

in-process concentration of Ce(IV). The addition rate is set to maintain a steady state concentration of Ce(IV) in the system. All the gaseous products from this reactor are vented into a second reactor – a packed bed reactor – in which the exhaust gases are contacted with a downflow of Ce(IV) anolyte. This reactor destroys any adventitious VOC materials that may have been volatilised from low boiling materials passed into the liquid-phase reactor.

Hydrocarbon materials and oxygenates, such as alcohols and ketones, are converted to carbon dioxide and water. Organic materials that contain other heteroatoms, such as chlorine, nitrogen, sulfur, phosphorus and many other members of the Periodic Table, are also broken down to carbon dioxide, water and an oxidised species containing the heteroatom. Carbon-bound Cl is converted to Cl<sub>2</sub> (chlorine gas), and N to nitric acid. The volatile products, such as Cl<sub>2</sub>, separate from the reactor along with the carbon dioxide and are removed from the exhaust stream before venting. Sulfur species are oxidised to sulfate and phosphorus species are oxidised to phosphate.

As stated previously the CerOx Process does not destroy or degrade fluorocarbon materials, such as Teflon, or its derivatives. These materials can therefore be used for the construction of the processing equipment. The carbon-fluorine bonds are not degraded during the process as they are stable to the chemical environment of the anolyte. Any inorganic fluoride added to the system is strongly bound to Ce forming an insoluble

fluoride. This sequestering of fluoride by Ce(III) prevents fluoride-promoted corrosion of the Ti electrodes.

## Conclusions

Using this electrode/membrane carrier construction system, it is possible to manufacture more simply and easily key components for the catalytic destruction of hazardous organic waste. These can be manufactured in high volume and are easy to maintain. The CerOx Process may be regarded as a solution to the problem of the total treatment of hazardous organic waste materials. It is the only non-thermal alternative to incineration that is both technically and economically viable for on-site treatment and destruction of organic wastes, to comply with current U.S. environmental regulations.

## References

- 1 The CerOx™ Process was originally developed by the Pacific Northwest National Laboratory (PNNL). J. E. Surma, G. H. Bryan, J. G. H. Geeting and R. S. Butner, *U.S. Patent* 5,707,508; 1998
- 2 The CerOx™ Process has been commercialised by CerOx Corporation under an exclusive license from the PNNL. G. A. Steward, *U.S. Patent* 5,756,874; 1998

### The Author

Norvell Nelson is the Chief Technology Officer (and co-founder) of CerOx Corp. He holds a PhD in organic chemistry from Stanford University and has been a Postdoctoral Fellow and Instructor at Northwestern University in inorganic chemistry. He worked at Eastman Kodak, Varian Associates and Catalytica before co-founding CerOx. His interests are in the application of novel chemistries for solving organic waste management problems. Information about CerOx can be found at [www.cerox.com](http://www.cerox.com).

## Modern Organic Catalytic Reactions

CATALYSIS OF ORGANIC REACTIONS, Chemical Industries Series, Vol. 82

EDITED BY MICHAEL E. FORD, Marcel Dekker, Inc., New York, 2001, 629 pages, ISBN 0-8247-0486-X, U.S. \$195.00

This book contains papers given at the 18th Conference on Catalysis of Organic Reactions, in Charleston, U.S.A., in 2000. Papers cover a wide range of material including the latest industrial and academic research. Platinum group metals (pgms) remain important and several themes emerge.

Pgms continue to replace base metal catalysts for environmental and cost reasons. In fat hardening (a multi-million tonne industry using base metal catalysts) superior catalytic processes would result in

economic, quality and environmental benefits.

Supported homogeneous pgm catalysts continue as a favourite topic, many based on well-known technologies. Pgms are now more widely used in selective oxidation reactions and industrial interest is growing. The work of industrial groups and collaborations looking at 'real' problems, besides more fundamental work, is of particular interest.

D. R. KELL

Darren Kell is Business Projects Manager at Avecia, Scotland. His interests are in the commercialisation of inkjet printing materials.