Electricity Generation under Multiple Pollutant Consideration

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Abstract

Increases in greenhouse gas emissions contribute to global warming and affects the environment requiring regulations such as the Kyoto protocol to control their emissions. Pollutants such as nitrogen oxides (NO_x), sulphur oxides (SO_x) and mercury also impose negative impacts on the environment and human health, requiring stringent government regulations to reduce their emissions. Electricity in Canada is produced by hydropower, fossil fuels, nuclear, and renewable energy. Of these, fossil fuels sources such as coal, oil, and natural gas produce a large amount of chemical emissions, increasing Canada's overall emissions. Coal is the most carbon intensive fossil fuel, yet, it continues to be used by industries as it is the most abundant resource and least expensive. As the electricity demand continues to rise, coal will continue to be used to meet this demand at a low cost; however, this will increase overall emissions. Hence, it is important for industries to reduce overall multi-pollutant emissions by implementing different pollution abatement technologies. A discrete optimization model was used within the General Algebraic Modeling System (GAMS) to determine the best option to meet specific reduction targets of NO_x, SO_x, and mercury emissions at a minimized cost. Fuel balancing was implemented and pollution abatement technologies were installed to meet specific reduction targets, while ensuring that the electricity demand is met to produce enough electricity to the Ontario power grid. A sensitivity analysis was also completed for the 20% reduction case of multiple pollutants to determine the effect of increasing the electricity demand on the total cost. It was found that for an increase in the electricity demand, there is an increase in the total cost to meet the electricity demand.

Keywords
Electricity generation, pollution control, optimization,

Biography

I. Alhajri holds a Bachelor degree and a Master degree in Chemical Engineering from the University of Kuwait and a Ph.D. degree in Chemical Engineering fromthe University of Waterloo. At Waterloo, he conducted research on the development of mathematical optimization frameworks that can support strategic decisions in designing and operating refinery operations and integrating hydrogen management. He is currently an Assistant Professor in the Department of Chemical Engineering at the College of Technological Studies, Kuwait. He worked previously as a process engineer at Kuwait National Petroleum Company. His research interests are in process systems engineering and optimization with applications to waste treatment and minimization and the oil and gas industry.

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