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Steel and Slag
By Gunter Pauli

This article introduces a creative approach to processing slag from steel as one of the 100 innovations that shape “The Blue Economy”. This article is part of a broad effort to stimulate entrepreneurship, competitiveness and employment.

The Market
The world market for steel in 2010 is estimated at $400 billion dollars and reaches 1.3 billion tons. The largest steel company ArcelorMittal, controlled by Lakshmi Mittal, is quoted on the Dutch Stock Exchange, with a turnover in excess of €30 billion. This conglomerate controls approximately 10 percent of global sales. Whereas the steel industry used to be an American business, it has decidedly turned into an Indian and Chinese affair. Over one third of the world’s steel output is produced in China. However the Indian market leaders made a string of global acquisitions after the sector went through a deep consolidation battling two decades over over-capacity, making them the captains of this growth industry. Strategically the Indians have a competitive advantage over the Chinese since India is the third largest producer of iron ore, after Australia and Brazil. Today, over half of India’s ore is exported, and this is likely to change as to secure strategic reserves.

Steel is the most recycled material on Earth. The total volume of steel recovered through industrial and consumer recycling programs is larger than paper, plastics, aluminum, copper and glass combined. Approximately 30 percent of all steel used today is recycled. Electric arc furnaces in Germany and Japan operate with 100 percent recovered steel, which has the great benefit that it can be reused indefinitely. Industry has made major strides forward with the car industry steel recycling rates in Europe reaching nearly one hundred percent after the European Union imposed the most stringent standards. However, over two thirds of all steel manufactured is still wasted. Recycling rates at homes for steel are particularly low. American homes discard 100 million steel cans per day (36.5 billion per year) and the non-recycled part is enough to put a pipeline from New York to Los Angeles and back each day.

Steel is thanks to its magnetism easy to sort and recycle. One ton of recycled steel saves 1.1 ton of ore, and 630 kilograms of coal. The recycled steel in North America saves enough energy to power 18 million households. One of the greatest challenges of steel remains its greenhouse gas emissions which is a natural by-product since the industry’s inception over 4,000 years ago. The energy requirements per ton of steel has dropped 30 percent over the past 20 years. Still, each ton of steel generates two tons of CO₂ equivalent, which even when it is much lower than aluminum that emits 11 tons, still represents a major contribution to global climate change.
The Innovation

The steel industry has a vast agenda for innovation, ranging from the production of high strength steel, to extracting more from ores, the production of coatings for steel including the revolutionary covering of steel with thin film solar cells. The rethinking of the size of steel mills has inspired engineers to create mini-mills reducing the capital investments per production facility with increased flexibility and a reduced environmental impact providing management with more opportunities to recover waste heat, especially from the cooling of the molten steel. This process allows the further compacting of the mills’ size and clustering of industrial activities. However one of the areas that need strategic attention is scrap and slag. While this is nothing new, it has always been a matter of recycling with low or no value added.

Ji Gengxin, a demobilized soldier from China's People's Liberation Army studied the massive accumulation of more than 10 million tons of slag that is discharged from steel works in his country each year. Internationally, most of this waste is recycled for road pavement. However slag waiting to be recycled covers large patches of arable land generating serious air and soil contamination. Mr. Ji realized that slag contains 15 percent waste steel and the remainder is known to be a high strength material, resistant to wear, tear and corrosion. Mr. Ji went on to create the Wuhan Metallurgical Slag Environment Protection Engineering Company and started with 25 unemployed and a small credit of 30,000 Yuan ($4,600) to work on the recovering of this pollutant.

Mr. Ji and Dr. Chen Yimin from the Chinese Academy of Construction Material Sciences succeeded in demonstrating that finely ground slag powder – the leftover after recovering the steel content – can replace 20 percent of cement as an active additive reinforcing the strength of concrete. Instead of recycling slag as low grade raw material for road pavement, it is now a high value ingredient in the construction industry. Generating more value by shifting the waste stream from one industry to another is a typical characteristic of the Blue Economy.

The First Cash Flow

Their patented technique, including the crushing, wet magnetic selection, screen separation, and grinding system was first successfully used in the cement to build pier beams for the Xia Bai Shi Great Bridge across the sea in Fujian Province. This provided the necessary breakthrough to start reprocessing one hundred hectares of slag piles at the Wuhan Iron and Steel Group (WISCO), the first Chinese supergiant industrial complex that started operations in 1958. Statistics show that more than 1.4 million tons of slag are discharged each year from this steel work alone. The creative and scientific work of the Wuhan team created a new industry that that earns an average of 200 Yuan ($30) net per ton of slag, including the provision to restore the polluted land. In one decade, this slag recycling company expanded from two dozen to 500 employees.
The Opportunity

While steel slag continues to be used to pave freeways in the rest of the world, it is seldom used for that purpose in China. It is highly unlikely as well since slag slag generates multiple revenues. The Wuhan Group has now introduced their technology to the building industry with a wide portfolio of implemented projects, including airports, subways and dams. After 17 years all slag piles around Wuhan have been removed. The steel content has first been fully recycled and now the left-overs generate more income than the scrap value. The annual slag output from this one plant in Wuhan is generating over $100 million in net income, a better performance than any other slag processing company on record. This offers an opportunity to start mining waste from steel mills and start building a cluster around it.

There is no doubt that this portfolio of innovations, providing higher quality with what is locally available offers a platform for entrepreneurship that can be repeated around any old steel mill around the world, provided there are the entrepreneurs to make it happen.

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