"Turning waste into a resource through innovative technologies, processes and services" (7th Framework Programme)

CoLaBATS

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this issue

Project Update:

The CoLaBATS project is now coming to the end after three years of intense activity. The international consortium, which spans academics, research institutes, recyclers, chemists and equipment producers, has brought together expertise to deliver a completely new and highly innovative hydrometallurgical process for leaching multiple metals from battery waste black mass (electrodes and electrolytes).

The CoLaBATS technology has been designed to provide a multi-stage process capable of extracting key high value individual metals (Ni, Co, Cu, Ln, Zn), plus the extraction of other metal mixtures suitable for further refining.

The key outcome of the technology has been the ability to use novel deep eutectic solvents for leaching metals from the black mass. Compared to current hydrometallurgical processes that employ strong acids, the deep eutectic solvent (DES) is much more benign. The DES has a low vapour pressure, making it easier to handle, and offering improved air quality in the workplace,.

In addition, the benefit of the project outcomes is the ability to reuse the chemistry. The DES can be stripped of the metals and reused in a closed loop process. The benefits of this are the reduction in chemical costs for operating the plant, reduction of waste, and improved environmental impacts compared to other hydrometallurgical recycling processes.

Editorial:

The CoLaBATS project has come to an end, with the successful demonstration of the technology. The pilot plant operated at C-Tech Innovation has processed over 10 kg of both Li-ion and NiMH black mass, the equivalent of approximately 50 kg of battery waste.

The CoLaBATS project has also successfully overcome issues such as leaching from battery black mass, liquid-liquid separation for ionic liquids and solvents and has created methods for the separation and delivery of single metal fractions suitable for placing back into the metals market.

The technology has proven to be relatively robust, being able to handle different black mass compositions, and metal ratios. The robustness of the technology is likely to render it applicable for use with many other waste materials and metal mixes. For the future, consortium members are planning to utilise many of the results in further waste treatment strategies.

CoLaBATS Consortium Members

aprofitament assessoramen ambiental, s.l.
CEDRAT TECHNOLOGIES Innovation in Mechatronics
Solvionic
CHALMERS
TU WIEN
University of Leicester
Env- Aqua Solutions
C-Tech INNOVATION
tecnalia Inspiring Business

Recycling Tools

The ECOMAP

A map designed to locate sustainable businesses and products.

http://the-ecomap.com/en/oikos-ecomap/

Waste Markets in the EU

An EC study on the internal waste recycling and recovery markets.

http://ec.europa.eu/environment/waste/studies/index.htm

EIONET

European Topic Centre on Sustainable Consumption and Production

http://scp.eionet.europa.eu/facts

WastePortal

Information on urban waste management with an emphasis on Low and Middle Income Countries

http://www.wasteportal.net/

The feasibility of recycling is not the critical aspect of achieving a zero waste Europe, recycling comes down to the economic drivers to recover low concentration strategic metals. In June, a zero waste conference was held in Brussels and brought together industry experts interested in leading towards a zero waste Europe. The conference aimed to address the future EU roadmaps for zero-waste, looking to identify current recycling obstacles and address actions required to move Europe to a near-zero waste society.

The conference was designed to tackle three key waste value chains: ICT-waste (waste electrical and electronic equipment, WEEE), End-of-Life Vehicles (ELV), and packaging waste. These topics were chosen because they contribute a large percentage to waste streams, and for ICT and vehicles, contain many strategic metals and minerals. The environmental consequences of dumping these materials include heavy metal poisoning of local habitats and waterways, release of plasticizers and phthalates to the local environment, and the sheer volume of waste generated occupying more and more landfill.

For example, EU plastic demand was 46.3 Mtonnes in 2013 of which, 63% was post consumer plastic waste derived from packaging. Many municipalities have recycling collection points designed to collect and separate this packaging waste from household waste. For materials like cardboard, wood pallets, glass and 'tin' containers separation and recycling is fairly simple, cost effective and efficient. However, plastic packaging waste comes in many forms and can be difficult to distinguish. Contamination of one plastic with another polymer ,or other contaminants, significantly reduces the value of the secondary material, generating a final material with little market value. In addition, by 2020 there will be 100 M scrapped cars in Europe; these contain a mix of plastics, composites, metals, batteries, and electronics. To meet the ELV Directive's targets, 85% of the car must be recovered for the materials (secondary raw materials) and up to a further 10% recovered for energy.

The conference's objective was to obtain an insight into the key areas that should be focused on in order to significantly improve the efficiency of recycling in these three sectors. Bottlenecks preventing improvements to the recycling of ELVs, ICT and packaging were identified and, for all three topics, some of the same bottlenecks arose. Primarily these were; performance of separation and sorting technology. There are many sophisticated new designs and technologies being demonstrated and operated for the chemical separation of materials. However, all these techniques run into the same issues – the cost of separating raw materials from complex mixes. Physical separation of materials was identified as one of the corner stone processes which needs improving in order to create a big impact on recycling materials from packaging, WEEE and vehicles. For all the sophisticated processes, the operational costs are often the sticking point.

Circular Economy designs and concepts need to be amalgamated with current legislation, as well as migrating research and innovation policies to push for Circular Economy accomplishments. It has become apparent through decades of EC investment that there are multiple technologies and approaches capable of recycling mixed wastes to recover multiple materials, however, often it is the case that these processes are not economically viable in the current metals market. A process adopting a more synergistic approach optimising collection, sorting, pretreatment and development of the secondary metals market is required. The CoLaBATS project adds to this knowledge base and provides a possible new recovery system for REE and other critical materials in regions which cannot afford large pyrometallurgical processing units. The CoLaBATS project is best scaled up to deal with large volumes of batteries, and to utilise the cyclic approach of the chemistry process design, minimising chemical costs and improving economics and metal recovery ratios. To improve upon this further, more detailed analysis of the separation technology should take place, coupled with more intensive pretreatment, sorting, shredding and separation.

Project Dissemination Event

C-Tech Innovation, Capenhurst 15th Sept 2016

Following the successful development and deployment of the new CoLaBATS battery recycling technology, the project team hosted a public dissemination event to interested attendees on 15th September at C-Tech Innovation in Capenhurst, Chester as part of the project's final progress meeting. The event, which was attended by key personnel from both industry and academia, was opened by Dr Rod Kellner from Env-Aqua Solutions Ltd, who gave an introduction to the structure of the event, which included both a series of presentations and a demonstration of the CoLaBATS technology. Dr Bob Crawford, the project's coordinator from C-Tech Innovation Ltd than presented an overview of the CoLaBATS project and its objectives. The structures of typical batteries were outlined and it was made clear how complex both battery structures and their chemical compositions actually were. Battery types varied by basic chemistry and manufacturer and, for each chemistry, the material composition was also changing with time. Dr Crawford showed data detailing the material make up of a typical lithium-ion battery and described how challenging it was to meet the legislatively required recycling targets that were mandated. The basic outline of the CoLaBATS metal recovery process was then described; it utilised a liquid-liquid extraction approach based on the use of specially developed deep eutectic solvents. The new process offered a number of key advantages over conventional aqueous approaches and it was possible to separate the valuable metals in high purity from those that were of less value or contaminants.

Professor Martin Goosey of Env-Aqua Solutions then gave a presentation detailing why battery recycling was becoming such an important issue. Two key drivers were the current European 'producer responsibility' legislation and the need to recover and conserve valuable material resources. Martin gave an introductory overview to the legislation and pointed out that it typically became more stringent each time the European Commission revisited it; recycling targets were thus likely to increase from the current 50% level. He detailed the huge volumes of batteries that were used and consumed in the UK, and globally, each year, and discussed this in the context of the subsequent waste stream and the valuable materials they contained. There was also predicted to be a huge emerging demand for new lithium-ion batteries for use in electric vehicles, which would turn drive the demand for the materials from which they were made. There was thus a real, and growing demand for new recycling and recovery technologies such as that developed in the CoLaBATS project.

Dissemination Event Continued:

Professor Karl Ryder from the University of Leicester, then gave a presentation on the fundamental deep eutectic solvent technology that was the basis of the novel CoLaBATS process. Karl outlined the properties of ionic liquids and the benefits they offered. They had low vapour pressures and were generally non-toxic. They also enabled chemical processes to be developed that were not possible in aqueous systems. He also described the work that had been performed by the university as part of the project to prepare low cost deep eutectic solvents and detailed some of the other applications of deep eutectic solvents that had been developed for related electronics applications. These included processes for the deposition of a range of metal coatings that showed superior properties compared to existing processes. He concluded by detailing how these new chemistries were playing an important role in the new CoLaBATS technology and how interest in these unique materials was rapidly increasing. The number of papers published on deep eutectic solvents and their applications was also continuously increasing.

Clare Downs from C-Tech Innovation then concluded the presentation session by giving a more detailed description of the specific CoLaBATS process. She began be outlining the solvent extraction and metal speciation approach that formed the unique fundamental basis of the CoLaBATS technology. The initial process development work had been carried out on a small scale and had allowed determination of the separation times. The technology had then been further developed around the use of novel mixer settlers specially developed for this specific application. The scaled-up demonstration unit had been running at C-Tech since June and was currently being used to generate as much performance information as possible. This data was subsequently fed into the operational costs analysis and life cycle assessment parts of the project. The key performance benefits of the process were then outlined and it had been found that the deep eutectic solvents could be recycled and reused multiple times. Recovered cobalt had a greater than 98 % purity and the mixed lanthanide product was >95 % pure. Clare concluded the presentation by detailing the future planned work that would be undertaken to bring the project to a successful conclusion.

The CoLaBATS team were also present at the event and, following a wrap-up question and answer session, the attendees were taken to C-Tech's development laboratories for a demonstration of the CoLaBATS equipment in operation. This highly successful event concluded with a networking lunch where the attendees were given the opportunity to ask the CoLaBATS team any final questions.

Consortium:

Aprofitament i assesorament ambiental S.L. is a SME created by Cristobal Hernandez in 2005. The company started in Les Franqueses del Vallès with the recycling of all kind of batteries as his main market, the thing that has made A3 different is that A3 started collecting the batteries and other hazardous waste from the garages as oil filters, antifreeze and hydrocarbon mixtures. A3 have the only precious metal recovery plant in Spain, recycling WEEE and Catalytic converters. A3 recycle about **20.000 tons** per year of **WEEE, batteries**, and **metal** scrap issued from industry.

CEDRAT TECHNOLOGIES (CTEC) is a high tech SME based in the French Innovation Valley, close to Grenoble, which provides innovative solutions in the electrical and mechatronic fields, ranging from the development of software tools, to the study, design and manufacture of systems. CTEC extensive R&D activity is conducted by a multidisciplinary team of experts. Its laboratories are equipped with a complete library of engineering software and specialised measurement apparatus. CTEC focuses its expertise on industry needs for innovation and optimisation and is a member of EARTO (European Association of Research and Technology Organisations).

At Chalmers University of Technology in the mid-2000s a new section was established in the department of Chemical & Biological Engineering which is named “Industrial Materials Recycling” (IMR). This is a section which is devoted to the study of recycling, the primary aim of this section is to create recycling methods for materials which cannot be recycled. Another key aim is to produce recycling processes which produce products which are at least as valuable as the original material was before it was fabricated into the product which is being recycled.

C-Tech Innovation is one of the UK’s most successful research, technology and innovation organisations. With clients across the globe in multiple sectors, we are focused on delivering outstanding solutions helping them to maximise their potential for success. We deliver government funded collaborative R&D (EU, Innovate UK), one-to-one bespoke research and have a successful track record in Innovation Voucher delivery.

An SME specialising in industrial end-of-life, waste treatment and pollution control, and has been instrumental in the design, installation and promotion of waste minimisation and resource recovery systems and programmes with a global industrial client base.

The company’s ethos is to support industrial symbiosis, resourcefulness and generate circular economies within industry. Recovery of materials from waste products and effluents is a key business area for Env-Aqua Solutions. The company designs and installs, on a turnkey basis, waste treatment and recovery based plant and equipment.

Consortium Focus:

G & P Batteries is the UK's leading authority on waste battery collection and recycling. We offer a nationwide service for the collection of every kind of waste battery or battery powered appliance. All batteries collected are taken to our headquarters in Darlaston, West Midlands where they are sorted into various chemistries and then stored until an optimum quantity is obtained for recycling. Wherever possible, waste batteries are recycled within the UK.

The Materials Group at the University of Leicester (UoL) are the pioneers of the Deep Eutectic Solvent (DES) technology that has grown in popularity and application over recent years. Prof. Karl Ryder has been working in the field of DESs for more than a decade now and his current interests are primarily focussed on developing electrochemical processes for modifying a range of metallic surfaces and also developing novel polymer batteries. Much of the surface modification work has revolved around the electroplating and electropolishing of a wide variety of real world substrates with the aim of replacing current processes already used by industry.

Solvionic produces more than 100 ionic liquids and related products references. Different quality standards are available depending on application. Volumes are adapted to every step of a process i.e. from few grams to the ton scale. Within the framework of sustainable development, Solvionic develops selective chemistry branching from the use of ionic liquids. Solvionic is actively engaged in the production of ionic liquids, the development of their applications and providing assistance to industrial projects in the field of energy storage, new materials and catalysis. Solvionic is also the choice for a privileged partnership offering dynamism, reactivity and competitiveness. Innovation, high-tech control and quality of the products are the key factors to Solvionic's success today and Solvionic products and services are being marketed worldwide.

TECNALIA RESEARCH & INNOVATION (www.tecnalia.com) is a private, independent, non-profitapplied research centre of international excellence. Legally a Foundation, Tecnalia is the leading private and independent research and technology organization in Spain and one of the largest in Europe, employing1.299 people (198 PhDs) and with income of 102 Million € in 2014. TECNALIA aims working with companies to promote the transformation of knowledge into wealth to improve people's quality of life by generating business opportunities for industry. TECNALIA is based on 7 sectorial Business Divisions: Sustainable Construction, Energy and Environment, Industry and Transport, ICT-European Software Institute, Health, Innovation Strategies and Technological Services, which allow TECNALIA to provide personalized and multidisciplinary attention to our clients. TECNALIA has been granted over 250 patents and promoted more than 30 spin-off companies.

Vienna University of Technology is Austria's largest scientific-technical research and educational institution and covers the classic engineering disciplines. In addition to basic research for the development of new methods and strategies of synthesis, the focus of the Institute of Applied Synthetic Chemistry is on practice-oriented synthetic chemistry. The cornerstones of its activities are the synthesis and characterization of products that are industrially and technologically exploitable and marketable as well as the development of technical manufacturing processes.

Upcoming EU H2020 Calls:

SCS-13-2016-2017: New solutions for sustainable production of raw materials

7th March 2017

SC5-14-2016-2017: Raw Materials Innovation Actions

7th March 2017

SC5-33-2017: Closing the Water Gap

7th March 2017

FOF-06-2017: New product functionalities through advanced surface manufacturing processes for mass production

19th January 2017

PILOTS-03-2017: Pilot lines for manufacturing of nano-textured surfaces with mechanically enhanced properties.

27th October 2016

Upcoming Milestones & Events:

Events -

19th October 2016

Brussels:

SCIENCE AND INNOVATION IN EUROPE: Horizon 2020 so far, completing the European Research Area and next stages for the Innovation Union **http://bit.ly/2aumk44**

15th November 2016

Barcelona:

EUROPEAN UTILITY WEEK 2016: A conference for connecting the smart utility community. This will showcase new developments in grid optimisation, renewables, energy storage, storage efficiency and more. http://eurobat.org/events

16th January 2017

London:

THE CHALLENGES OF HYDROGEN AND METALS: The Royal Society is hosting a scientific discussion about producing hydrogen from renewable energy sources, and its damaging effects on metals used in its handling and storage.

Useful Links:

CoLaBATS	www.colabats.eu
EWIT	www.ewit.site
ProSUM	www.prosumproject.eu
Closing the Loop	www.closingtheloop.eu

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Env-Aqua Solutions