REAPING THE PROFITS OF PLASTIC WASTE

Jaap Vandehoek & Peter Rem

The Urban Mining Corp is on the brink of large-scale market introduction of its MDS technology for plastic recycling. It is the result of years of intensive research and a close collaboration between Professor Peter Rem's Resources and Recycling group and the young company, led by Managing Director Jaap Vandehoek.

Recycling is an expanding field with huge economic potential, according to Professor Peter Rem, who heads TU Delft's Resources and Recycling research group. He has the numbers at hand: "Germany was the first country to report macro-economic figures on recycling, and in 2000 the country stated that three percent of all raw materials used had come from recycling. By 2009, that figure had risen to fourteen percent, almost a fivefold increase in less than a decade." In financial terms the figures are indeed impressive. "In Europe we use 400 billion euro per year in raw materials to produce our consumer goods and supply our infrastructural needs." Most of that is still being mined or extracted from below the earth's surface. However, Europe has set itself ambitious targets and aims to source 30 percent of its raw materials from recycling by 2030. "In the current state of technology that is not possible, at least not at acceptable costs", says Rem.
It can be done though, as has already been proven with another TU Delft spin-out company, Inahsco. In 2007, Jaap Vandehoek was involved in setting up Inashco, a company for the recycling of metals and minerals from bottom ash, the ash that is leftover after municipal solid waste is incinerated. Inashco

has since grown to a globally operating business with some 150 employees. Inashco was based on research of Rem's department. "The technological breakthrough here was that you can separate moist bottom ash without the need to either dry it, or add water", explains Rem. However, the revelation for Rem was how Vandehoek managed the start-up phase of the company. "It is very difficult for a small team to oversee the technology, the finances, the customer relations and all else in that situation. Once you have seen a success like Inashco, you are eager to repeat it."

Team work

Vandehoek is quick to share the credit: "In my experience, the cooperation with Rem and his team at TU Delft was vital. We regularly talked over the commercial and the technical sides together, rather than one of us staying in the lab with the other one continually on the road pitching the business. I believe that this kind of interaction over an extended period is vital." Rem agrees that university involvement in the first phases of commercialisation is important, especially in an expanding field such as recycling. "Any technological improvement in a more-established industry will probably find its way to the industry, but in a relatively new field you have to work harder as a university to get the technology to the market."

In all fairness, it takes both breakthrough technology and business acumen, Rem acknowledges. "You need a technology that is profoundly different from what has gone before, and then you need someone who understands all aspects involved so he can make a business out of the technology." They are now in the act of repeating Inashco's achievements with Urban Mining Corp, which specialises in the recycling of plastics. "We have learned a lot from our previous collaboration, and we are eager to maintain a longstanding research relationship," says Vandehoek. "As with Inashco, we have jointly developed the technology from lab to demo scale and are now upgrading to industrial scale and building a business model. Any gains should then partially flow back to the university, so we can stay ahead in the field of recycling", says Vandehoek.

That takes some doing, as Rem explains. "Magnetic density separation, or MDS is not based on a single invention, but on a portfolio of insights and patents in various fields that combined have the potential to change the way we deal with our plastic waste." Vandehoek was impressed by Rem's perseverance in the early stages of the project. "He completely immersed himself in the subject, researching into the details which substances make up the waste streams and what their properties were. He then came up with various technical approaches to deal with all possible issues."

No eureka moment then, but years of painstaking research that have over time led to a game-changing innovation. "The quantum leap here is the MDS process, that enables us to produce very pure material streams from a waste flow containing a hundred or more different materials", says Rem. "The beauty of it is, that this can be achieved with only a modest investment. A typical recycling plant today comprises eight or ten separation units that make only a couple of products. With MDS, we intend to make up to 80 different products with just three or four separation units."

Downcycling

Although there are clear parallels between Inashco and Urban Mining Corp, the difference is one of scale. "This has the potential to become much bigger", says Rem. "Looking at metals and minerals contained in bottom ash in Europe, you are talking about a value of one billion euro per year." In contrast, the recycling of polymers - the building blocks of plastics - has a combined potential value of ten billion euro per year, estimates Rem. Currently, most of our polymer waste ends up in the incinerator or the landfill, and what is being recycled, results in low-grade products. "Our household waste contains some 250 different polymers", says Rem. "These are recycled in very broad categories, such as polyethylene and polypropylene, but these are in fact compounds that contain all sorts of additives and colourings. You can still make something out of it, but that is definitely downcycling."

Then there is the cost of the recycling system. "In the Netherlands we use about 40 euro per person on plastic packaging. Only ten percent of that value, so four euro, is recovered through plastic collection or deposits on bottles. Moreover, this system costs an average of eight euro per person per year, plus the effort of taking your plastic waste to the collection points."

Clearly, there is room for improvement here, and Vandehoek and his colleagues are about to deliver that. "This is a very exciting time for us. We have a demo installation that can process 300 kilo of plastic waste per hour. We are now upgrading that to a continuously working installation that is meant

W2Plastics

Magnetic density separation, or MDS, was developed within the framework of the European W2Plastics (waste to plastics) project that was led by TU Delft. “At the start of the project we had a working installation the size of a kitchen machine”, says Professor Peter Rem, head of the Resources and Recycling research group. “The amount of work it takes to bring that to an installation that can process hundreds of kilo’s per hour, is staggering. It took us four and a half years, and we were funded by the EU during that entire period.”
That is not as excessive as it perhaps sounds. “The EU invests in the research of thousands of new concepts every year, and hardly any of them turn out to be winners. It is impossible to predict which; that is why the chances of success are so low when you are still in the research phase.” Nevertheless it is worth investing in, he stresses. “We spend about half a percent of our GDP on such high-risk, early-stage research. However, if a new technology does prove to be successful, it can generate sums in the region of twenty or thirty years worth of GDP.”

for the Romanian market.” That is an economically viable scale for Romania; it is also a big step forward for the country that is currently only recycling about one per cent of its household waste. A much larger installation is in the pipeline for the Netherlands. “We have just signed an agreement that will ensure us the necessary input materials and are building an installation that can process 1,500 kilo per hour.”

Seed industry

Apart from plastics, magnetic density separation can be used for other substances too. “Polymers are probably the most important application”, explains Vandehoek. “But with MDS we can separate material streams in a single process step based on very small differences in density and that has a lot of possible fields of application.” An example far removed from the recycling of plastics is the seed industry. “Tomato seeds of a certain weight have a higher germination quality. With our technology you can weed out the low-quality seeds, making for a higher yield in your tomato beds. In a greenhouse environment, where space is at a premium, that can make all the difference.”
Then there is WEEE, the Waste from Electrical and Electronic Equipment. “Traditionally, recycling focuses either on bulk flows with low value, such as building materials, or on small-volume, high-value waste”, says Vandehoek. But electronic waste contains a host of different materials that you would all want to recycle, glass, plastic, heavy and light metals. You need a technology that can separate these at an acceptable level of purity, so they all count towards the average product value. With MDS you can do this profitably without an enormous economy of scale.”

Mining

The collaboration between Rem and Vandehoek dates back a long time. “I studied raw materials at the former Mining Faculty, and Peter Rem was one of my lecturers. I was fascinated by secondary materials, a relatively new subject at that time.”
Research into recycling techniques was often based on mining techniques in those days. Rem gives an example: “Floatation is a process where you grind an ore and mix this with water. When you blow air through the water, small particles of copper sulphide will cling to the bubbles. The idea was that this could work for particles of plastic too.”
Since his graduation, Vandehoek has been involved in revolutionising recycling. Yet the success of

Inashco and Urban Mining Corp did not happen overnight. Soon after graduation, he embarked on projects backed by private investors. Some came to fruition, others did not. “I must have undertaken twenty feasibility studies in that time”, says Vandehoek. He always stayed in touch with the university, among others working with Rem on research into the recycling of garnet sand, an abrasive that is used in sand blasting. “Garnet sand is valuable mineral that is found in Australia. We found an economically viable way to recycle it. As a matter of fact, it was upcycling, as we could separate the best grains, so the sand was more effective after being recycled.” However, the modest volumes involved made it commercially less interesting, so the idea was shelved for the time being. Other recycling projects ranged from petrochemical catalysts to metallurgical slugs. Then, in 2007, they embarked on the commercialisation of the bottom ash recycling technology.

That effort has been an unqualified success, but the potential for Urban Mining Corp is an order of magnitude larger. An increase of scale that could already be seen in the research phase. “We have been working together with four other universities on various aspects of the technology, building up knowledge”, says Rem. The social and economic impact can be even greater. “For the Netherlands alone, this could create some 4,000 jobs.” Moreover, Rem stresses that the recycling in general can not only reduce money spent on raw materials, but also on energy. Producing goods from raw materials requires enormous amounts of energy. In fact, the amounts of money saved on energy could equal that of the amounts of money saved on raw materials. Reasons enough to get governments interested, at national or even European level. Yet Rem is not in favour of outright subsidizing of the recycling industry. “It already has the whiff of being a subsidized industry, but that is a misunderstanding. Only recycling enterprises that have real economic perspective flourish.”

Other than subsidies, governments could still do a lot more to encourage enterprise, in the sense of creating a business-friendly environment. Again, Rem holds up Germany as an example. “Germany has a long-term view on the kind of industry it wants to develop. The technological developments needed for that are encouraged, and appropriate rules and regulations are introduced, or legislation that hampers innovation is changed. In short, the relationship between the public and commercial sectors is very productive.” He hopes the Dutch government will take a leaf from the same book. “A break-through technology can mean a lot to a country’s economy, but rules and regulations can either make or break it.”

Defying the odds

So far, their story has been one of achievement, defying some of the odds. “Generally speaking, the chances of investing in a technology and developing it into an international business, are about twenty percent. In our case, we have scored 40 percent over the past twelve projects”, enthuses Rem. He feels their high level of interaction was instrumental in this. Vandehoek agrees. “Not everything works at once. You have to work together and solve all technical problems until you finally achieve your goal.” In the case of Urban Mining Corp, giving up was never an option. “At some point you realise you are working on something with enormous social and economical potential. It is that dot on the horizon that keeps you going. But you need a team you can trust, and that you can work with for a number of years. You should also stay critical on what you are doing. I believe these are the real keys to our success.” <<

Magnetic Density Separation (MDS)

MDS is a departure from current plastic recycling technology, Jaap Vandehoek, Managing Director of Urban Mining Corp, explains. “Current practice is the sorting of plastics at object level, such as bottles or egg boxes. These are then shredded an extruded in the form of pellets. You can imagine that this leads to very impure products.” With MDS, plastics are shredded before sorting. “By shredding the plastic in particles no larger than a few millimetres, you free up all the component polymers. These are then separated by way of a magnetic fluid.” The plastic particles are mixed in a water stream containing ferrous oxide particles. With the help of magnets, the density of the fluid is increased; the closer to the magnet, the higher the density will be. The plastic particles will then start to float at different levels according to their density, and can be removed from the solution.