Reducing the environmental footprint in the industrial mineral sector: Case studies and industry innovation initiatives

A. Shtiza, R. Doome and M. Wyart
Industrial Minerals Association Europe (IMA-Europe)

ABSTRACT

Using a life cycle thinking approach industrial minerals companies have managed to reduce the energy consumption (in bentonite production process), to ensure overall resource efficiency and decrease the pressure on the primary resources. The recycling, reuse and recovery of the various industrial minerals are achieved in the range of 50% - 70% multiple applications such as paper, glass, plastic and others. In addition the functionality, use of waste streams as secondary raw materials and the decrease of pressure in primary raw materials along the value chain are also addressed in two FP7 projects lead by IMERYS and S&B for specific industrial minerals.

Life cycle thinking and LCA tools encourage the selection of the most sustainable technical and financial options to quantify and assist meaningful decisions in the sustainable management of primary raw materials, reducing environmental impacts and operational costs for various industrial minerals therefore resulting in a sustainable mining and processing sector.

1. INTRODUCTION

The European Industrial Minerals Association (IMA-Europe) is the umbrella association which brings together nine European and one international association covering more than 500 European producers in the field of industrial minerals such as.calcium carbonate, bentonite, industrial silica, talc, bentonite, borates, diatomite, lime, feldspar, kaolin, plastic clays and many others. Industrial minerals exist all around us. Their unique qualities have made them a key ingredient in human life throughout the history of civilisation, from its earliest beginnings to contemporary modern manufacturing. Industrial minerals are essential raw materials and form an integral part of modern life: a family house contains up to 150 tons of minerals, and a car up to 250 kg. Minerals make up 50% of paint and up to 50% of paper, whereas ceramics and glass comprise 100% mineral content. The list of applications using industrial minerals including, paper, plastic, glass, paint, construction and building materials, foundry, steel-making, automotive, metallurgy, agriculture, is indicative, but not exhaustive. Industrial minerals are also essential components of today's most eco-efficient products and technologies such as wind turbines and photovoltaic panels.

The Industrial Minerals (IM) industry benefits from a solid European basis. IM are extracted from deposits found across Europe, in some 685 mines & quarries, processed in more than 750 plants and with more than 42.500 direct employees in processing sites and headquarters. Unlike other mining sectors, the European industrial minerals industry and its markets are largely self-sufficient. Industrial mineral companies convert natural resources into customized value-adding industrial solutions for a broad range of applications. Industrial Minerals Association- Europe (IMA-Europe) welcomed the update of the Europe 2020 flagship initiative on Industrial Policy adopted by the Commission in October 2012 as well as the launch of the European Innovation partnership on raw materials (February 2013). The re-launch of an actual EU industrial policy is indeed essential for ensuring EU growth and maintaining the European competition in the world markets.

The large variety of constituents, complex supply chains and the complex final products we use daily have driven the creation of the life cycle assessment (LCA) standard tools which would assist to quantify the environmental impacts of products, services and applications in order to support the green claims. Life cycle thinking is an approach which evaluates in a holistic approach (the raw material extraction, material processing, transportation, distribution, consumption, reuse/recycling, and disposal) the entire product life cycle and its related environmental impacts. The life cycle assessment helps to identify hot spots in the life cycle of a product, therefore driving management decisions and action accordingly in order to minimize the environmental impact for industrial minerals manufacturing.

In addition of above a summary of findings and some conclusions from real cases is made to illustrate the approach of the sector for issues related to environmental footprint and innovation challenges in general. A resource-efficient Europe is generally seen as one of the solutions to boost economic performance while reducing resource use, as it will create new opportunities for economic growth and innovations and will ensure the supply of essential resources whilst limiting their environmental impact (EC, 2011). One of the measures that have been defined for delivering the transition towards a resource-efficient Europe is the strategy to make the EU a 'circular economy' based on recycling with the aim of reducing waste generation and using waste as a resource. Hence, turning waste into a resource is one of the key elements defined in the Europe 2020 Strategy and its flagship initiative on "A Resource Efficient Europe".

Resource efficiency is now a key priority for policymakers across Europe – as the EU underlined when it designated resource efficiency as one of the seven flagships initiatives in its Europe 2020 strategy for smart, sustainable and inclusive growth. A survey of resource efficiency policies and instruments with its member and cooperating countries network (Eionet) was held in November 2010 with the aim to collect, analyse and disseminate information about national experiences in developing and implementing resource efficiency policies, and to facilitate sharing of experiences and good practices. In this survey, the priority resources most commonly reported by countries were energy carriers and waste, followed by minerals, raw materials and water.

The aim of this contribution is to illustrate some success stories within the industrial mineral sector which address the challenges of resource efficiency, decrease the use of energy, increase the performance of the industrial minerals, reduce waste streams as well as increase recycling rates. The myriad applications where industrial minerals are used, stress the need for close cooperation within the value chain by means of innovation.

2. CASE STUDIES FROM INDUSTRIAL MINERALS COMPANIES

In light of the EU Raw Materials Initiative and in order to meet Europe 2020 objectives it is critical to improve all raw materials efficiency and to remain as self-sufficient and self-sustainable as possible. Various calls of interest were launched in the recent years to accommodate the innovation efforts and life cycle assessment of primary/secondary raw materials in Europe. Two leading companies from the industrial minerals sector have taken the opportunity to embark on innovation projects involving various partners from various parts of the values chain.

2.1 Innovation and reduction of overall environmental footprint as shown in FP7 projects

In view of improving resource efficiency, initiatives in the EU level the European authorities have put a strong focus on innovation in order to foster job creation and increase the GDP of Europe from 16% into 20% by 2020. In order to address the dependency of raw materials from exports and in order to address the societal challenges, two industrial mineral companies have engaged in the following large 7th Framework Programme (FP7) consortiums. These consortiums include all the life cycle phases of the industrial minerals from the extraction into the various waste streams.

2.1.1 STOICISM (IMERYS leader of the project)

To address the issues related to innovation the European Seventh Framework Programme for Research (FP7) launched its bids for large projects under the umbrella of Nanosciences, Nanotechnologies, Materials and New Production Technologies (NMP) which included "NMP.2012. 4.1-1: New environmentally friendly approaches to mineral processing". The STOICISM stands for Sustainable Technologies for Calcined Industrial Minerals and is a European consortium led by IMERYS a major industrial mineral producing company. The consortium consists of 17 partners from 8 different European countries (UK, Belgium, Germany, Finland, France, Spain, the Netherlands, Czech Republic). Key contributors on this multidisciplinary platform include several Universities, specialized SMEs & corporations, an industry association (IMA-Europe), as well as applied technology and research institutes. Focus of the STOICISM project will be to develop sustainable and innovative solutions for minerals processing routes reducing the carbon footprint of several calcined industrial minerals, thereby looking at the whole supply chain from the extraction, waste valorisation and optimisation of the functionality for the end users. More in particular, the Research Development and Innovation (RDI) technologies will be tested for the beneficiation, drying, and calcination of minerals, notably diatomaceous earth, perlite and clay and new technologies for energy production will be evaluated. Eventually, the processes implemented will easily be transferable to other industrial minerals. The partners in the consortium include also two end users, which will test in pilot applications namely brewery and paints the progress and functionality of the newly manufactured industrial minerals calcined and flux calcined diatomaceous earth, perlite and clay. The project will be carried out over the period 2013-2017.

2.1.2 ExPerl (S&B leader of the project)

ExPerl is the FP7 project that addresses the exploration of European perlite deposits to develop innovative micro-perlite products. S&B Industrial Minerals (Greece) is the coordinator in a €8.3 million research project, €5 million of which will be funded by the European Commission / Research Directorate-General, within the FP7 project within the theme: NMP-2008-4.0-5 Innovative concepts and processes for strategic mineral supply and for new high added value mineral-based products). The objectives of the project, with the code name "ExPerl", include: (1) The development of micro-sized closed structure perlite (CSP) and similar micronized perlite-based particles through the development of breakthrough perlite expansion technologies with special insulating and mechanical properties highly exceeding those of conventional perlite; (2) The development of innovative end-products based on perlite to be used in the construction, manufacturing and chemical industries. The project is being carried out over the period 2009-2013 by a network of 12 industrial partners, universities and research centers from Greece, Germany, Italy, Spain, Norway and Israel. ExPerl addresses a very important topic of industrial minerals supply and for new high added value mineral-based products.

Among the various industrial minerals needed by the EU industry, perlite is highly important both from technological and economic point of view with many applications in construction (ceiling tiles; mortars, as loose-fill insulation), chemical industry (cryogenics, filter media for chemicals, food products, water purification) and in horticultural applications. Conventionally expanded perlite has a number of favourable properties (inert, fire resistant and incombustible, good sound and thermal insulation) but is also characterised by low strength, lack of durability, high porosity and easy deterioration that limit the range of its applications and affect the quality of conventional perlite based products. These unfavourable properties originate from the sponge-like open structure of expanded perlite granules, which results from the technology of the expansion process. The new CSP-based end-products will present a good number of favourable properties as they will be lightweight, inert, recyclable, of high strength, with improved insulating properties, incombustible, unchangeable over time under and of low cost highly attractive for the European consumer.

2.2 Reduction of energy consumption by natural pre-drying process

Bentonite is a naturally occurring swelling clay. Its volume increases several times on contact with water to create a gelatinous, viscous fluid. Bentonite's properties of water absorption and viscosity make it a valuable material for a wide range of applications such as foundry, pelletising, construction and civil engineering, agriculture, paints, cat litter and others. It is frequently used as a binding, sealing, absorbing and lubricating agent (Roskil, 2008).

Every year around 1,200,000 MTs of bentonite are mined on Milos island by S&B and almost all of that quantity has to be dried to about 15% on average. Milos is the largest European mining center for bentonite and is estimated that S&B production on Milos covers some 30% of the total European bentonite production.

Significant energy saving is achieved by exploiting Milos' climatic conditions -that is high temperature and wind during summer- for the natural pre-drying of bentonite in open fields, resulting in approximately 35% annual energy savings, compared to the energy that would be required if industrial drying was exclusively used.

It is estimated that some 100.000 MTs of water are evaporated on a yearly basis through this field drying process. This is equivalent to actual savings of about 7,500 MTs of annual heavy fuel oil consumption, corresponding to CO2 emissions reduction in the range of 24,000 MT per annum. Milos is an island in the Aegean Sea, a pure energy importer (fuel transportation with vessels) and the above savings constitute a significant reduction not only of S&B's energy consumption but of the total energy consumption of the island.

Another indirect effect of air drying is the increase in resource efficiency through the effective blending of variable bentonite qualities, allowing no sacrifice of raw materials and without undermining the quality for the end application. This is based on the fact that air drying takes place in large fields with sequential deposition of bentonite layers of relatively small thickness on top of each other. Each layer is left to dry for a couple of weeks, being intermittently exposed to air with use of agricultural type plough equipment. This process gives a lot of flexibility in blending, allowing optimal use of reserves of variable quality. In addition the mild drying conditions do not lead to destruction of the crystalline structure of bentonite, which is inherently associated with industrial drying, increasing therefore resource efficiency further.

Above practice received the IMA-Europe Recognition Award 2012 by IMA-Europe in a special ceremony at the European Parliament, on November 14, 2012. The independent Award Jury with members from a European institutional body, academia, an environmental organization, and the European Press, highlighted that the implicit simplicity of this project in combination with its significant and measurable results (IMA Website, 2013a).

2.3 Recycling of industrial minerals

Industrial Minerals are used in a wide range of applications and end products. Recycling these minerals from their end applications would be technically complicated, time consuming and, in some cases environmentally unsound.

However, although the minerals themselves are not always recyclable per se, many of them through the products of the applications in which they are used, i.e. industrial silica used for glass making. The IMA-Europe Recycling Sheets gather publicly available data on the recycling rate of the main applications and products in which industrial minerals are used as primary raw materials.

"Recycling" should be understood being in compliance with the definition in the Waste Framework Directive (Directive 2008/98/EC on waste), as: "any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes".

The market share of lime for steel use is about 40% while the recycling rate of lime via the steel scrap is around 95%. Therefore the lime recycling rate is about 38% for steel alone. Similar calculations are also made for various uses of lime in various applications giving an overall lime recycling rate of 68% (Table 1).

Table 1: Calculated recycling rate of lime in various applications.

	Lime Markets	Application Recycling Rate	Lime Recycling Rate
Steel	40%	95%	38%
Environmental Applications	14%	90%	13%
Concrete and Bricks	5%	65%	3%
Soil Stabilisation and Mortars	12%	75%	9%
Chemistry	8%	70%	6%
Other Uses	21%		
Total	100%		68%

Table 2: Calculated recycling rate of industrial silica in various applications.

	Silica Markets	Application Recycling Rate	Silica Recycling Rate
Construction and Soil	39%	85%	33%
Container Glass	17%	75%	13%
Flat Glass	17%	80%	14%
Glass (Other)	5%	25%	1%
Foundry	12%	80%	10%
Ceramics	4%	60%	2%
Other Uses	6%		
Total	100%		73%

For the industrial silica the overall recycling rate is about 73% if the main applications are accounted for (Table 2).

Similar calculations are also made for other industrial minerals such as feldspar, clays, calcium carbonate and so on. Today, the industrial minerals sector estimates that a total 50 to 70% of all the minerals (such as calcium carbonate, lime, silica, feldspar, kaolin and plastic clays) consumed in Europe are recycled along with the glass, paper, plastic or concrete, where they are used in based on our current market analysis (IMA website, 2013b).

3. CONCLUSIONS

The cases presented illustrate the awareness within the industrial mineral sector of the environmental footprint and action to quantify and reduce the overall impact on the environment. The list of the examples shown in this contribution is indicative, but the list is not exhaustive. The action by companies and the sector demonstrate the contribution of European industry in tackling the societal challenges and reducing the overall environmental footprint of its activities, in order to ensure that Industrial minerals remain part of a sustainable EU based industry.

REFERENCES

EC, (2011). European commission, A resource-efficient Europe – Flagship initiative under the Europe 2020 Strategy.

IMA-Website, (2013a). http://conferenceandaward2012.ima-europe.eu/award.

IMA-Website, (2013b). http://www.ima-europe.eu/content/ima-recycling-sheets-full.

Roskil, (2008). The economics of Bentonite, pp. 1-130.