Research pair devise a way to make nylon precursor that is less harmful to the ozone layer

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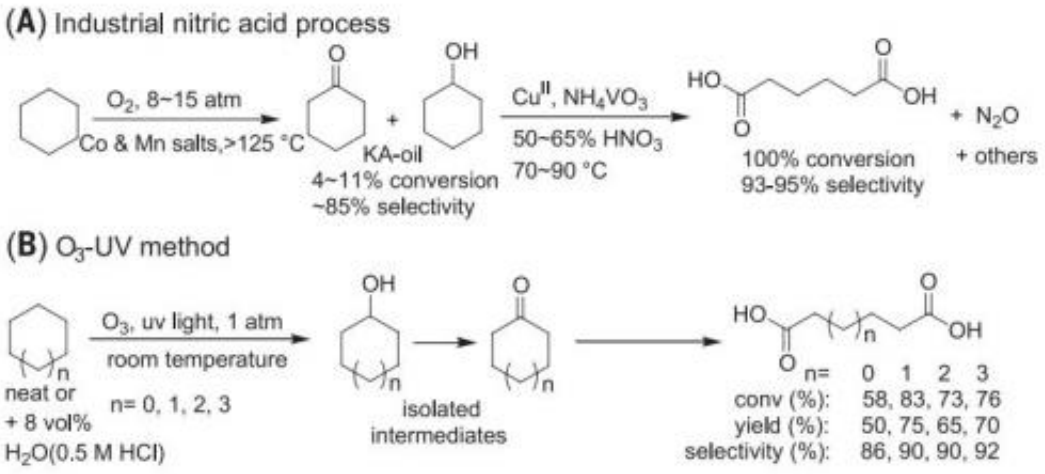

Comparison of the industrial process and the method presented herein for production of adipic acid. (A) Industrial nitric acid process. (B) O3-UV method. Credit: *Science* 19 December 2014: Vol. 346 no. 6216 pp. 1495-1498. DOI: 10.1126/science.1259684

(Phys.org)—A pair of researchers working at National Tsing Hua University in Taiwan, has found a way to make a precursor to the synthetic polymer commonly known as nylon that doesn't cause the release of ozone damaging nitrous oxide. Kuo Chu Hwang and Arunachalam Sagadevan describe their process in a paper they've had published in the journal *Science* and explain why what they've discovered

is important.

To make nylon, popularly used in panty hose, rope and a huge variety of other products, manufacturers first make adipic acid by mixing nitric acid with hexagon-shaped carbon molecules (cyclohexane) and other ingredients such as cobalt, copper, manganese, vanadate salts, and highly pressured oxygen. In addition to adipic acid, the process gives off nitrous oxide which is allowed to escape into the atmosphere where it harms the planet's ozone layer (it's also considered a greenhouse gas). So popular is nylon, and adipic acid (95 percent of it that's made is used to make nylon), that prior research has found that up to eight percent of the eight million metric tons of nitrous oxide released into the atmosphere each year, is the result of making adipic acid for nylon production. In this new effort, the pair of researchers describe a process they developed for creating adipic acid that doesn't release any nitrous oxide at all—it's also simpler and costs less.

Instead of adding nitric acid to cyclohexane (or cyclohexanol, or cyclohexanone) the two added ozone bubbles and ultraviolet light. The UV light caused the ozone to break down to O_2 releasing single highly reactive oxygen atoms. Those atoms attached themselves to the carbon molecules weakening their bonds and eventually causing the hexagon rings to break, which resulted in the formation of adipic acid. They note that the process doesn't require high pressure or any other new ingredients.

Excited by their discovery, the two researchers tried the same method on other, larger hydrocarbons—no report on what they found, but they imply that the possibilities are tantalizing, which suggests other researchers might be looking to do the same very soon—that could conceivably lead to the development of ways to create other common materials that aren't so harmful to the planet.

More information: One-pot room-temperature conversion of cyclohexane to adipic acid by ozone and UV light, *Science* 19 December 2014: Vol. 346 no. 6216 pp. 1495-1498. DOI: 10.1126/science.1259684

ABSTRACT

Nitric acid oxidation of cyclohexane accounts for ~95% of the worldwide adipic acid production and is also responsible for ~5 to 8% of the annual worldwide anthropogenic emission of the ozone-depleting greenhouse gas nitrous oxide (N2O). Here we report a N2O-free process for adipic acid synthesis. Treatment of neat cyclohexane, cyclohexanol, or cyclohexanone with ozone at room temperature and 1 atmosphere of pressure affords adipic acid as a solid precipitate. Addition of acidic water or exposure to ultraviolet (UV) light irradiation (or a combination of both) dramatically enhances the oxidative conversion of cyclohexane to adipic acid.