HELPING REFINERIES REDUCE CO_2 EMISSIONS

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Today, petroleum refineries are under pressure to reduce their carbon dioxide (CO_2) emissions, which contribute to global warming. At the same time, they need to meet quality specifications and maximize profits. Because refineries are complex operations, deciding how to best achieve those goals is no simple task. Thanks to chemical engineers at the University of Waterloo, however, the job just got a little easier.

The four researchers created a mixed-integer nonlinear programming model that considers three different strategies for reducing the CO_2 emissions. Flow rate balancing decreases the inlet flow rate to refinery units that emit more CO_2 while increasing inlet flow to units that emit less. Fuel switching involves converting operations to fuels such as natural gas that emit less CO_2. Finally, CO_2 capture uses end-of-pipe technologies to prevent the release of CO_2 into the atmosphere.

The researchers developed individual nonlinear models for each unit within a refinery, as well as a master planning model, taking into account variables such as feed flow rate, feed properties, product flow rates and the properties of the products. They then applied the model to several case studies using a global optimization algorithm.

The results reveal that using flow rate balancing achieves CO_2 reductions of just 0.4 per cent. In contrast, fuel switching can reduce CO_2 emission by as much as 30 per cent, although retrofitting costs and the price of natural gas eat into the profits. To achieve reductions of more than 30 per cent, refineries need to turn to CO_2 capture. Although this is the most expensive approach, it can cut CO_2 emissions by as much as 90 per cent.

Partners: Natural Science and Engineering Research Council of Canada, Natural Resources Canada, Ontario Power Generation