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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 combined heat and power (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.

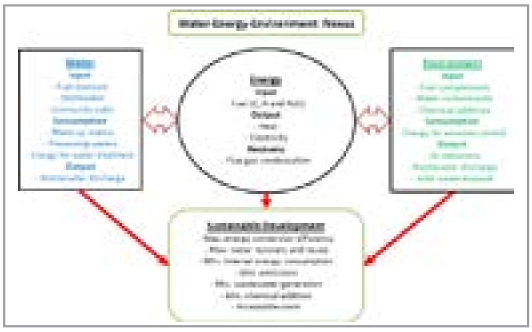

Figure1: Illustration of the concept development for a sustainable water-energy-environment nexus in thermal bioenergy conversion processes

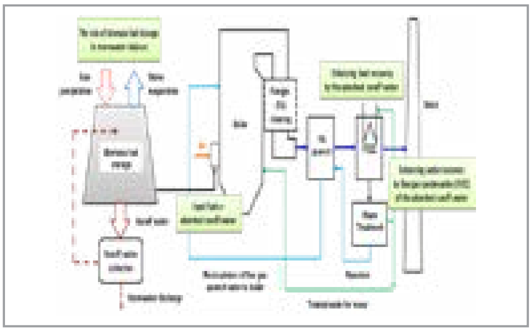

Figure2: Minimising storm water discharge could be achieved by a water

Recent Publications

1. Galanopoulos C, Yan J, Li H and 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 and Yu Z (2017) Capturing CO2 from biogas plants. Energy Procedia 114:6030-6035.
3. Larsson M, Yan J, Nordenskjöld C, Forsberg K and 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 and 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 and 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

Jinying Yan is the Adjunct Professor of Chemical Engineering and Technology at KTH Royal Institute of Technology, Stockholm, Sweden. Currently his research interests are the emission control technologies for bioenergy conversion processes and energy storage technologies for integration of renewable energy. He has also more than 10 years research experience working on the development of CO_2 capture technologies for thermal power generation with focus on gas cleaning, CO_2 capture, and CO_2 compression & purification. He joined Chemical Engineering and Applied Chemistry, University of Toronto as a Postdoctoral research fellow from 1999 to 2000. He received his PhD in Chemical Engineering from KTH Royal Institute Technology, Stockholm, Sweden in 1998.

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