Energy sufficiency analysis of biorefinery annexed to South African sugar mill

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The South African Sugar Industry which has significant impact on the national economy is currently facing problems due to increasing energy price and low global sugar price. The available bagasse is already combusted in low efficiency boilers of the sugar mills while bagasse is generally recognized as promising feedstock for second generation bioethanol production. Establishment of biorefinery annexed to the existing sugar mills as an alternative for re-vitalisation of sugar industry producing biofuel and electricity has been proposed and considered in this study. Since scale is an important issue in feasibility of the technology, this study has taken into account a typical sugar mill with 300 ton/hour sugarcane capacity. The biorefinery simulation is carried out using Aspen Plus™ V8.6 in which the sugar mill’s power and steam demand has been considered. Hence, sugar mills in South Africa can be categorized as highly efficient, efficient and not efficient with steam consumption of 33, 40 and 60 tons of steam per ton of cane and electric power demand of 10 MW. Three different scenarios are studied. The sugar cane bagasse and tops/trash are supplied to the biorefinery process and the wastes/residues (mostly lignin) from the process are burnt in the CHP plant in order to produce steam and electricity for the biorefinery and sugar mill as well. Considering the efficient sugar mill, the CHP plant has generated 5 MW surplus electric powers but the obtained energy is not enough for self-sufficiency of the plant (Biorefinery and Sugar mill) due to lack of 34 MW heat. One of the advantages of second generation biorefinery is its low impact on the environment and carbon footprint. Thus, the plant should be self-sufficient in energy without using fossil fuels. For this reason, a portion of fresh bagasse should be sent to the CHP plant to meet the energy requirements. An optimization procedure was carried out to find out the appropriate portion to be burnt in the combustor. As a result, 20% of the bagasse is re-routed to the combustor which leads to 5 tonnes of LP Steam and 8.6 MW electric powers surplus. Since drying the residue entering the combustor will increase, lower heating value of the fuel by removal of water, steam dryer is considered. In this case, more heat is available for steam and electricity production due to the reduction in heat loss by water vapour leaving with the flue gases and it leads to more available bagasse for ethanol production.

Dynamics of nanotechnology tools to combat plant pathogens

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Nanotechnology has emerged with varied scopes in the field of plant pathology. In recent years, the science of plant pathology has witnessed major breakthroughs in plant defense and disease combating programs. The nanotubes, an important tool of nanotechnology which is a cylindrically shaped carbon molecules having a diameter of about one nanometer can be exploited to deliver proteins, nucleic acids and drugsto cells. This technique also helps to recognize and fight pathogens in agriculture crops. Although carbon nanotubes had toxic effects, because they induce programmed cell death in plant cells but do not show any adverse impact at the tissue level indicating that injecting cells with carbon nanotubes caused only limited injury. Thus, to design a Disease Combating Nanotechnology Model (DCNM) requires assessment of bioavailability and toxicity of carbon nanotubes and their impurities on the crops. The crops should also be tested for their cell viability, genetic material, gene expression, seed germination, seed growth and various other physiological, biochemical and genetic characteristics before applying the nanotechnology principles. The doses of nanotubes can act as a limiting factor in these programs. The use of magnetic nanoparticles through magnetic field gradients has been proved significant in selected plant tissues. The magnet helps these nanoparticles that are charged with different substances to get introduced within the plants and if necessary concentrated into localized areas modifying pathogenesis mechanism. The safer use of nanotechnology techniques to combat agriculture crop pathogens and evaluation of new tools for a successful plant disease management programs are reviewed.