Centre for Sustainable Resource Processing

The CSRP Extract

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From the CEO

Welcome to the CSRP Extract.

Our Newsletter has a fresh new look as well as a new name. TOur Newsletter has a fresh new look as well as a new name. The CSRP Extract will continue to provide updates on our various activities, as well as introduce to you our team of researchers.

There has been tremendous amount of effort that had gone into developing the new suite of projects within CSRP. In this edition, it is with great pleasure that I introduce the many new projects currently underway in the CSRP Research Portfolio.

The research is a mix of fundamental work and applied demonstrations. Many projects have taken the findings from the original suite of projects and translated them into a more applied research direction. The end goal is to ensure the uptake of this world class research into industry operations.

The effort required to introduce such a large number of projects has been significant. I am pleased to say that the collaboration between our researchers and industry participants has been outstanding and there is significant industry involvement the new suite of projects. Our research is and will continue to be world class and, with the current level of industry involvement, is relevant to a number of different mineral processing industries.

Another major activity for CSRP in the previous few months has been the "DEST 3rd Year Review", led by Prof Cyril O'Connor from the University of Cape Town. The review team looked at many aspects of CSRP's activities and met with more than 60 people in Perth, Melbourne and Brisbane. The review team were impressed by the progress of CSRP to date and made recommendations to further enhance our effectiveness. These recommendations will be considered by the Board and any actions arising will be announced in due course. I would like to thank all those involved in this review, CSRP participants and non-participants alike, for all their efforts

Stevan Green

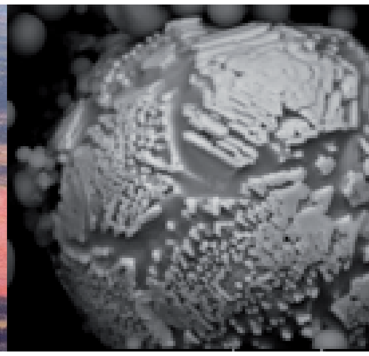
CEO

The Next Phase …

There have been a number of CSRP foundation projects that have recently come to an end. The next suite of projects is looking to take the outcomes from the foundation work and translate it into more applied research. Here we introduce the next stage of research in CSRP.

Characterisation of Rock Mass for Liberation at Coarse Sizes (Project 2B8)

Substantial reduction in beneficiation costs can be achieved by significantly reducing the proportion of mine output to be processed by fine comminution and flotation. Outcomes of the 2B1 project on



eco-efficient coarse particle liberation and separation shows that it is possible through the blasting process to enhance selective mineral and waste liberation at coarse particle sizes. This project will address three aspects: mathematical modelling of rock fragmentation, experimental studies and the implications of blasting fragmentation methods to geo-mechanics modelling.

The overall objectives are to increase further understanding of breakage due to blasting and crushing, and how these fragmentation methods can induce mineral and waste liberation and to develop alternative rock mass characterisation methods that will be useful for quantifying rock mechanics properties of the ore with emphasis on rock comminution.

Knowing the breakage characteristics of the ore will allow for the design and selection of appropriate rock fragmentation (blasting) and crushing processes prior to pre-concentration. Moreover the method would also assist in developing geo-mechanical rock characterisation which would then be useful for stope or open pit design. The objectives of this work are consistent with the CSRP objective to reduce energy and greenhouse gases.

Value Recovery from Bauxite Residue – A Zero Waste Approach (Project 4A8)

This project is part of the research effort to develop and demonstrate an economically feasible zero waste flowsheet for the processing of red mud (bauxite residue), based on chemical and phase transformation of red mud through high temperature processing. The research will involve: design of optimum slag practice using CSIRO's Multi Phase Equilibrium package; validation of model predictions and establishment of smelting parameters in small scale tests; development and evaluation of leaching processes for the slags, and techno-economic analysis of the smelting and leaching flowsheet. The overall objective of the research into zero waste from red mud is to develop conceptual flow sheets for red mud processing and evaluate these with respect to zero waste goal; economic recovery of valuable components and life cycle assessment. This includes establishing technical and economic bases for further development through bench and pilot scale tests

Geopolymer in Mine Fill (Project 4B2)

The project will investigate the potential for geopolymer-based backfill products to substitute Ordinary Portland Cement (OPC) in underground mine backfill. The suitability of using mine tailings and smelter slag as feedstock for geopolymers will be investigated and geopolymer-based back fill products will be subsequently developed and tested, to demonstrate technical feasibility, economic viability and sustainability/greenhouse gas benefits. A major outcome will be a successful demonstration in a fill application. This will require understanding of the required fill specifications and process conditions, an initial characterisation of the mine fill feedstock material and testing of various geopolymer-based formulations using different combinations of the feedstock.

View of Kwinana Industrial Area

Kwinana Industrial Inorganic By-Product Reuse (Project 3B3)

This project aims to evaluate a selected set of 10-15 synergy opportunities for inorganic by-product recovery in the Kwinana Industrial Area. It will initially focus on the following high volume industrial inorganic by-products: red sand and red lime, gypsum, and fly ash. These inorganic by-products are currently being disposed of and/or stored in large volumes in dedicated facilities in Kwinana. Large volumes of inorganic by-products are produced within the Kwinana Industrial Area and their utilisation as valuable by-products will significantly reduce liabilities associated with current management and storage practices. The opportunity exists to replace virgin materials with recovered, and potentially beneficiated, inorganic by-products from industrial operations in Kwinana, either directly or after some processing to improve properties, in construction and engineering, sustainable agriculture, minerals and metals production and other applications.

Early Removal and Safe Disposal of Arsenic and Other Minor Elements during Base Metal Processing (Project 2D8)

In this project a new flowsheet for dealing for base metal sulphides containing minors/toxics will be developed and tested. In this scheme minor elements (minors) are removed early in the beneficiation process so that a clean, low-minors concentrate can go to smelting. The minors concentrate is then roasted selectively to fume off the minor into a low volume stream and recover residual valuables. Next, the fume is stabilised chemically/physically such that it can be safely deposited back into the ground.

Leanne Smith investigating the early removal of minor elements using flotation (Image by misheye)

The penalties charged by smelters for minor elements in concentrates are increasing because the smelters are forced to manage the removal and disposal of the toxics, which is difficult and costly. Governments are becoming increasingly sensitive to smelter emissions and pressure is building from the community in general for more sustainable processing. If an economically viable early removal option for minors can be developed the impact of the above considerations would be greatly diminished.

Development of a Non Invasive Continuous Mill Charge Monitoring System (Project 2B6)

This project is based on the measurements of electrical resistivity of the mill charge by using electrodes contacting the outer surface of the mill shell, without penetrating mill shell or liner. In this project we will map the interior of the mill (position and shape of the charge) by measuring minute amounts of electrical current which will leak from the mill shell into the charge, and the consequence of such current leakage on the effective resistivity of the selected section of the mill shell and part of the charge in the proximity to the tested part of the mill shell.

Motion of the charge within tumbling mill has critical influence of the mode and intensity of rock breakage as well as wear of the mill liner and steel balls in the case of SAG mills. SAG/AG mills are difficult to run optimally due to the need for constant balancing of feed rocks (particularly larger rocks) and steel balls with their consumption within the mill. Therefore accurate timely information about the shape of the charge as well as composition of the charge is of critical importance for mill optimization and operation. A method will be developed for reliable, real time collection of information about mill charge, obtained in a way which will not interfere with normal operation of the mill. Developed technology will be able to assist mill operators in optimizing efficiency of rock size reduction process within SAG/AG mills.

Improvement of Energy Efficiency of Rock Comminution through Reduction of Thermal Losses (Project 2B7)

The purpose of this project is to quantify comminution energy losses that occur due to heating of rock during comminution. It aims to provide quantitative answers as to how much introduced energy ends up as heat, how this varies with rock type, what is the influence of the method of rock crushing and what can be done to minimise such waste of introduced energy. These objectives will be accomplished through measurements of thermal energy radiation from the surface of rocks, during the crushing process. Measured thermal energy will be compared with consumed energy and produced fragment size distribution.

Beside temperature measurements and determination of thermal energy, this project will correlate thermal energy parameters, with other physical parameters of rock, such as elasticity, compressive strength, tensile strength, coefficient of friction, mineralogical composition. Results will be also analysed in context of achieved fragment size distribution.

The project will further investigate modalities of rock breakage which are characterised with minimal thermal losses and correlate that with achieved fragmentation. This project will contribute to a more informed selection of rock size reduction process / equipment.

Biomass 1A - Mallee Leaf/Twig Charcoal as Metallurgical Reductant (WA) (Project 4C2)

There were several major outcomes from project 4C1 “Biomass as fuel and reductant in modern smelting processes”. These include the demonstration of the potential for biomass to be used as a reductant in metallurgical processes and the identification of the leaf/twig fraction as the source of the lowest cost charcoal. This project will use these outcomes to develop the concept of using Mallee-derived charcoal as a metallurgical reductant and define the cost range of Mallee leaf/twig derived charcoal to metallurgical companies in WA.

The range of stakeholders in this project is diverse with strategic relationships being developed between CSRP, Salinity CRC, CALM, the WA State Government and industry to support larger scale tests/plant trials; and characterise the key properties of leaf/twig derived charcoals relevant to metallurgical applications.

Biomass 2: The Utilisation of Carbonaceous Waste in Metallurgical Processes (Project 4C3)

The project will build upon project 4C1 “Biomass as fuel and reductant in modern smelting processes”. Large amounts of waste biomass are generated each year in rural and regional Australia, in the agricultural, forestry, sewage and waste treatment industries. It should be possible to utilise these materials in metallurgical processes as a substitute for fossil fuels such as coal and metallurgical coke. In this way the energy and carbon content and value of the waste materials are recovered. Considerable environmental and economic benefits may then be available to the minerals processing and biomass waste generating industries.

The key sustainability outcomes of the project are expected to be a reduction in the dependence of the metallurgical industry on fossil fuels; a tighter CO_2 cycle in the use of reductants; redirecting some waste materials from landfill disposal to useful application; the recovery of inherent value and energy locked in carbonaceous waste materials; and cost benefit to industry (lower carbon input costs and reduced disposal costs).

Biomass in the Iron and Steel Industry (Project 4C4)

The iron & steelmaking industry faces increasing pressure to reduce the emissions of greenhouse gases. The predominant contributor to greenhouse emissions within the Blast Furnace-BOS integrated steelmaking process is the coal-coke used as both a metallurgical reductant and energy source. A small quantity of coke is also used in Electric Arc furnace steelmaking. The overall objective of this project is to determine the areas in integrated and EAF steelmaking where the use of biomass may be ultimately viable, in order to propose further focussed development research in those areas.

Aerial View of Part of Gladstone

Regional Synergies (Rustenberg – Project 3D1, Kwinana – Project 3B1, Gladstone – Project 3C1)

The overall aim of the Rustenberg project is to assess whether and how regional synergies can contribute to sustainable development in the Rustenburg area. The project aims at regional synergies, which could be between operations of the same company (intra-industry, between e.g. mines, concentrators and smelters), between operations of different companies (inter-industry, for instance with platinum producers and nearby chromium, vanadium and chemical industries), or a combination thereof.

CSRP already has regional synergy projects on-going in Kwinana and Gladstone. The Kwinana project has been given a 2 year extension to provide hands-on support to the companies in the Kwinana Industrial Area, to develop, evaluate and implement synergy opportunities, and communicate the gains in the overall eco-efficiency of the area. The Gladstone project has been granted a 1 year extension, which will pay particular attention to the research questions being proposed in the region.

Use of Beneficiated Residue Sand (Project 4A7)

The extraction of alumina from bauxites results in the production of bauxite residues that might be further processed into valuable by-products thereby reducing the quantity of residue requiring final storage. This project will study the potential to separate and/or beneficiate bauxite residues into different materials using a variety of mineral processing equipment. The residues will be characterised by size analyses, x-ray diffraction and chemical analyses, and separations by gravity, magnetic and froth flotation processes will be undertaken. The objectives of the current study are to gain a better understanding of the mineral phases that can be separated by conventional mineral dressing; to understand how mineral dressing can be manipulated to provide various minerals from the Red Sand™ and Red Mud residues: and to gain an understanding of how these minerals compare as a feed stock to other mineral extraction processes.

Assessing the Potential for Hyperspectral Technology to Verify the Distribution of Red Mud Used as a Soil Amendment in Agriculture (Project 4A9)

This project seeks to investigate the feasibility of providing a spatially-comprehensive monitoring technique using airborne hyperspectral technology that can identify and quantify the distribution of bauxite residuals and it's effectiveness as remediation on the environment where it has been applied, namely, on agricultural lands and native woodlands.

There will be a pilot study that investigates in the laboratory and field using a field portable spectrometer the feasibility of detecting bauxite residuals and the detection limit; followed by a "scaling-up" phase using an airborne hyperspectral sensor.

Slag Waste Heat Recovery and Utilisation (Project 4D1)

Overall objective of this project is to determine the potentially viable opportunities in integrated and EAF steelmaking where the waste heat from molten slag cooling from 1500C may be utilised, in order to propose further focussed development research in those areas. The research case centres on identifying potentially practical and economically viable opportunities for capture and use of waste heat from molten slag cooling in iron and steelmaking. The information gained from this project will possibly have applicability to other metallurgical industries handling slags such as Lead/Zinc smelters.

Mallee belts in wheat crop near Toolibin Lake via Narrogin WA (Courtesy of CALM)

Heat Recovery from Molten Slags through Dry Granulation (Project 4D2)

Pyrometallurgy industry faces increasing pressure to reduce its energy and water consumption and the emissions of greenhouse gases. A huge amount of heat in high volume molten slag (melts) is currently discharged from pyrometallurgical processes without being able to recover it. Industry has strong interest in recovering and utilising waste heat. Dry granulation of molten slags potentially offers an effective means to recover heat, significantly reduce water usage and associated pollution issues (eg acid mists), and convert waste slags into valuable / saleable products.

The overall objectives are to assess options and viability of recovery and utilisation of waste heat from molten slag in pyrometallurgical industries; to develop a conceptual outline for heat recovery and utilisation based on technological and economic analysis and modelling; to design a suitable method / process and build a prototype rig to prove the concept and demonstrate the viability of the technology; and the technology developed being scaled up / commercialised and utilised by industries.

Centre for Sustainable Resource Processing

Meet and Greet

Our staff bring to CSRP a wide range of knowledge and experience. we are pleased to introduce some of them here.

Mr Michael Somerville, CSIRO

Michael Somerville has 15 years experience with the High Temperature Processing Program at CSIRO Minerals. His expertise extends to small scale (5-10 grams) thermodynamic and kinetic investigations into slag/metal/gas systems; bench scale investigations (1-2 kilogram) into the feasibility of high temperature chemical processes; and pilot scale (250 kilogram) investigations into novel high temperature industrial processes. He has managed large multi-disciplined teams to develop single stage copper making processes and study the injection of solid particles into deep slag baths. Prior to joining the CSIRO, Michael spent 6 years with Pasminco in a variety of technical improvement positions at the Port Pirie smelter and Hobart zinc refinery. Michael has Bachelor of Engineering from the RMIT and Masters of Engineering from The University of Melbourne. At the CSRP his work deals mostly with the biomass and toward zero waste projects within Program 4 - Breakthrough Technologies.

Dr Cliff Quan, ANSTO

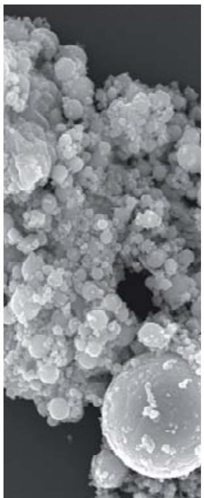
Dr Clifford Quan received both his BSc and MSc in Industrial Chemistry and Chemical Engineering from UNSW, and a PhD degree in Chemical Engineering from the University of Sydney. Prior to joining ANSTO in 1984, he had 5 years mineral processing research with Warman International Australia. Dr Quan is now working with the Process Development team/Research Group of ANSTO Minerals and has broad experience in mineral processing for many laboratory and pilot plant studies. His main interests are in hydrometallurgy, precipitate flotation and waste treatment.

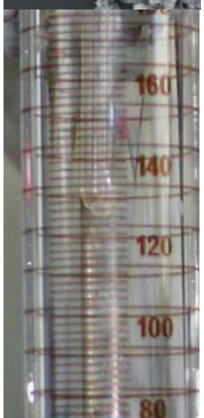
Assoc Prof Hamid Nikraz, Curtin University

Assoc Professor Hamid Nikraz obtained his PhD from Curtin University of Technology in 1989. His professional experience includes work as Research Associate at the Minerals and Energy Institute of Western Australia, Geotechnical Engineer with Abb and Sang Consulting Engineers, Iran; Sandconsult PBI (UK) Ltd, UK; and Granitext Laneh Company, Iran. Hamid's research Interests are in fields of soil stabilization in road construction, seasonal heave of clay soils in Perth, geotextile performance, rock mechanics and pit slope stability, and transport and traffic engineering. Hamid has been a member of staff in the Department of Civil Engineering at Curtin University of Technology since 1997.

Dr Nenad Djordjevic, University of Queensland

Dr Nenad Djordjevic is a Principal Research Fellow at the Julius Kruttschnitt Mineral Research Centre at the University of Queensland. He holds Bachelors and MSc degrees in Geology and Applied Geophysics, and a PhD in Mining Engineering. He has more than 20 years experience in applied geophysics, rock mechanics and blasting geomechanics. He joined the staff of JKMRC in 1992 and is involved in research related to rock fragmentation and comminution, blasting geomechanics, non-destructive testing and monitoring of rocks and engineering structures. The work has been implemented in mine sites in Australia, New Guinea, Chile, South Africa, USA and Canada.





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