# Zero-waste technology for chromium industry will reduce costs and protect the environment

## New process for recycling chromium from industrial wastes recovers valuable materials and eliminates need for landfill disposal

*'For the first time, it will be possible to re-process waste from chromium chemicals production, recovering all of the metal and other saleable by-products.'*

A new 'zero-waste' process for chromium chemical and metal producers, developed at the University of Leeds, could reduce production costs, recover valuable raw materials and protect the environment, it was announced today (27th September 2002). The new technique will eliminate the need to dispose of hundreds of thousands of tonnes of chromium-containing waste in landfill sites, helping to meet increasingly stringent regulations worldwide.

Pioneered as part of a major waste minimisation initiative backed by government and industry, the process could have 'great commercial significance', say its developers. For the first time, it will be possible to re-process waste from chromium chemicals production, recovering all of the metal and other saleable by-products.

'Our zero-waste process extracts 100% of the chromium and other valuable materials. This has never been possible in the chromium chemicals industry before,' says Professor Animesh Jha of the Department of Materials at the University of Leeds, who led the research. 'The technique is extremely simple and can be applied anywhere in the world. We can recycle any process waste and incorporate it with ore to derive chromium chemicals without sacrificing purity.'

A novel method has also been developed to obtain ferro-chrome alloy by blending waste from chromium chemicals and chromium metals production. The resulting alloy is of high quality, with very low carbon and silicon content – ideal for making stainless steel.

The new technology has been pioneered through the Government's programme for Waste Minimisation through Recycling, Re-use and Recovery in Industry. The Engineering and Physical Sciences Research Council provided a grant of just over £170,000 for the three-year project. Researchers (Drs. Vilas Tathavadkar, M. P. Antony, and Prof. Jha) from the Department of Materials analysed ways of extracting chromium oxide from wastes and recycling it in both chemical and metal production processes.

Typical chromium ore process residues contain 14% by weight of chromium oxide, all of which can now be recovered as sodium chromate. If required, a company may also choose to generate additional revenues from the sale of marketable by-products – alumina, magnesium oxide and iron oxide.

In chromium metal production, slag typically contains around 8% of chromium oxide, which can also be recovered.

Detailed investigations were carried out into physical chemistry of the soda-ash roasting process, which is used worldwide to extract chromium from chromite ore as water-soluble sodium chromate. Treatment with various proportions of waste and catalyst was found to achieve a dramatic increase in conversion rates. Nearly 100% of sodium chromate was extracted with chromite ores from major producers South Africa, India, Turkey, and China.

**WMR3**
**(Waste Minimisation through Recycling, Re-use and Recovery in Industry) was a collaborative industrial research programme supported by £12m of funding from EPSRC and DTI during 1995 – 2003.**

**www.oakdenehollins.co.uk/wmr3**

*‘The new technique will enable producers to make major savings by removing the need to handle waste, manage landfill sites and pay landfill tax.’*

By comparison, conventional soda-ash roasting produces far lower yields – less than 30% from Chinese ores, 50-55% from Indian and 80-85% from South African.

As well as extracting all valuable raw materials, the new technique will enable producers to make major savings by removing the need to handle waste, manage landfill sites and pay landfill tax. In the UK, conservative estimates put these savings at £1m per annum for a typical firm.

The new technique could also help to solve environmental concerns arising from the legacy of old landfill sites. Lime-based processes abandoned in the UK and other developed countries around 40 years ago left residues containing chromium in its hexavalent form, which is toxic and hazardous to plant and animal life. The $Cr^{6+}$-ions can leach out into ground and surface water over very long periods of time. Discussions are already taking place with the Environmental Protection Agency and Regional Councils with legacy landfill sites about the prospects for tackling potentially hazardous sites.

‘We are currently looking at various routes to deal with this industrial legacy,’ says Professor Jha. ‘Our aim is to create a consortium to remediate these old sites and rid them of hexavalent chromium. That could be an extremely important next step, which is both intellectually challenging and rewarding for the Society, in general.’

Further development is also planned to improve the efficiency of the zero-waste process. ‘Our future aim is to design a much more energy efficient zero-waste process by halving the energy consumption and minimising the $CO_2$ emission from soda roasting process – an ultimate example of zero-waste process.’

## Additional Project details and background

***What are the main applications of chromium?***

Chromium is widely used in industries such as steel making, automobiles, chromium plating, leather, pigments, chemicals and laboratory reagents.

***What are its main sources?***

Chromite ore is the primary source for derivation of chromium chemicals. The largest producers are South Africa, India and Turkey. Other major producers include the former Soviet Union, Indonesia, China and the Philippines.

***How is the metal extracted?***

Oxidative alkali roasting is the main method used worldwide to extract chromium as water-soluble sodium chromate. The amount of chromium recovered depends on roasting time and temperature, and the source of chromite ore. In tests the maximum recovery of chromium was found to be 83%, with South African ore. Yields from Chinese ore can be lower than 30%.

***What happens to the process residue?***

At present, process residue has to be disposed of in landfill sites. In addition to the remaining chromium, it contains large amounts of alumina, magnesium oxide and iron oxide. A typical UK producer would have to dispose of more than 100,000 tonnes of process residue every year. This is costly and increasing restrictions mean that an alternative to landfill is urgently needed. The sites are rigorously monitored to ensure safety.

***Why are old landfill sites the main environmental concern?***

Lime-based extraction processes, which were abandoned in the UK and other developed countries more than 25 years ago, generated the hexavalent form of chromium, Cr6+. Compounds containing this form of chromium are toxic and hazardous to plant and animal life. Old landfill sites containing Cr6+ are now seen as a significant source of environmental contamination.

Lime-based processes are still in use in some other parts of the world, including India, where there are major environmental concerns.


### Sponsored by...

EPSRC dti

**The Engineering and Physical Sciences Research Council is the UK Government’s leading funding agency for research and training in engineering and the physical sciences. The Department of Trade and Industry co-sponsors industrial R&D projects through LINK.**

### Produced by...

OAKDENE HOLLINS

**Oakdene Hollins Ltd’s consultants deliver Lean Manufacturing to industry, and technical & economic studies and programme co-ordination to the investment sector, industry & Government.**

*design by www.icatching.co.uk 05052003*