Welders can breathe easier with chromium-free alloy

February 10 2011, by Pam Frost Gorder

A new alloy promises to lessen welders' risk of breathing toxic fumes on the job.

The alloy is a welding "consumable" – the material that melts under the welder's torch to fill the gap between parts that are being joined.

The new nickel alloy consumable is more expensive compared to those already on the market, but worth the cost in situations where adequate ventilation is a problem.

That's why two Ohio State University engineers invented the alloy – specifically to aid military and commercial welding personnel who work in tight spaces.

In tests, welds made with the new consumable proved just as strong and corrosion-resistant as welds made with commercial stainless steel consumables. When melted, however, the new alloy does not produce fumes of hexavalent chromium, a toxic form of the element chromium which has been linked to cancer.

All stainless steels contain chromium, but Gerald Frankel and John Lippold, both professors of materials science and engineering at Ohio State, determined that the consumable alloy that joins stainless steel parts together doesn't have to contain the metal.

Use of the new alloy essentially eliminates hexavalent chromium in the

welding fumes.

The university has three issued US patents and a pending European patent application covering a series of alloys – based on nickel and copper but with no chromium – all of which can be used with standard welding equipment.

The new alloy is expensive, however. The engineers estimated that it would cost five to 10 times more than standard welding consumables, depending on metal prices.

The Occupational Safety and Health Administration sets limits on workers' exposure to hexavalent chromium in welding fumes, which affect welders themselves and their surrounding coworkers. Reduced exposure to such toxic fumes requires either extreme ventilation or use of a chromium-free consumable.

Frankel said that the high cost of the alloy would be justified in situations where ample ventilation may be impossible.

"I always think of someone welding a steel pipe, deep inside a ship at sea," he said. "Ventilation might not be possible, and a breathing appartus for the welder would make working in a confined space even more difficult. In that case, using our alloy would lower the amount of ventilation needed, and help reduce costs overall."

Frankel is a corrosion expert; Lippold is a welding expert. Lippold was already looking for ways to limit the amount of another metal – manganese, which can cause neurological damage – in welding consumables, when Frankel approached him about chromium.

"We came up with an alloy that is compatible with stainless steel from a corrosion perspective, and a welding process that results in high quality

welds," Lippold said. "It is a drop-in replacement for stainless steel comsumables welders use now."

Sometimes welders use a consumable as a bare metal wire, and other times they need to use an electrode made from a metal core coated with flux – a chemical agent that removes impurities from the weld. The Ohio State alloy works for either application.

In the laboratory, the researchers performed electrochemical tests to optimize the composition for corrosion resistance. They also performed mechanical tests of the weld joint to test the alloy's strength. The new alloy's performance was comparable to standard commercial welding consumables for stainless steel.

Frankel and Lippold have begun further testing of their alloy with Euroweld, Ltd., a manufacturer of specialty welding materials headquartered in Mooresville, North Carolina.

The engineers are now working on ways to lower the cost of the consumable.

The university will license the alloy and its applications for commercial development.

Provided by The Ohio State University