Multi-metal recycling for a sustainable society

by Chris K. Holding, Editor, Copper Worldwide magazine

Without advances in recycling, according to the UNEP International Resource Panel, the 'business as usual' scenario could lead to a tripling of global annual ground/subsea resource extraction by 2050. This is the true meaning of waste, when an opportunity is not taken. The opportunity is to preserve the planet by practising resource efficiency, and this must apply in the case of all seven billion of us.

Introduction

In an imperfect world, mankind is usually pretty good at organising itself to make things happen, and to progress. The first signs of copper smelting from malachite and similar oxidic ores date to around 5,000 B.C. Since then, the technology for extracting, refining and smelting copper from a variety of metallic ores has been developed, and a global industry established to further process copper and its alloys into rod, wire, tube, strip and profiles for so many essential applications.

The subject of a resource efficient economy was high on the agenda at the recent Copper Recycling Conference in Brussels. Within the production and manufacturing chain recycling mostly reaches its optimum as metal yield is maximised. So what happens when an old copper boiler cylinder and pipework are taken out of your house, you drop your old computer off at the recycling centre, or your car goes to the breakers yard? Twenty years ago, a fair portion of it would have gone to landfill or been shipped to another country. Today, you'd be surprised at what is being done at both a local and a global level. The major advantage in using recycled copper is that recycling uses only 20% of the energy needed for primary production. Couple this with a growing global mountain range of electronic waste (e-waste), and a new business model is born. I was moved on this occasion to join the debate about where this new technology sector is going, because I believe we can all contribute to its success, in however small a way.

Much progress is needed

By 2050 the population of Asia will be about 5.2 billion, of which India will be 1.66 billion. China's population is expected to stabilise around its current 1.35 billion. African population will grow from 994.5 million to 2.27 billion, compared to Americas 1.13 billion and Europe declining to just 677 million. Get familiar with these numbers, because this is where the largest markets should be, but close attention must also be paid to a persisting raft of nations with the potential to grow rapidly given the right conditions.

Much controlled disposal takes place in developed countries, but work is still needed in many developing countries to improve disposal following mining, smelting, battery and e-waste recycling. There are still too many countries where waste disposal rather than integrated waste management is practised without resource and materials recovery, where there are weak institutional and regulatory frameworks (primarily in national waste policy and legislation on integrated waste management), where there is poor enforcement of existing laws, where infrastructure for collection is inadequate, and where crude and resource-inefficient recycling exists in the informal economy. The above is not my conclusion, it is the conclusion of the fifth edition of the Global Environmental Outlook (GEO-5), launched on the eve of the Rio+20 Summit in June 2012. It assessed 90 of the most important

environmental goals and objectives and found that significant progress had only been made in four.

This is what the experts think, but we all know that the true test of any industry activity is public opinion. The miners know this very well, and in the vast majority of cases they are practising corporate social responsibility both regionally and globally. Employee training and safety is seen as paramount, but when you consider the scale of operations and the man-hours in the millions, they can at best minimise the occurrence of injuries or accidents.

Copper tube and strip scrap awaiting processing (Photo: CDA)

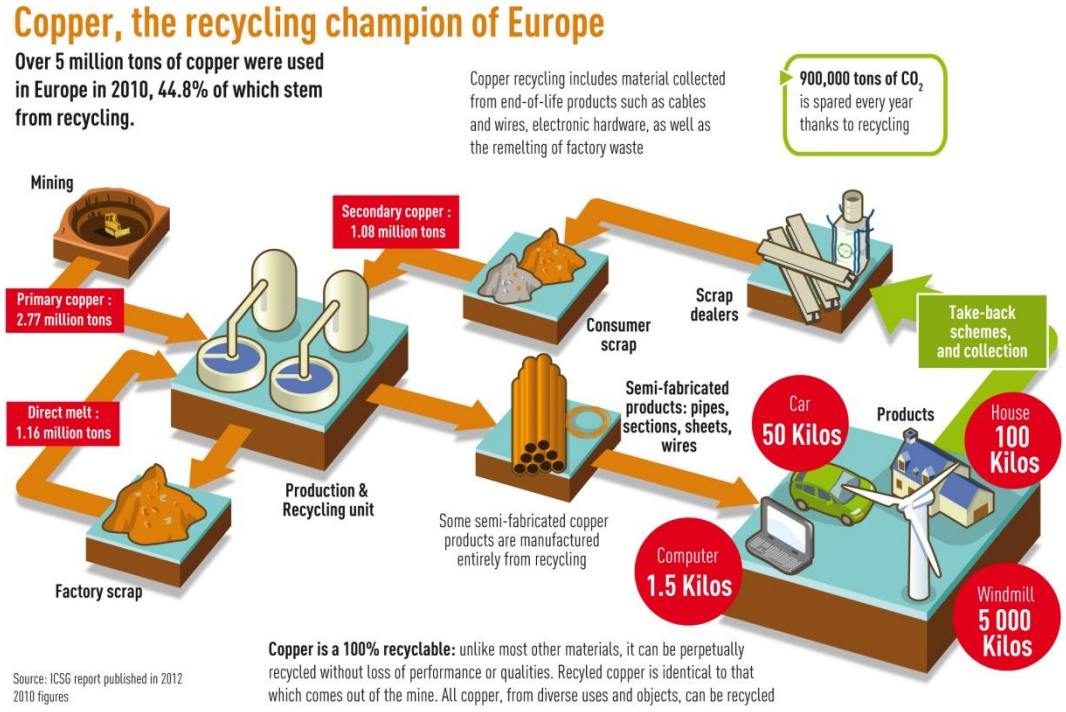
Multi-metal recycling

In the case of sustainable multi-metal recycling, the business model is being pioneered, practised and developed by Aurubis, Boliden, Metallo-Chimique and Umicore in Europe, and by the integrated approach of JX Nippon Mining & Metals Group at the HMC (Hitachi Metal Recycling Complex) in Japan among others. JX Nippon is promoting the recycling of metal resources from 'urban mines' by using technologies and expertise accumulated in its mining and smelting and refining operations over the years. In March 2009, it completed construction of new recycling facilities in Hitachi City, Ibaraki Prefecture, as part of the HMC (Hitachi Metal Recycling Complex) project. Taking advantage of its close proximity to the Tokyo metropolitan area urban mine, it increased capacity for the collection of materials and recovers 16 different metals, including precious and rare metals by a unique combination of hydro- and pyro-metallurgical processes. The metals recovered at the HMC Works are used as the raw materials for its electronic materials business.

The increased use of electronic products, shorter product lifecycles and stricter legislation governing electronic waste means that the global availability of waste (scrap) from electrical and electronic equipment (WEEE) is increasing. The Japanese National Institute for Materials

Science estimates 38 million tonnes of copper already exists in the Japanese urban mine alone. Electronics, for example computers and mobile telephones, contain valuable metals such as gold, silver, copper and palladium. One tonne of electronic scrap yields 100 g of gold, while ore concentrate only yields 8 g. With the population growth predicted above, the 16 million tonnes per year produced by mines will still be needed in at least the medium term.

On the demand side, for example, development of new and existing applications is key to the European Copper Industry's Manifesto and subsequent Technology Roadmap series. For example, electric motors consume about 60% of industrial electricity demand. Full implementation of the Minimum Energy Performance Standards for electric motors (published in The Official Journal of the European Union L 191/26, July 2009) will typically require a 50% increase in the copper content in the motor windings. This will deliver electricity savings of 135 TWh/year (more than the combined annual electricity consumption of Finland and Greece) and will avoid 63 million tonnes per year of CO_2 emissions.



Simplified copper recycling process (Photo: CDA)

Private sector

Sims Metal Management Asia recently said the scrap loop was still some way from being closed in Asia. It has acquired a stake in Hong Kong based Chiho-Tiande, China's largest importer of mixed scrap, working to become a best practice scrap processor. Sweden has come a long way within the e-recycling field, but other European countries are gaining ground now. Boliden Rönnskär Smelter's capacity for e-scrap is now 120,000 tonnes per year. Before the electronic scrap arrives at the smelter, the material is stripped down and crushed. Glass and a quantity of plastic, iron and aluminium are also separated out. The

secondary raw materials constitute an ever increasing share of the smelter's metals flow. Two thirds of the gold extracted at Rönnskär comes from recycled materials.

Metallo-Chimique N.V. in Belgium has set about creating a 21st century multi-metal recycling (MMR) group for maximum valorisation of metals and minimum waste. Their recycling and refining facility at Beerse in Belgium processes secondary raw materials for the production of copper, tin, lead and nickel. As a zero-waste producer, Metallo is continuously seeking to optimise its operations on the basis of extensive in-house technological knowhow and broad market knowledge. The last sentence highlights four areas which should be explored in more detail. Achieving the goal of becoming a zero-waste producer is now a benchmark for any recycling operation. This means assisting all who already produce, receive, sort and process scrap in general with knowledge about the processing options for their metal content mix, new separating and environmental technologies, and so on.

Broad market knowledge gives the flexibility to provide solutions to anticipate the needs of the product life cycle. There is now an onus on designers to build recyclability into their products. As product/alloy complexity and miniaturisation increases, recyclability should become an integral part of the thinking process of new product design. It has happened in the automotive and packaging industries most notably, and is happening behind the scenes in legislation, regulations and so on in other sectors.

As MMR and the recycling sector develops, and more and more of us push to achieve zero-waste, the private sector contribution has to be continually supported. For example, smelting technology provider Outotec's chosen mission is to strive for sustainable use of Earth's natural resources. Going forward, the company intends to focus more on providing sustainable life cycle solutions. It has become a leader in environmental technology.

Smelting operations require long term power supply agreements and scrap feedstock sourcing agreements. The average cost of even renewable energy is constantly increasing (a wind turbine uses up to 20 tonnes of copper in its construction). Environmentally sound energy recovery will benefit some MMR situations if balanced with emphasis on waste recovery for reuse and recycling rather than competing with energy solutions. Aurubis power costs have already risen threefold in ten years.

Recovery optimisation

There are many niches yet to be filled even adequately in recycling. In-house development and investment to meet health, safety and environmental requirements is not uniform globally. Policies have been rather designed to minimise harm to humans and the environment rather than to maximise the amount of recoverable materials for recycling. With different elements coming into the recycling equation, such as bismuth (lead substitute) and antimony (for antimicrobial use), all the time, having experienced metallurgists and assayers with accurate equipment and methods checking or certifying feedstocks is essential. The capability to optimise process control in terms of temperature and mass flows can be adversely affected by undetected raw material impurities. Technology selection ability is also essential. Certain plant types may not even be able to process a particular metal.

Optimising operations on an MMR site covers two main areas. Optimising the process steps means deciding which metals to focus recovery efforts upon, which metals to avoid, and increasingly likely, which other recyclers to collaborate with commercially. Whilst MMR may be seen as a gap in the market to be exploited, it may not be that easy to fill quickly or

effectively. For one thing, a stable and reliable core scrap feedstock mix needs to be secured. The typical processing steps for multi-metal and e-scrap are shown in APPENDIX I.

Then there are the permissions and environmental measures to be gained and put into practice respectively. The initial process steps still need to be commercially proven and any adjustments or additions made, costing time or money, or both. Lastly, whatever products are produced will need to be sold quickly and at the right price to sustain the operation.

Only thorough research and broad market knowledge can support this heavy set of hurdles. Having built up a large amount of proprietary knowhow, usually after a lot of investment and over a long period of time, for commercial considerations nearly all organisations will want to protect this. The pace of transfer of this knowhow could determine the growth of the sector. A gradual transfer or no transfer at all would be undesirable for all of us. A level playing field of fair competition will be in evidence at the London 2012 Olympics, when all nations embrace an ideal and a motto 'citius, altius, fortius' (Latin: 'swifter, higher, stronger') which can be seen as an aim for all of our societies.

Final thought

Clearly there are many aspects to MMR and a certain amount of know-how is required in order to achieve a profitable operation, but it has been demonstrated to be possible and there will only be more of these regional MMR installations processing your metal scrap going forwards. As the technology and knowhow begins to cross boundaries, it is likely that towards the medium term the scrap itself will be more and more effectively processed nearer to where it was created.

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Acknowledgments

1. The Official Journal of the European Union L 191/26, July 2009.
2. The European Copper Industry's Manifesto, 29 June 2010.
3. The fifth edition of the Global Environmental Outlook (GEO-5), United Nations Environment Programme (UNEP), June 2012.
4. Fellow delegates at the Metal Bulletin Copper Recycling Conference, Brussels, 13-15 June 2012.
5. EERA Prospectus for Membership.
6. Aurubis Recycling Brochure.
7. Copper Development Association (CDA) for illustrations.
8. STEINERT Elektromagnetbau GmbH for APPENDIX I diagrams.

About the Author:

Chris K. Holding is Editor and Publisher of Copper Worldwide quarterly technology magazine, which he launched in July 2011. This article is written in part as a celebration of the first year of existence of that publication. Chris is also a freelance technical writer and has been the Editor of Aluminium Times magazine since mid-2010. He has also written articles for Cast Metal & Diecasting Times magazine.