Into the fire: Infrared sensor could help reduce greenhouse gas emissions

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Imagine peering into the blazing heat of a 1,600 C industrial furnace with a cool goal: reducing the greenhouse gases it produces every year. Now, engineers at the University of Toronto are doing just that. Professor Murray Thomson, who leads the combustion group in the Department of Mechanical Engineering, has just completed the first industrial test of a prototype infrared sensor that could potentially increase the efficiency of large industrial furnaces and simultaneously reduce their output of harmful greenhouse gases such as carbon dioxide (CO_2).

Thomson says that if this technology were used on every large industrial furnace across Canada, it would prevent 157,000 tonnes of CO_2 emissions per year. The team tested the prototype at Ontario Power Generation's Nanticoke coal-fired boiler. On Feb. 15, they ran a test at steelmaker Stelco Inc. in Hamilton.

Currently, Stelco has no way to monitor gases or temperature in the middle of the furnace, which works like this: pig iron, which has a high carbon content, is put inside a basic oxygen furnace and oxygen is injected into the inferno, which oxidizes the carbon, releasing energy and producing steel.

Once all the metal's carbon is gone, levels of both carbon monoxide and carbon dioxide gases inside the furnace drop and the iron itself starts to burn, which is a waste of their product. With steel furnaces, roughly half of the energy used in the process is wasted. "If they knew what the CO

and CO_2 levels were, they could stop the oxygen injection as soon as the carbon oxide levels disappear," Thomson says. "The motivation is primarily energy efficiency. But it's more than that — there's potential for productivity gains and you get higher quality steel."

Thomson has been working in this field for nearly a decade. About six months ago he started building a passive sensor technology that examines the light produced by the furnace.

The sensor, protected by a heat shield, peers through a 20 centimetre by 20 centimetre window in the furnace. "The device collects all the light that arrives at the infrared sensor and passes it through a spectrometer, which acts like a prism in that it spreads out light of different wavelengths," says Salvador Rego, a PhD candidate in the combustion group. "We've selected a region of the spectrum where we know that we will find the signal for CO and CO_2 — between four and five microns." They can detect a change in gas levels within five seconds, allowing the company to adjust the furnace conditions. For example, to prevent the wasteful burning of iron, Stelco would shut off the oxygen injection as soon as levels of carbon oxides dropped.

Moreover, when unburned fuels leave the furnace they add to greenhouse gas emissions. Carbon dioxide produced in industries like steel or energy is vented into the atmosphere where it forms a layer through which sunlight can pass, heating up the planet, but through which heat can't escape. "We want to stop climate change and global warming," Thomson says. "The way we're going to do that is to minimize CO_2 emissions.

"This technology in itself isn't going to solve the whole greenhouse gas problem but it's one piece of the puzzle."

Source: University of Toronto