Jinying Yan et al., J Bioremediat Biodegrad 2018, Volume 9
DOI: 10.4172/2155-6199-C1-015

Sustainable Water-Energy-Environment Nexus for Thermal Bioenergy Conversion

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A concept of sustainable water-energy-environment nexus has been developed for thermal bioenergy conversion processes as shown in Figures 1 and 2. Two case studies are performed in a biomass-fired CHP plant and a waste incineration unit, which intend to approve and implement the concept. The main results from the case study on stormwater issues in biomass-fired CHP plant show that the biomass fuel storage can play an important role in the sustainable development for the water-energy-environment nexus. It has been proved that the water adsorption capacity of wood chips can be used as a buffer to reduce water runoff, to extend the time for natural water evaporation, to receive the recycled runoff water without significant impacts on fuel quality. The runoff water absorbed by the biomass fuels could increase heat recovery and water reuse. The results also indicate that it is possible to achieve near zero water runoff and wastewater emissions in the tested plant area by an integration of stormwater management with the bioenergy conversion processes. Another case study is focused on a closed water loop in Waste-to-Energy (waste incineration) unit. The closed water loop can properly integrate the thermal energy conversion with an efficient flue gas cleaning, cost-effective water treatment and energy-effective water recovery. The investigation shows that it is possible to achieve a near zero wastewater discharge, which could also result in a significant amount of water recovery for internal usage. The two case studies demonstrate that sustainable water-energy-nexus could be set up in biomass energy conversion processes, which can provide good solutions handle important issues associate with water resource, energy efficiency and emissions to air and waters in bio energy conversion processes.

Figure 1. Illustration of the concept development for a sustainable water-energy-environment nexus in thermal bioenergy conversion processes

Figure 2. Minimising storm water discharge could be achieved by a water balance through water retention, water evaporation in biomass fuel storage. The recirculated runoff water by biomass fuels can further enhance heat and water recovery in flue gas condensation.

Recent Publications

1. Galanopoulos C, Yan J., Li H, Liu L (2018) Impacts of acidic gas components on combustion of contaminated biomass fuels. Biomass and Bioenergy 111:263-277.
2. Li H, Tan Y, Ditaranto M, Yan J, Yu Z (2017) Capturing CO2 from biogas plants. Energy Procedia 114:6030-6035.
3. Larsson M, Yan J, Nordenskjöld C, Forsberg K, Liu L (2016) Characterisation of stormwater in biomass-fired combined heat and power plant – Impacts of biomass fuel storage. Applied Energy 170:116-129.
4. Zhang X, Yan J, Li H, Chekani S, Liu L (2015) Investigation of integration between biogas production and upgrading. Energy Conversion and Management 102:131-139.
5. Sun Q, Li H, Yan J, Liu L, Yu Z, Yu X (2015) Selection of appropriate biogas upgrading technology - A review of biogas cleaning, upgrading and utilisation. Renewable & Sustainable Energy Reviews 51:521-532.

Biography

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