

According to U.S.-based MBA Polymers Inc., its technology has the potential revolutionise plastics recycling in the same way that the advent of the mini-mill changed the world steelmaking landscape. The company is sorting and upgrading mixed plastics streams to the point where they can be reused in the same types of applications, and it has already sold millions of pounds of its recycled materials back into a variety of demanding durable goods applications, such as TV housings. Furthermore, the company began 2004 by announcing the formation of a joint venture with a large Chinese company to build and operate a state-of-the-art plastics recycling facility in Guangzhou.

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Breaking the plastics industry mould

Mixed plastics are a typical by-product of numerous durable goods recycling processes that primarily recover ferrous and non-ferrous metals following large-scale shredding. Until now, the majority of these by-products have remained as waste due to their complicated nature - more than twenty different types and hundreds of grades of plastics mixed with varying amounts of non-plastic materials such as wood, glass, wire, foam, textiles and rubber.

Overall, only a few percent of all plastics are recycled. Estimates of the recycling rate of plastics from durable goods range from less than 1% up to 4%. This compares to recycling rates for metals such as steel and aluminium from durable goods of over 90%. One might assume that this is because metals are much more valuable. However, the technical plastics used in durable goods are much more valuable than steel on a price per weight basis and some are more valuable than even aluminium. Even less valuable glass, paper and wood typically have recycling rates much higher than plastics.

MBA Polymers has developed and demonstrated technology on a production level that can process these mixed plastics-rich streams to recover the plastics, just as metals are separated and recycled for reuse. Plastics are the last of the major material cat-

The final product – high-quality plastic pellets.



Big silos are needed for storage and blending to ensure consistent products.

egories to be recycled at high levels - not because they aren't valuable, but because it's not easy. If it were easy, there would be hundreds of MBA Polymers, just as there are hundreds of metal recyclers.

Creating a new industry

Professor Clayton Christensen of the renowned U.S. Harvard Business School, whose extensive studies on the creation of new industries have won him worldwide acclaim, has examined the challenges faced by new methods as they replace existing approaches within mature industries. Mature businesses often resist the introduction of 'disruptive tech-

nology' that might upset the 'status quo'. His book on the subject entitled 'Innovator's Dilemma' gives numerous examples including the introduction of personal computers, low-cost airlines, Japanese automobiles (from low cost to leaders) and low-cost chips.

One of Professor Christensen's frequently-used examples is the Nucor Steel story. Nucor helped launch the adoption and then widespread use of the mini-mill to lower significantly the costs of steel-making, and the company is now the largest and most profitable steel company in all of the U.S. And all this is based on the use of scrap metal!

The use of the mini-mill to make steel is now well-established, but when Nucor launched its first plant in the 1960s, the steel industry was sceptical. It was suggested that Nucor could never make high-quality steel based simply on scrap and that it would always be limited to reuse in low-end applications such as reinforcing bar. Four decades later, many of those large integrated steel mills are out of business and many of the rest are fighting for their lives because they can't compete with the lower-cost scrap metal recyclers.

The 'Nucor of the plastics industry'

MBA Polymers has often been called the 'Nucor of the plastics industry', and with good reason. The similarities are amazing. At ICM's International Electronics Recycling Congress (IERC) held in Switzerland at the start of the year, several speakers from the plastics industry and academia were saying that plastics couldn't be reused in high-quality applications. MBA Polymers and a few other plastics recyclers present at the meeting begged to differ because they were already doing it! These recyclers believe that this nascent industry will grow in the same way as metal recycling and for the same fundamental economic reasons.

This can be illustrated by comparing virgin plastics manufacturing using petrochemicals to making plastics with recycled feedstock. Contrary to popular opinion, the use of recycled plastics provides significant cost savings from just about every perspective. A mechanical recycling plant is much less expensive to build than a chemical plant of comparable capacity, its feed is 'waste' rather than unpredictable petrochemicals, and its operating costs are much lower.

One aspect of these lower operating costs is energy. Similar to the energy savings realised with aluminium recycling, MBA's mechanical recycling process requires less than 10% of the energy compared to making the same plastic from oil.

I agree that technology initially held up the high volume recycling of plastics from complex streams

of mixed plastics, as was the case with metals decades ago. Technology changed the landscape for metals and this is just now happening for plastics.

Sourcing is critical

At MBA, we have demonstrated for years that the technology works on a large-scale at our Richmond pilot line. The most prominent issues that our company had to address were business issues. Three of these are typical of those faced by many recycling industries: finding sufficient source material; finding good markets/customers for the products; and financing the construction of large facilities.

Sourcing is fundamental to any industry and certainly critical to any recycler. However, the issue relating to plastics from durable goods is not the lack of material - there are over 4 million tonnes used in automobiles and electrical/electronic equipment each year in Europe alone and the figures for North America are about the same. The issue is having this material collected and concentrated to a point where it can be economically transported and processed. Fortunately for MBA, widespread take-back and recycling legislation in Asia and Europe took care of that. In Asia alone, there is already well over 150 000 tonnes of mixed plastic by-products from electrical and electronic equipment and these



The founders of MBA: Mike Biddle (left) and Trip Allen, Chief Technology Officer.

MBA expands into China

MBA Polymers Inc. started 2004 with a bang by announcing the formation of a joint venture with a large Chinese company to build and operate a state-of-the-art plastics recycling facility in Guangzhou. The joint venture plans to begin operation of the 40 000 metric tons per year plant by the beginning of 2005.

MBA's joint venture partner is Guangzhou Iron & Steel Enterprises Holdings, Ltd (GISE). MBA Polymers owns 55% of the joint venture and GISE 45%. MBA is supplying technology, know-how, customers and suppliers, while GISE is providing experience of working in China, important government contacts, and scrap import and processing expertise.

The new company, called GISE-MBA New Plastics Technology Co. Ltd, will process highly mixed plastics resulting from the legislated take-back and recycling of durable goods such as appliances, electrical equipment and automobiles. Durable goods recycling is taking place on a very large scale in places like Japan, Taiwan and Korea, as well as all over Europe, where producer responsibility legislation has been implemented. China is also expected to implement such legislation.

Early this year, Mike Biddle signed a joint venture agreement with Chinese company Guangzhou Iron & Steel Enterprises Holdings for a state-of-the-art plastics recycling plant.



volumes are still growing. At the IERC, several speakers quoted numbers as high as 500 000 tonnes for the amount of material expected from Europe following implementation of WEEE legislation.

Stable markets needed

Just as important as sourcing is finding good markets and/or customers for the products. Most recycling industries begin selling materials into 'low-end' products, a process often referred to as 'down-cycling'. This occurs for several reasons: first, the technology may still be evolving to create high-quality material from mixed sources; second, purchasers of materials for demanding applications, such as durable goods, are rightly cautious of trying any new materials, especially ones that might have contamination, come from a new company or raise supply reliability questions; and lastly, it is a shorter and easier process to break into less demanding applications.

With MBA's technology, mixed plastics streams can now be sorted and upgraded to the point where they can be reused in the same types of applications. In fact, MBA has sold millions of pounds of its recycled materials back into a variety of demanding durable goods applications, such as TV housings.

We have also worked with many multi-national original equipment manufacturers (OEMs) to qualify our recycled material for various durable goods applications. Several MBA products have now been approved by leading OEMs that are waiting for MBA to be able to manufacture sufficient quantities for their new products. I think we are ready to meet the needs of these larger customers.

Benefits from recycled plastics

Original equipment manufacturers are highly motivated to use recycled plastics. They have a lower cost and increase recycling rates such that users can not only save money by reducing their raw material costs but can also benefit their green marketing programmes. Most of the major automotive manufac-

turers have announced aggressive targets for the use of recycled plastics, some as high as 25-30% of the plastics used in new vehicles. With around 2 million tonnes of plastics used in each of the U.S. and European automotive markets, this alone results in a very high demand for recycled plastics.

Interest among electronics manufacturers in using recycled plastics has also started to accelerate. Flextronics, a Singapore-based company with U.S. headquarters in San Jose, California, has more than US\$ 13 billion in annual sales and is the largest contract electronics manufacturer in the world. Flextronics is also one of the world's largest injection moulders of plastics used in electronics. In 2001, Flextronics invested in MBA because it recognised the increased interest in recycling among its large customers.

Sharing some secrets

As happened in the metal recycling industry, entrepreneurial companies such as MBA saw the opportunity to extract greater value from this valuable plastics resource. And also in line with experience in the metals sector, this meant dramatically improving the separation, formulation and upgrading capabilities for recycled material streams.

At MBA, we have invested nearly US\$ 30 million over 10 years to develop, refine and demonstrate our technology. Our plant in Richmond reflects numerous generations of plant design and plenty of past mistakes and grand successes, as is the case with the development of any breakthrough 'disruptive technology'.

Given this large investment of dollars and human resources, it may not come as a surprise that we do not tend to share the innermost secrets of how the process works. However, I can give some general insights into how MBA tackles the numerous challenges.

Firstly, we break these challenges down into three major areas:

- * separating the non-plastics such as metals, rubber, foam, fibres, glass and dirt from the plastics;
- * separating the different plastics - and grades, if necessary - from one another;
- * formulating and compounding the products, if necessary, to meet specific customer specifications.

The feed material received by MBA is usually shredded and mixed with other items that the recycler or collector was not able to remove fully. Even though many of MBA's suppliers are metal recyclers, it is uneconomic for them to extract every last bit of metal. However, MBA must remove all of the remain-



Storage bins for sorted plastics.



Some of the parts manufactured from MBA Polymer pellets.



Pre-processing of electronic scrap.



Plastic-rich feedstock from electronics.



MBA Polymers' pre-processing line.

ing metal since this cannot be tolerated in our customers' processes. The separated and concentrated metal is sent back to the supplier or sold to other metal recyclers, depending on the supply arrangement.

There is no single 'magic technique' - such as a magnet for steel - for separating plastics from other materials. There is not even a single 'gross technique' like eddy current separation for non-ferrous metals. If it were easy to extract this last bit of metal, it would have been done by the supplier. As a result, MBA has had to develop some new techniques to separate the remaining metal.

Fingernail-size flakes

The story is the same for the other non-plastic materials, the removal of which requires numerous steps. Additional size reduction is carried out to both liberate well-attached materials and to improve material handling and separation processes. Once the non-plastics have been removed, the resultant material is mostly plastic 'flakes' of fingernail size. Now begins the most difficult and important part: separating the plastics from one another by type and by grade, if necessary.

Again, there is no single technique that works in this area. Many plastics recyclers have traditionally used density differences to separate simple mixtures of plastics: for example, PET bottles can easily be separated from PP and HPDE bottles by a sink-float method in water. Unfortunately, most plastics streams are much more complicated than this. Many of the plastics used in durable goods, for example, have overlapping density ranges.

Therefore, MBA had to be more creative in its approach to separating these various types and grades of plastics from one another. But rather than separating the literally thousands of grades, one of the most important things we have learned over the years is which separations are important and which ones are not from a commercial standpoint. Metal recyclers have done the same when faced with many different grades of the same metal, for example, aluminium alloys.

MBA has developed a processing approach that addresses the realities of the marketplace and has developed its separation strategy to maximise value and minimise costs. This processing approach includes formulations that meet the needs of its customers.

Global expansion plans

MBA has received plenty of recognition and awards relating to the environment or recycling, but I am most proud of two that our company won in 2002 that relate simply to MBA's innovations



The MBA staff in front of the office buildings.

and efforts to create a new industry. MBA won the 2002 Thomas Alva Edison Award for Innovation from the Edison Foundation and YEO (Young Entrepreneurs Organisation). MBA was also recognised by Inc. magazine as 'One of America's Most Innovative Companies'.

These awards are nice, but they don't pay the bills. They are not the reason why we started this company and they are not the reason why our shareholders invested in it.

We are very excited to be building our first large-scale commercial plant in 2004. While it might appear strange that this first facility is to be located in China rather than the U.S., it should be noted that many of MBA's customers have moved their moulding operations to China and so the country has a very large customer base. China recently became the second largest plastics market in the world based on volume, and it is also the world's largest importer of plastics. Rather than make the tens of millions of tons of plastics that China needs each year from petrochemicals, the nation has a chance to manufacture a substantial amount of the plastics it needs in a more cost-effective and environmentally-sound manner.

For China, two of the main barriers to on-going, incredible growth rates are obtaining the energy it needs and the materials it needs. The recycling of plastics is beneficial in both these regards.

MBA also hopes to build and operate similar-scale plants in Europe and North America, as well as more in Asia. While we plan to be a multi-national company given that our customers and suppliers are mostly multi-national, we are looking for partners like we found with Guangzhou Iron & Steel Enterprises Holdings, Ltd (GISE) in China because we realise that we need local expertise to be successful. □



Material for recycling at Sony's recycling plant in Nagoya, Japan.



Mice and joysticks feedstock.

The author of this article, Dr Michael B. Biddle, CEO of MBA Polymers, Inc., is considered to be a leading expert in plastics recycling. He has over 25 years of experience in the plastics field and began his recycling adventure over 15 years ago. MBA Polymers was founded in 1994 by Dr Biddle and Trip Allen to expand research capabilities in the area of plastics recycling, and to develop a commercial process for recovering plastics from durable goods such as computers, electronics, appliances, automobiles and even sporting goods. MBA is located in Richmond, California, U.S., and operates a 90 000 square foot research, demonstration and commercial recycling facility. It is considered to be the most advanced centre in the world focusing on the recycling of plastics from durable products. For more information: www.mbapolymers.com