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RAPID Steps Toward Sustainability

Global challenges related to economic development, environmental protection, and social equality — such as conflicts triggered by drought in Africa, toxic chemical releases in India, over-exploitation of resources in the oceans and forests, and extreme hunger and poverty in developing countries — spawned interest in sustainable development. The United Nations (UN) recognized these global challenges and convened the World Commission on Environment and Development, which produced a report in 1987 that proposed long-term environmental strategies to achieve sustainable development.

Through coordinated efforts among nations, great strides have been made to alleviate the most severe sustainable development challenges around the world. Yet more must be done to address issues such as climate change and water security, as well as achieve many more of the UN's sustainable development goals set for 2030.

Many sectors of society, including the chemical process industries (CPI), have developed sustainability strategies to improve performance and achieve both short-term and long-term sustainability goals. The National Research Council published a report in 2006 laying out a sustainability agenda for the chemical industry. The report explains the CPI's goal to advance applications to support sustainability, helping society meet current environmental, economic, and societal needs, without compromising the progress and success of future generations. The report describes a process to move the industry from the current paradigm — in which processes are heavily energy intensive and reliant on fossil fuels — to environmentally sustainable processes. To make the transition, CPI companies will need to pursue sustainability education, lifecycle assessments, and green chemistry, as well as move toward renewable fuels and feedstocks.

Sustainability and the RAPID Manufacturing Institute. Process intensification (PI) includes many strategies to reduce the cost, energy intensity, and emissions of a process. An intensified process might combine multiple reaction and separation processes into a single unit to take advantage of chemical and physical driving forces and exchange energy and waste streams internally.

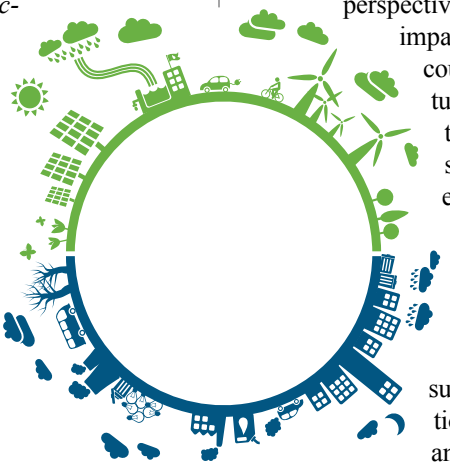
An intensified process might also employ modular chemical process intensification (MCPI), in which standardized, premanufactured small-scale process units are linked to help manage investment risk while achieving the same economic benefit of similar large-scale processes. MCPI improvements could be deployed broadly to minimize the energy and carbon footprint of the CPI without compromising the bottom line.

The RAPID Manufacturing Institute is focusing on MCPI technologies to address their manufacturability, provide supply chain strategies, and realize their potential to reduce process costs. Much of the cost reduction is derived from the numbering up of modular processing units, unlike the scale up of a single unit.

RAPID also aims to help the CPI convert to renewable feedstocks via MCPI. Modular chemical processes could be used for distributed production of biofuels and bioproducts at the sites where the feedstocks are grown and harvested. This could eliminate the need for long-haul transport, increase energy density of the feedstocks, and improve local economies.

RAPID is helping to advance these PI technologies through developments in modeling and simulation. Modeling tools for the design, control, and analysis of PI processes and products can help ensure the processes reach their full potential. The models couple process simulation of new PI designs with assessments of the process'or product's sustainability based on technoeconomic, environmental, and societal indicators. A process simulation, for example, might include a description of an MCPI process' net present value, energy and greenhouse gas (GHG) emissions intensity, and community impact. The SYNOPIS project led by Texas A&M Univ. is developing a framework for the synthesis of operable intensification systems that incorporate key sustainability indicators as some of its operability criteria.

Ideally, analyses could be conducted with a lifecycle perspective to capture upstream and downstream impacts of the MCPI process. Analyses could be conducted early during conceptual design to screen alternatives and then later during detailed design when specific MCPI strategies are considered. Comparisons to traditional designs and products can help to establish further justification for commercial deployment.



RAPID has the promise and potential to take giant steps toward sustainability for the CPI through innovations in MCPI that are guided by systems analyses for sustainability. CEP