Biochemists reveal new twist on old fuel source

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(PhysOrg.com) -- Stinging from humiliating defeat in World War I, Germany's Nazi regime seized on technology developed by chemists Franz Fischer and Hans Tropsch that enabled the coal-rich, petroleum-poor country to produce synthetic fuels for its military machine. Research in Fischer-Tropsch or "FT" synthesis waned in the latter half of the 20th century but, like "a bubblin' crude," has resurfaced in recent years with growing interest in alternative fuels.

While studying bacterial enzymes, known as nitrogenases, used in nitrogen reduction, Utah State University biochemists Zhi-Yong Yang and Lance Seefeldt, along with colleague Dennis Dean of Virginia Tech, discovered a molybdenum nitrogenase capable of converting carbon monoxide into usable hydrocarbons. The reaction is similar, they say, to FT synthesis.

"This is pretty profound," says Seefeldt, professor in USU's Department of Chemistry and Biochemistry. "Understanding this process paves the way for developing better ways of converting carbon monoxide, a toxic waste product of combustion, into transportation fuel and precursors for plastics – without the time and energy required for conventional extraction of fossil fuels."

The scientists' findings appear in the article "Molybdenum Nitrogenase Catalyzes the Reduction and Coupling of CO to Form Hydrocarbons," in the June 3, 2011 issue (and May 27 online issue) of Journal of Biological Chemistry. The paper was selected as "Paper of the Week" by the journal's editorial board, an honor bestowed on the top one percent of more than 6,600 manuscripts reviewed annually

by the publication's editors. In the "Paper of the Week" feature, Yang, a doctoral candidate mentored by Seefeldt, is highlighted as an up-and-coming researcher.

Molybdenum, often called "Moly," is a brittle, silver-gray metal found in soil and used in steel alloys. It's also found, in small amounts, in the human body, where it metabolizes certain amino acids, produces uric acid and helps to break down drugs and toxins.

"There's tremendous interest in converting various kinds of waste into fuel and, especially, in finding cost-effective and environmentally clean ways to do it," says Yang, who earned his first doctorate in organic chemistry at China's Nankai University.

Unlike coal, Fischer and Tropsch's original source for synthetic fuels, carbon monoxide produces hydrocarbons with much less pollution. The substance provides an added benefit: it allows scientists to produce longer chain, double and triple-bond hydrocarbons, which provides a richer feedstock for production of refined transportation fuels.

"Like many waste-to-energy processes, we've found we can produce such hydrocarbons as propane and butane from carbon monoxide," Yang says. "But using this process, we may have the potential to produce such transportation fuels as diesel and gasoline that are readily adaptable to today's vehicles."

Dinitrogen, Seefeldt says, makes up about 80 percent of the air we breathe. Though essential for all life on the planet, it's not in a form higher organisms can directly access.

“It’s kind of like being hungry and sitting at a table laden with food but not being able to eat,” he says.

Humans and animals take in nitrogen – in the form of protein – from food; plants obtain nitrogen from soil.

In recent years, Seefeldt has identified key steps involved in nitrogen fixation, the process by which nitrogen is converted to ammonia. The findings contribute to research that could enable an alternative, clean method of producing nitrogen.

Science and industry currently rely on the century-old Häber-Bosch process to produce nitrogen for fertilizer, paper, pharmaceuticals, plastics, mining and explosives. Developed by German Nobel Prize winner Fritz Häber and Carl Bosch during World War I, the process, Seefeldt says, is costly and energy-intensive.

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