Promising early signs for ball valve effectiveness

▲ *John Williams*

By Mark Fraser

A TECHNOLOGY DEVELOPED by the US navy could soon be commonly used in high pressure acid nickel leaching (HPAL) circuits to help keep abrasion wear at bay.

BACK IN 1996 the Office of Naval Research initiated a program which looked specifically at thermal spray processing on nanostructured coatings.

This research found that nanostructured ceramic (alumina-titania) coatings proved to be very sound when it came to bond strength (two times) and abrasion wear resistance (four times) – compared to its conventional microstructured coating counterpart of the same composition.

The coating, the navy discovered, had the unique property of enhanced toughness without compromising strength or hardness.

Then, four years later in May 2000, FW Gartner Thermal Spraying Company – in partnership with Mogas Industries and using the services of Perpetual Technologies – set about devising novel ball valves for the severe processing conditions found in HPAL plants.

These metal-seated ball valves' angular (as opposed to volumetric) displacement capability and their large low stress precision-lapped seal, combined with their ability to continue to operate in an environment with crushed abrasive solids, made them the best choice for isolation in severe service applications.

In essence, metal seated ball valves used in nickel/cobalt HPAL circuits incorporate a protective thermal sprayed ceramic top coat that is lap-finished to minimise wear and maximise valve sealing life.

During 2001, Mogas qualified and applied a nanostructured titanium oxide coating for gold and nickel/cobalt HPAL services.

The field results validated the superior performance observed in the qualification tests, and in 2006 Scientific Valve and Seal LP teamed up with Perpetual Technologies to adopt the latest knowledge in nanostructured oxide coatings in order to provide superior protection against abrasive and erosive wear.

At the ALTA Nickel/Cobalt Conference held in Western Australia earlier this year, Scientific Valve and Seal's John Williams said the two companies had been continuing their work on developing nanostructured chromia matrix composite coatings.

In a paper prepared with Perpetual Technologies' Dr George Kim, Williams explained the objective of this work was to determine whether thermal sprayed nanostructured chromium oxide coatings would also exhibit the enhanced properties observed in alumina-titania and titania coatings.

The choice to investigate the use of chromia as the top coat material was based on the following information:

- When deposited using the same thermal spray process and powder structure, chromia outperformed titania with respect to hardness, wear resistance and, in many cases, corrosion resistance;
- Although there were clear signs of corrosive attack against vacuum plasma spray applied chromia-blend coatings, atmospheric plasma spray applied coatings of the same composition did not show similar propensity to corrosive attack in similar operating conditions, and;
- It has also been observed that, in general, composites of chromia and titania produced tougher, more wear resistant coatings, than pure chromia or titania (a theory as to the cause of this was that immiscible second phase materials served as crack arrestors; plus, it was believed that the second phase particles tended to pin the grain boundaries, thereby inhibiting growth to a larger size).

Williams said by recognising this, significant improvements were achievable in conventional coating systems by optimising the processing of these coatings. Subsequently, an optimisation program of conventional chromia and titania coating had been carried out in parallel with the nanostructured chromia coatings development.

In this manner, the nano effect on performance could be identified through characterisation.

According to Williams, while sufficiently successful to prove the process viability the first generation of HPAL plants – Murrin Murrin, Cawse and Bulong – also identified the need for grassroots development of designs, materials and processes.

"Initially, ball valves with ceramic sealing surfaces used in the first generation HPAL plants were undependable, presenting a major operating expense for the valve maintenance with high indirect costs because of a lack of isolation," he said.

"Today, significant improvements in design and materials have been achieved by a few manufacturers, however, the true level of performance gained has not been demonstrated in the second generation HPAL plants ... materials and designs are still evolving.

"The ceramic coatings applied to the balls and sets play a major role in the dependability of the life of a valve."

Next step

Williams said both coatings and valves continued to evolve for HPAL applications.

And while significant improvements had been achieved, he believed there was room for improvement.

"Nanostructured chromia offers the promise of improved abrasion and erosion resistance over both conventional and nanostructured titania coatings and over any known coatings available today," Williams added.

"Such coatings are well along in development with optimisation, detailed characterisation and field validation phases remaining."

Commercialisation of nanostructured chromia would follow these optimisation efforts, while characterisation of abrasion, erosion and field performance would also be ongoing.