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How to make steelmaking 'green?' Add some plastic.

By Peter N. Spotts | *Staff writer of The Christian Science Monitor*

SYDNEY – A trash bin is not the first place most people would search when hunting for ingredients to make steel.

But to Veena Sahajwalla, plastic castoffs represent a potential "green" solution to some of the environmental problems that result when today's scrap metal is converted into tomorrow's girders. Where today's furnaces use coal, she envisions partially replacing it with waste plastic. Think of it as "beating" plastic grocery bags into plowshares.

Her research is part of a broader global effort to align steelmaking with 21st-century goals of sustainable development. Over the past three decades, steelmakers in industrial countries have made significant strides in building more energy-efficient plants and in capturing more of the pollutants that once billowed from their facilities.

But today's technologies still rely on coal - and in a few cases natural gas - as a source of carbon to purify iron ore or scrap metal, researchers say. Many developing countries, meanwhile, run plants that are far less efficient and emit far more pollutants into the air. If they had more ecologically friendly technologies to use at affordable prices, they could clean their air and water and still build homegrown steel industries,

researchers reason.

In Asia, North America, and Europe, scientists also are looking at replacing coal with biomass and hydrogen. They even see ways to eliminate additives altogether for some steps in the steelmaking process.

"If we look at waste material as a valuable resource and we can put it to some use, that effectively leads to the concept of sustainable materials," Dr. Sahajwalla says. "If you want to look to see whether a waste material is a potential resource, you have to go back and question the current technologies and processes."

At first blush, chucking plastics into a furnace hardly sounds environmentally responsible. Indeed, researchers note that not all plastics would be suitable.

But Sahajwalla, a professor of materials science and engineering at the University of New South Wales in Sydney, explains that in their most basic form, plastics are made of hydrogen, oxygen, and carbon. And it's the carbon that she has her eye on as she considers the use of plastics in electric steelmaking furnaces.

Before coal can be used in refining iron or making steel, it must be turned into coke - a carbonized form of coal with the impurities baked out of it. During the baking process, the coal releases a range of noxious compounds, such as mercury and other metals, as well as sulfur and nitrogen oxides - the building blocks of acid rain and smog.

In the torrid heat of the furnace, coke's carbon reacts with the liquid metal, carrying away the oxygen in iron ore or rusty scrap as carbon monoxide or carbon dioxide gas.

While she acknowledges that carbon-dioxide emissions don't go away when plastics are used, plastics give off less CO_2 than equivalent amounts of coal. And they don't produce the other noxious byproducts. In the lab, she and her research team have found that a 50/50 mixture of coke and plastic works just as well as a furnace filled with coke.

The approach wouldn't require manufacturing plastics specifically for steelmaking. "Let's put it this way," she says, grinning. "You definitely have enough plastics" in the world's landfills.

She and her colleagues are looking for an industrial partner to conduct full-scale experiments.

At the other end of the scale for "greening" steel production sits Donald Sadoway, a professor of materials science at the Massachusetts Institute of Technology in Cambridge. He and his colleagues are devising ways to draw the oxygen out of iron ore using electricity. The approach, called electrolysis, already is used to make

aluminum.

The approach uses an electric current to separate iron from oxygen. The ore is dissolved in a solvent, then the current is applied to the liquid. Iron gathers around one electrode, oxygen around the other. The process's only gas byproduct is pure oxygen. Given the relatively cheap cost of energy for traditional methods of iron refinement versus his electrolytic approach, Dr. Sadoway acknowledges that its near-term prospects may look brighter for metals such as titanium, which currently undergoes "a torturous set of thermochemical operations" during refinement.

Yet as countries begin to eye carbon taxes as a way to encourage greater energy efficiency and reduce CO2 emissions, he continues, his approach may begin to look more economically competitive for steel.

Its ultimate use, however, may be off the planet. The National Aeronautics and Space Administration has expressed an interest in the technology as one possible approach to "living off the land" when exploring the moon or Mars. Traditional metal refining would require a constant stream of coal from Earth. Once a suitable source of electricity is established, however, electrolysis could provide the iron needed to build or repair structures.

"In 21st-century metallurgy, the only class of emissions should be products," Sadoway says.