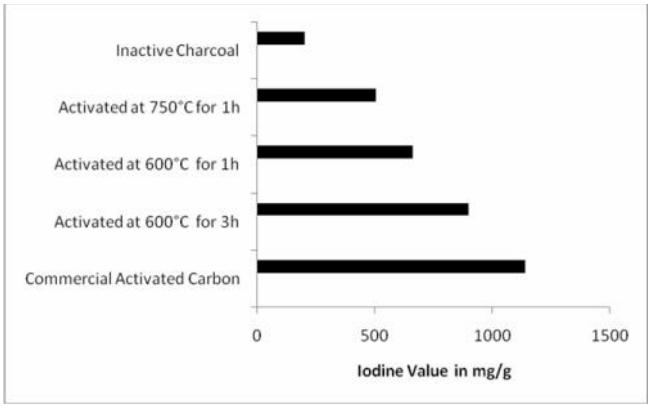

Figure 4. Activation Level of Charcoal at Different Temperature

3.5 Effect of Activated Charcoal on TDS and COD of Waste Water

The filter unit is filled with optimized charcoal size i.e. 0.5-1.0 cm length & diameter and upto 35 cm bed height. The treated water received after the filter unit was analysed for TDS and COD of water. The charcoal treatment had shown increase in total dissolve solid. This may be due to increase in soluble and metal oxide present in char during treatment. The reduction in Chemical Oxygen Demand (COD) was observed 30.2%.The change in TDS and COD is shown in figure 5.

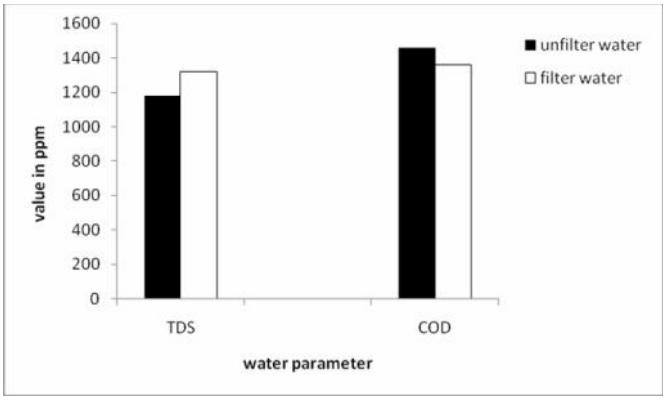

Figure 5. Treatment of Water with Activated Charcoal

3.6 Economics of Waste Water Treatment

The economics of waste water treatment was analysed considering the cost of activated charcoal and amount of charcoal required for waste water treatment. The cost of treatment is Rs.0.97 per litre with 70% reduction in turbidity and 30% reduction in COD.

4. Conclusions

The thermally treated gasifier charcoal could be effectively used to clean the contaminated water. The treated clean water would enhance its recycling ability resulting in lowering the water requirement for biomass based power plant. The charcoal treated water would be safer to dispose in to natural stream.

References:

1. Sridhar G. , Paul P. J. and Mukunda H. S., "Biomass derived producer gas as a reciprocating engine fuel-an experimental analysis," Biomass and Bioenergy, 2001, vol. no. 21,Issue no. 1, Page no. 61-72,.
2. Fcok M. W., "Toxicity of wastewater generated from gasification of woodchips," Technology Brief, Dept. Water & Env. Eng., Lund Inst. Tech., Denmark, 2002.
3. Hasler P.and Nussbaumer Th., "Gas cleaning for IC engine applications from fixed bed biomass gasification," Biomass and Bioenergy, 1999, vol. no. 16,Issue no. 6, Page no. 385-395,.
4. Jayamurthy M., Dasappa S., Paul P. J., Sridhar G., Sridhar H. V., Mukunda H. S., Rajan N. K. S., Brage C., Liliedahl T.and Sjostrom K., "Tar characterization in new generation agro-residue gasifiers-cyclone and downdraft open top twin air entry systems," in Biomass gasification and pyrolysis, State of the art and Future Prospects, CPL press, UK, , 1997, Page no. 235-248, .
5. Rogers M.W., "Gasification apparatus and method," U. S. Patent , 2004.
6. Kesalkar V.P., Khedikar Isha.P., Sudame A.M., "Physico-chemical characteristics of wastewater from Paper Industry International Journal of Engineering Research and Applications" , 2012, Vol. 2, Issue 4, pp.137-143 137,
7. Weijuan Lan, Guanyi Chen, Beibei Yan, Weiyi Li, "Biomass Gasification for Power Generation in China" International Conference on Biological and Biomedical Sciences, 2012, Vol.9, Page No. 72-78,.
8. Mehta Vrajesh, Chavan Anal, "Physico-chemical Treatment of Tar-Containing Wastewater Generated from Biomass Gasification Plants", World Academy of Science, Engineering and Technology, 2009, Vol. No. 33.
9. Zhang Wenhua, Tian Shen, Qian Cheng, Cao Yali, Wu Chuangzhi, Yuan Zhenhong, Yang Xiushan, "Study on Microbial Degradation of Biomass Gasification Wastewater after Coagulation andAdsorption", Journal of Capital Normal University(Natural Science Edition, 2002, vol 23, page no. 64-78.
10. Asilian H., Fard Sh. M., Rezaei A., Mortazavi S. B. and Khavanin A., "The removal of color and COD from wastewater containing water base color by coagulation process," Int. J. Env. Sci. Tech., Apr. 2006, vol. 3, no. 2, pp. 153-157.

*****