A heap of great returns

Molectra

An Australian innovator and determined entrepreneur is taking on one of the globe's confounding environmental challenges: used tyres. His unique and innovative processing technology transforms tyres into their component parts, producing jet fuel, carbon for diamonds and other commodities that can be reused in an encouraging array of value-added products. **Wendy Pyper** reports.

Australians' love affair with the car contributes more than 18 million used tyres (170 000 tonnes) every year to the annual global stockpile of 1.2 billion tyres. It's a well-documented phenomenon; across the world, mountains of rubber are blacking out the sky and sullying river systems and oceans, replacing the natural features of landscapes with a permanent monument to our obsession.

For decades, various tyre recycling methods have been trialled, with varying degrees of success. In some cases the solution is as bad as the problem. Incinerating tyres as fuel, for example, generates toxic fumes that cost a packet to control. And breaking up whole tyres into smaller pieces is energy intensive, and produces a contaminated product with very little commodity value. As the majority of tyre recycling efforts have failed to turn a profit, motivation and incentive to recycle is floundering.

The irony is that tyres are made up of raw materials such as steel, fibre, rubber, oil and carbon, which, if they could be extracted in their pure form, would constitute useful and valuable products. Now self-confessed 'persistent inventor', John Dobozy, has found a way to do just that. His unlisted company, Molectra Technologies, which formed in March 2000 on Queensland's Gold Coast, is piloting a waste tyre recycling technology that is based on the principle; 'waste does not disappear – it is only transformed'.

The technology has its origins in the late 1970s when Dobozy first discussed the recycling problem with tyre companies.

'I was into problem solving and I got sucked into trying to solve this one and couldn't walk away,' he recalls.

'It's just like fishing … you get addicted. I came up with a few machines, produced some samples, and asked various universities to do some independent testing, to ensure I was on the right track. By then I was hooked.'

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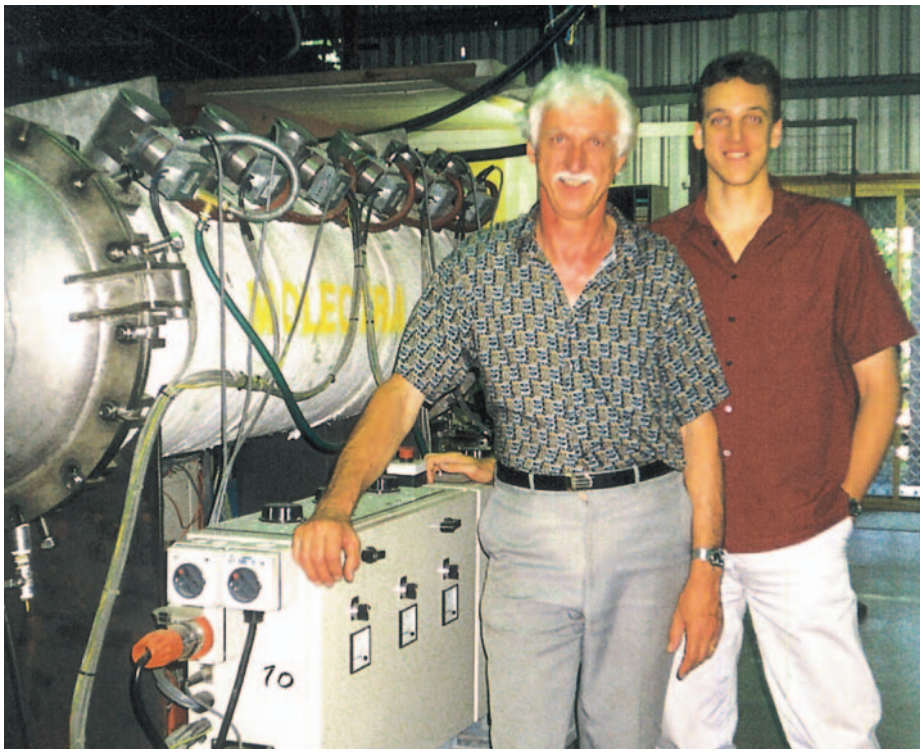
Molectra

John Dobozy and his son beside the Molectravac, the key component that contains emissions under negative pressure in his unique, clean process.

In the early days a small operation, using Dobozy's machines to chop up the tyres and separate the steel and fibre from the rubber, produced high quality rubber. But no one wanted to buy it.

'The tyre industry wasn't interested in incorporating recycled rubber into the manufacture of new tyres, so the only market for it was for asphalt,' Dobozy says.

'But even then there were problems introducing the rubber into hot asphalt, because it created smoke that's hazardous to human health and the environment.'

Dobozy realised the future of tyre recycling lay in extracting other tyre components and finding uses for them. In other words, value-adding. He has since developed a three-part process comprising mechanical, chemical and microwave treatments, to extract up to 13 base commodities from each tyre.

Transforming tyres

In the first stage, two steel beadwires are extracted from the tyre intact. This wire can be cut into small pellets suitable for sandblasting shots, which Australia currently imports from overseas. The tyres are then treated in a blend of softening agents (extracted from tyres) until they soften to a consistency Dobozy likens to 'Coon cheese'. This makes the rubber easy to crumble and removes dirt and other contaminants. The belted steel wires are then mechanically removed along with long pieces of fibre, including nylon, polyester and rayon. These can be recycled as a reinforcement material for concrete in the construction industry.


Molectra

The Molectra process yields a remarkable range of value-added recycled products which are finding markets internationally. Left to right: non-slip tiles, garden soil aerator and wetting agent, fuel oil, industrial heat tiles, rubber soles, carbon black, and different shredded stock.

The rubber is then granulated into various sizes or grades suitable for different uses, including soil aeration, garden mulch, floor tiles, safety matting, drainage, equestrian surfacing and waterproofing.

'We've worked with a number of industries to develop environmentally sound and affordable rubber products,' Dobozy says.

'The horse racing industry, for example, asked us to develop an alternative to virgin rubber sheets, which are very expensive. We worked for six months to develop a product from tyres, which they could mix with sand and use in exercise yards to prevent injury. We have also developed a reconstituted rubber-sheeting product from our crumb rubber … and they love it.

As an addition to marketing the rubber products, the treated rubber crumb can pass through a microwave treatment, where it is transformed into carbon, hydrocarbons and zinc oxide. The carbon produced in the process is 97.4% pure and can be crushed to form carbon black, which is used in the manufacture of new tyres, paints, inks and batteries. Alternatively, the carbon can be converted to activated carbon for water purification, gold production and air filtration.

'Activated carbon is relatively expensive because it's produced from a few selected raw materials including wood, coconut shell and coal,' Dobozy says.

'Now we can offer the market a quality activated carbon at a lower production cost, because it's recovered from a waste product.'

Dobozy also hopes to establish a collaboration with CSIRO to use the carbon in the manufacture of buckyballs and nanotubes, used in nanotechnology (*Ecos* 108). Further research is also underway into the manufacture of industrial diamond from the carbon.

A variety of hydrocarbons are produced during the microwave process. The organic solvent limonene ($C_{10}H_{16}$) can be used as an environmentally safe cleaning agent in a range of industries, while jet A-1 fuel, diesel and lube oil have markets in the transport industry. Importantly, due to the flexibility of the Molectra technology, these commodities can be produced in various ratios according to the market demand for each.

Courtesy of the Cement Industry Federation

Used tyres can replace fossil fuels as a source of thermal energy in the manufacturing process (such as for cement) but emissions need to be carefully controlled.

Dobozy hopes the work of Molectra Technologies will help shift people's view of used tyres from that of waste product to valuable resource.

Economic and environmental profits

The cost and environmental efficiency of the Molectra technology is also key to the company's future success. Dobozy says the technology was designed to lower the cost of processing tyres in a number of ways.

First, the machines used in the plant are small (125 horsepower maximum) in comparison to traditional shredding machines, which average 300–500 horsepower. This reduces energy consumption. The wear and tear on the machines is also reduced because the tyres fed through them have been softened. And about one-third of some 3.9 litres of oil extracted from each passenger car tyre is used to generate electricity to power the plant.

As a result, the operating costs have decreased, and gross return for new products has increased, compared to other tyre recycling processes that produce only rubber products.

Costs are about $0.20 to recover one kilogram of product, compared to $0.28 per kilogram for other tyre recycling processes that produce only rubber products. The gross return for new products averages $0.54 per kilogram, compared to $0.45 per kilogram from lower-grade products derived from other recycling processes. Subsequently the Molectra process recovers around $5.40 value from each average tyre whereas other tyre recycling processes used all around the world recover a fraction of this amount. Value-adding – due to cleaner processing and the ability to recycle the whole tyre – also significantly increases the profit margin.

In terms of environmental benefits, there are no emissions or exhausts as all the recovered components of the tyre are contained within the system using negative pressure and vacuum.

'We don't want to release anything into the atmosphere because that would be a potential product literally going up in smoke. This would be a loss both economically and environmentally,' Dobozy says.

Demonstrating the technology

The production of quality crumb rubber, carbon, oil, steel and fibre has been demonstrated through Molectra Technologies' pilot plant on the Gold Coast, which was set up to showcase the technology and produce small quantities of value-added products. The company is now planning to build a commercial facility in Sydney that will include the microwave technology, and which is expected to process two million tyres a year (three tonnes per hour). Other commercial plants are planned for Melbourne, Brisbane and Adelaide.

In 2003 Dobozy received acknowledgement for his work when he won the Eureka Prize for Engineering Innovation. Almost overnight Dobozy says the company became a success, as national and international callers began inquiring about the technology. Dobozy's unflagging spirit and 'inability to take no for an answer' has also pushed the company's profile to greater heights, with some 27 countries (including Canada, Japan, United Arab Emirates, USA, UK, Italy, Hungary, Indonesia and China) interested in licensing the technology, which is protected by an international patent.

It seems uptake of such technology is imperative as the natural environment chokes under the growing global tyre problem. Dobozy estimates that 10 plants would be needed in Australia, operating at three tonnes per hour, 24 hours a day, just to stabilise our stockpile. In America, 100 plants are needed to stabilise the three billion tyre stockpile already littering the landscape, and the further 240 million tyres added to it each year.

Dobozy hopes the work of Molectra Technologies will help shift people's view of used tyres from that of waste product to valuable resource.

'Companies that manufacture the original tyre, and individuals that use the tyres and generate the waste, should actively participate in the turnaround of this environmental burden by vesting their interest in this issue,' he says.

'This technology, which recovers and reuses the Earth's resources, is a prime ethical investment opportunity for everybody, given both its global environmental impact and the products that it creates for the population.'

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