NICKEL PROCESSING TECHNOLOGY 10 YEARS ON FROM CAWSE, BULONG AND MURRIN MURRIN

Presented by

Alan Taylor ALTA Metallurgical Services - Australia

alantaylor@altamet.com.au

10 years ago, the nickel processing scene changed dramatically.

The first PAL laterite plants since Moa Bay were under construction in WA.

Leaching commenced at Cawse in September 1998,





at Bulong in December 1998





and at Murrin Murrin also in December 1998.





Executives from all three projects have been Key Note Speakers at previous ALTA conferences:

ALTA 1996: Bob Pett Chairman of Resolute, who built Bulong.

ALTA 1997: Ken Hellsten General Manager Cawse Operations.

ALTA 1998: Andrew Forrest, CEO of Anaconda Nickel, who developed Murrin Murrin.

ALTA 2001: Adrian Griffin CEO of Preston, who operated Bulong.

In commemoration of the start of PAL in WA in 1998, the ALTA 2008 Conference in May 19-24 will feature a special Symposium:

"PAL 10 YEARS ON FROM CAWSE, BULONG & MURRIN."

The Key Note Speaker at the Ni-Co Dinner will be : Mr Murilo Ferreira President & CEO of CVRD Inco

We are now issuing a call for papers – contact ALTA soonest to secure a place in the program.

The events of the past 10 years for PAL could be described as "TURBULENT".

Cawse started well but the Centaur group ran into financial difficulties and sold the operation to OMG.

OMG terminated downstream processing and sent an intermediate precipitate to Finland for refining.

Cawse is now operating under the banner of Russian nickel giant Norilsk.

Bulong suffered a lengthy ramp-up period due to equipment problems in the PAL area and gypsum precipitation in SX.

These were ere eventually solved, but the operation was closed in 2003 after it lost its acid supply from the WMC's Kalgoorlie Nickel Smelter, and could not source an alternative low cost supply.

It is now owned by LionOre who are considering converting it for the pressure oxidation of sulphides.

The future has now been complicated as it appears that LionOre will be taken over by Xstrata or Norilsk.

Murrin Murrin experienced lengthy problems in the both process area and ancillary operations.

Anaconda defaulted on debts in 2002 and was restructured as Minara Resources in 2003.

Continuous focus on maintenance and debottlenecking have since steadily improved performance.

Has recently completed construction a heap leach demonstration operation for scats, and is targeting ore.

Western Australia's second largest nickel producer, and one of the top ten in the world.

"Prophets of doom" wrote off PAL after the experiences of the WA operations.

But wiser heads knew that:

-Most of the world's future nickel has to come from laterites.

- Most known laterite resources are unsuitable for smelting.
- Future projects could learn from the WA experiences.
- -The WA projects each chose a different process route, providing a great opportunity for comparison.

Thus it was not such a great surprise when major players began to announce new PAL projects to meet the rising metal demand. An article by the author in the November 2001 Minerals Gazette entitled "Laterites Dead and Buried or Alive and Kicking" asked the million (or perhaps billion!) dollar question:

"The trials and tribulations of the three WA pressure acid leaching operations have been well publicised. But what effect will all of this have on the future of laterites as a major source of nickel and cobalt?" The author then answered his own question:

"THE FUNDAMENTALS REMAIN THE SAME"

Which is why we are seeing the development of new PAL projects including:

Sumitomo's Coral Bay Project in the Philippines, which successfully came on stream in 2005.

It was featured in several presentations at ALTA 2006, including the Key Note address by Naoyuki Tsuchida, Exec. VP of Coral Bay Nickel.

Sumitomo have now announced an expansion project.

CORAL BAY NICKEL



CVRD Inco's Goro Project which is under construction in New Caledonia.

Notable for an innovative flowsheet in PAL, SX and product recovery areas.

Major project reviews were conducted from 2003-2004

Many changes made to reduce capital costs, but basic flowsheet unchanged. Production is expected late 2008/early 2009

Gord Bacon, Technical Director of Inco, was Key Note speaker at ALTA 2000

GORO PILOT PLANT



BHPB's Ravensthorpe project which under construction in WA.

Includes both PAL and atmospheric leaching and will produce a mixed hydroxide precipitate for refining at the Yabulu ammonia leach operation in QLD.

Like many other current projects, it has suffered from escalations in capex.

It is due on-steam in 2008.

RAVENSTHORPE PROJECT



CVRD Inco's Verhelmo Project which is under development in Brazil.

It basically follows original Cawse process route.

A detailed feasibility study has been completed, ant it is awaiting for the environmental permit to proceed.

VERHELMO PROJECT



Other major PAL projects at various stages of development include:

Weda Bay in Indonesia - now owned by Eranet of France.

Ramu in PNG - owned by MCC of Chin (majority) together with the original developer Highlands Pacific.

Ambatovy in Madagascar - owned by Dynatec (operator)/Sumitomo/KORES Korea/SNC-Lavalin. (Dynatec is being taken over by Sherritt International who are part owners of the Moa Bay PAL operation)

Gladstone Pacific in QLD.

However, PAL has some rivals:

Atmospheric leaching is included in the Ravensthorpe flowsheet, and is under consideration for other projects.

Atmospheric chloride leaching technology is also under development.

Skye Resources in Canada have developed a new sulphation-atmospheric leach process for their Phoenix Project in Guatemala.

Heap leaching is finally emerging as a serious contender.

European Nickel are advancing the Çaldağ Project in Turkey.

Minara have constructed a heap leach demonstration operation for scats from their PAL plant in WA.

Heron are developing the Jump-Up Dam Project in WA.

Metallica are progressing the NORNICO Project in QLD.

Plus other development programs are underway elsewhere.

ÇALDAĞ PROJECT



In the meantime, sulphide processing technology has been undergoing a "quiet revolution" of its own.

LionOre have announced the first large scale commercialization of their Activox low pressure oxidation process for sulphide concentrates at Tati Nickel in Botswana.

Gary Johnson, Managing Director of LionOre Technologies, is Key Note Speaker at ALTA 2007.

ACTIVOX PILOT PLANT



Polymet Mining of Canada are developing the NorthMet Project in Minnesota, USA, with the PLATSOL[™] Process which uses high pressure oxidation at 220-230°C.

It is the largest undeveloped non-ferrous metal project in the U.S. Polymetallic sulfide deposit containing platinum, palladium, gold, copper, nickel, cobalt, and silver.

A small amount of chloride is included in leach process to extract precious metals.

A pilot plant has operated at Lakefield, Canada.

Former low grade iron ore plant is to be used.

NORTHMET PROJECT



CVRD Inco are developing a pressure oxidation Process to treat sulphide concentrate from the Voisey's Bay Project in Labrador in Canada.

A demonstration plant is operating at Argentia, Newfoundland.

A feasibility study for a commercial plant is being carried out.

Commercial operation projected for 2011.

VOYSEY'S BAY DEMONSTRATION PLANT



Cominco Engineering Services Ltd (Teck Cominco) in Vancouver, Canada, is developing the CESL process.

CESL is a medium pressure oxidation process.

Integrated pilot and demonstration plants have been operated in Vancouver.

CESL DEMO PLANT



Heap Leaching also emerging for sulphide ores.

BioHeap Ltd in WA is developing the BioHeap[™] process.

Test heaps operated in 1999-2002 at Titan's Radio Hill Operation in WA.

It is being tested for Australian Resources' Sherlock Bay Project in WA.

Bill Ryan, CEO of Titan, was Key Note Speaker at ALTA 2002.

RADIO HILL TEST HEAPS



Talivaara Mining is developing heap bioleaching for the polymetallic deposits at Sotkamo, Finland.

Talvivaara deposits comprise the largest known nickel sulphide resource in Europe.

Demonstration heap and plant started in 2005 at Sotkamo, where the climatic conditions are subarctic.

Targeted for commercial operation in 2009.

SUMMER AND WINTER AT TALIVAARA DEMO PLANT



So what do the next 10 years hold for nickel processing?

Some key influences include:

Obviously the nickel price – currently in uncharted waters, and who knows what in the future?

Demand in China and other rapidly developing countries such as India.

Environmental issues – efforts are now being made to add carbon dioxide to the list of undesirables.

Health/Toxicity regulation trends – eg in the EU.

Water availability – especially in dry regions of Australia such as WA. A major copper concentrator is already under threat of closure in NSW

Based on today's picture, likely trends could be:

- Continued application of PAL for laterites especially for large projects and higher grade deposits.
- Further development of atmospheric agitated and heap leaching, especially for smaller projects, adjunct and satellite operations, and lower grade deposits.
- Increased application of pressure oxidation for sulphide concentrates, especially for large projects.
- Commercialization of heap bio-leaching for lower grade sulphide ores and those with impurity issues.

ALTA hopes to continue to play a useful role as the annual gathering place for the global Nickel-Cobalt Industry.