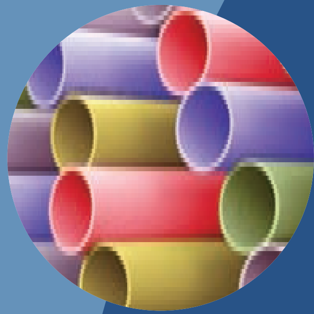
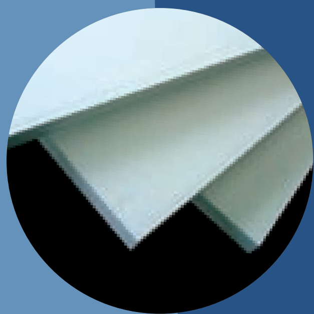
PLASTICS NEW ZEALAND
best practice programme

iconic
KIWI PLASTIC PRODUCTS
2007

Improving their Environmental Footprint



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MAXIMISING THE GROWTH AND SUCCESS OF PLASTICS BASED TECHNOLOGY IN NEW ZEALAND IN AN ECONOMICALLY, SOCIALLY AND ENVIRONMENTALLY RESPONSIBLE MANNER

Contents

Iconic Kiwi Plastic Products 2007

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FOREWORD

Plastic products have revolutionised the way we live our lives, in many positive ways. Examples include reducing fuel costs, through weight reduction and insulation, to improving the shelf life of foodstuffs by using intelligent packaging. New Zealand's agricultural sector has benefited greatly from the innovative plastic products available - from storage and transportation solutions to animal health, viticulture and aquaculture applications. Some of these plastic products were recently celebrated by the New Zealand Kiwi Made Campaign - www.buykiwimade.govt.nz/.

The local plastics industry has supported the international success of the New Zealand electronics and whitegoods sector. We have featured components in the well known NZ success story of the Fisher and Paykel DishDrawer®. The New Zealand Plastics Industry employs more than 8,000 people and contributes more than $400 million in exports to our Gross Domestic Product.

In this publication Plastics New Zealand has profiled six iconic Kiwi plastic products. These are the first in a series that will look at plastic products that have made a difference in the NZ environment and to the lives of New Zealanders and many people overseas.

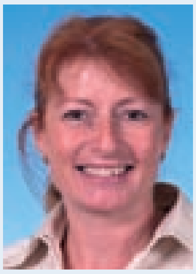
These case studies highlight the innovation and Kiwi ingenuity that went into their design and manufacture. An important part of these profiles is to identify improvements made to the environmental footprint in the different phases of the product's lifecycle.

Over the last four years our Plastics Environmental Best Practice Programme has received generous financial support from the Minister for the Environment's Sustainable Management Fund, which is administered by the Ministry for the Environment. This publication about iconic Kiwi plastic products marks the end of the fourth year. It complements our previous Best Practice Programme publications;

- 'Good News for the Environment from the New Zealand Plastics Industry' in 2005 and
- The 'Plastics NZ Design for the Environment Guidelines' in 2006.

We are indebted to Simon Wilkinson, Best Practice Programme Facilitator, and Ket Bradshaw, Environmental Manager, for bringing this publication together.

I encourage you to read these case studies and the team at Plastics NZ would appreciate any feedback.



Dennise Chapman,
Chair Environmental Committee,
Plastics New Zealand

Introduction

We have profiled six iconic Kiwi plastic products across the plastics industry. Their iconic status is as varied as the internationally recognised DishDrawer® made by Fisher and Paykel to the very Kiwi Tip Top 2-litre ice cream tub. Much of New Zealand's infrastructure uses plastic piping and the insulative qualities of our expanded polystyrene have long been recognised as the cornerstone of exporting our primary produce to the other side of the world. It's no surprise, given New Zealand's natural productivity, that we have also chosen two products from the agricultural sector that assist with the irrigation of our pastures and the packaging of our dairy products.

The iconic Kiwi plastic products are:

1. Multi-layer laminated plastic 20-kg cheese pack [flexible packaging]
2. Fisher and Paykel DishDrawer® and components [electronic]
3. Expanded polystyrene insulation [construction]
4. RX Plastics K-line irrigator [agriculture]
5. Tip Top 2-litre ice cream container [rigid packaging]
6. PVC piping [construction]

Each case study looks at how the product was developed and demonstrates the environmental improvements made over this time. Much of this has been through finding innovative solutions to issues at the design, manufacture, use and end-of-life phases of the product's lifecycle.

During the fourth year (2006-2007) of the successful Plastics Best Practice Programme we have worked with plastics companies and encouraged them to use the tools developed in the programme to date. We would like to congratulate all our Plastics Best Practice companies on their achievements to date.

In 2006 we published the Plastics NZ Design for the Environment Guidelines about developing products in a way that minimises their environmental impact; http://www.plastics.org.nz/_attachments/docs/bpp-dfe-final-4.pdf These guidelines profile some of their exciting design projects, clearly demonstrating that good design improves performance and is good news for business and the environment. We profiled our Best Practice Programme companies in our 2005 report entitled: 'Good News for the Environment from the New Zealand Plastics Industry'; http://www.plastics.org.nz/_attachments/docs/best-practice-prog-v2-e-final-draft-1.pdf.

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CHEESE POUCHES BY SEALED AIR

Packaging for maximum materials efficiency

About the product

This 20-kg cheese pouch is a silent yet iconic achiever, rarely seen by the general public. It demonstrates Kiwi innovation in flexible packaging, an area where New Zealand has excelled over the last 30 years. Its significance lies in the leading edge design and applied polymer technology used to enhance the quality and safety of our exported products. The cheese pouch is exported from Hamilton to cheese factories throughout the world.

Material and process efficiency

The multi-layered plastic protects the cheese from degrading and allows the maturing process to take place for up to 18 months. Many environmental gains have been achieved through product development and improvements such as automation of the filling of the pouches at the cheese factory.

Under the manual filling system, bag lengths were 690 mm. Now they are able to be manufactured to 670 mm – a reduction of 5% that represents a material saving of hundreds of kilometres of plastic every year.

Lightweighting

Since 1998 there has been a gradual reduction in the thickness of the plastic pouches from 120 to 90 microns. This represents a 25% reduction in the material used in the millions of these bags produced each year.

Distribution improvements

Cheese pouches are now distributed to cheese factories in a vacuum bag rather than cardboard boxes. This has significantly reduced the volume of the product for distribution. The new system means 160% more bags can be fitted onto a pallet within New Zealand and 240% more bags on an export pallet. These improvements have reduced truck trips in New Zealand by 40% and the number of 20-ft containers used for export has been reduced by 60%. Carbon dioxide (CO^2) emissions have also been saved through this reduction in transportation and the company no longer has to buy thousands of cardboard boxes.

Recycling

The Sealed Air factory that makes the cheese pouches has reduced manufacturing waste going to landfill by 80%. Since 2001 recycling has steadily increased from 45% to more than 80% now – despite a significant increase in production levels.

CHEESE POUCHES BY SEALED AIR

Packaging for maximum materials efficiency

Iconic Status

Sealed Air cheese pouches reflect a packaging innovation that successfully connects with another vital New Zealand sector – the dairy industry. Cheese is one of our most important exports and highly regarded throughout the world.

The pouches are designed to give high gas and moisture barrier protection combined with good puncture resistance and effective heat sealing. After cheese is placed into the pouches they are vacuum-packed and then sealed. The multi-layer plastic protects the cheese from degrading and allows the maturing process to take place for up to 18 months. Since the introduction of the pouch, Sealed Air has further improved efficiencies, for example by reducing material use by up to 25% as a result of lightweighting.

While the cheese pouch is never seen by the general public, it demonstrates the significance of leading edge design and applied polymer technology that further enhance product safety and exports. The cheese pouch is also exported from Hamilton to cheese factories throughout the world.

About the Product

The Sealed Air cheese pouches are used in cheese factories to package 20-kg blocks of cheese for maturing. They are used for dry salt cheese, particularly cheddar, but also varieties such as Mozzarella and Egmont. The pouches are designed to give high gas and moisture barrier protection combined with good puncture resistance and ease of heat sealing. Cheese is packed into the pouches, which are vacuum-packed and then sealed. The multi-layer plastic protects the cheese from degrading and allows the maturing process to take place for up to 18 months.

The pouches were developed in New Zealand and have been manufactured at the Hamilton Cryovac division of Sealed Air (New Zealand) since 1998.

The traditional packaging method was to wrap cheese cloths around round blocks of cheese. As the dairy industry moved towards mass production, plastic bags or pouches were used to wrap square blocks of cheese. These pouches were made of biaxial nylon. During the 1970s New Zealand companies pioneered the coextrusion of three-layer polymers for packaging applications which led on to the development of the multi-layered pouches we see today.

The most recent pouches are a multi-layered coextruded polymer comprising linear low-density polyethylene (LLDPE), tie resins, nylon and ethylene vinyl alcohol (EVOH). In a coextrusion process all of the polymers are extruded together and allowed to bond while in a molten state. Each layer has a particular function, for example the EVOH layer provides a barrier to oxygen and extends shelf life. LLDPE provides a moisture barrier but is more resistant to stress cracking than other polymers, making it ideal for thinner packaging films.

The further development of this multi-layered plastic technology has lead to a gradual reduction in the thickness of material required and therefore the amount of material used.

Company Background

Sealed Air is a leading global manufacturer of materials and systems for protective, presentation and fresh food packaging in the industrial, food and consumer markets.

For more than half a century, Cryovac, the food packaging division of Sealed Air Corporation, has helped to shape and create markets for a host of new products. Cryovac works closely with the supermarket, food processing and food service industries to develop packaging systems that are in use throughout the world. These packaging systems enable perishable foods to be distributed safely and efficiently.

Cryovac manufacture the cheese pouches in Hamilton. The pouches are used predominantly by cheese makers in New Zealand, but are also exported all over the world.

Environmental Properties, Features and Benefits

The cheese pouch has been through a continual process of product development and improvement. Many of these improvements have resulted in environmental gains.

Product safety

The pouches protect cheese from contamination during the maturing process, thus safeguarding the quality and safety of the product. Effective packaging also reduces food wastage throughout the supply chain.

Material efficiency

The cheese pouch is made to exact dimensions in order to avoid waste in the packing stage of the process. The bag is sized precisely for the 20-kg block of cheese.

Previously the pouches were closed manually by staff at the dairy factories. This meant a 'margin of error' had to be built into the pouch length. By shifting to an automated process that heat-seals the pouches once filled, Sealed Air has reduced the amount of material used. Under the manual system, bag lengths were 690 mm. Now they are manufactured to 670 mm – a reduction of 5% that represents a significant material saving.

Is food packaging bad for the environment?

Packaging preserves and protects foodstuffs and prevents the waste of produce.

One international study found that the loss of foodstuffs between grower and consumer is about 2% in the developed world and up to 33% in the developing world.

Lightweighting

The original pouches were 120 microns in thickness. As polymer technology and processing efficiency improved the bags were reduced gradually to 90 microns and even lower for some markets. These reductions in thickness represent up to a 25% reduction in material used to manufacture the pouches.

Recycled content

There are very strict controls placed on the quality of materials used in any packaging that comes into contact with food. These controls are to protect against the migration of additives or contaminants into food. For this reason recycled material cannot currently be used in the manufacture of cheese pouches.

Process efficiency

Manufacturing of the cheese pouch has been refined over the years and is now extremely efficient. In terms of material waste the extrusion process is now 99% efficient, and the process of converting extruded film into the pouch is 97% efficient. Sealed Air have continued to develop processes and introduce automation, resulting in savings in manpower and a reduction in repetitive job functions. These changes have produced labour savings and created more diverse job functions for employees.

A recent development has been the introduction of a unique barcode that is printed on every cheese pouch. This barcode enables traceability of the cheese and packaging back to the time of manufacture should any problems arise.

Site environmental initiatives

Sealed Air Hamilton has been active in improving its environmental performance. The company has a global Environment, Health and Safety policy which states that 'EHS considerations are an important element in the design, production, distribution, use, recycling, and ultimate disposal of our products' (www.sealedair.com)

A complete review of waste management at the Hamilton site led to greatly increased recycling and an 80% reduction in the volume of waste being sent to landfill. This waste reduction project started in 2001. At that time 55% of waste was being sent to landfill and 45% was recycled. This was reduced to 30% landfill and 70% recycled by 2003 – despite a 30% increase in production output. Quantities of waste being sent to landfill are now just 20% of what they used to be in 2001.

Improvements in distribution

Until 2007, cheese pouches were distributed from Cryovac in Hamilton to cheese factories throughout the world in traditional cardboard cartons. Cryovac reviewed their packaging systems to identify opportunities for efficiency improvements. They found that they could vacuum-pack their cheese pouches in a plastic pouch made on site in Hamilton. This significantly reduced the volume of the product for shipping.

The new carton-less system, combined with a pallet sizing review has increased the efficiency of cheese pouch distribution packaging significantly. The new carton-less system means up to 60% more bags can be fitted onto a pallet within New Zealand and up to 140% more bags on an export pallet. These improvements have reduced truck trips in New Zealand by up to 40% and the number of FCL containers used for export has been reduced by up to 60%. Carbon dioxide (CO^2) emissions have also been reduced through more efficient transportation. The company also no longer has to buy thousands of cardboard boxes and their customers have significantly lower volumes of packaging waste to process.

Recycling at end of life

Multi-layer polymers are extremely difficult to recycle. Recovery technologies which are being investigated around the world include the separation of the different polymer layers in a mechanical recycling process, mixed polymer recycling (for example, to manufacture plastic lumber or vineyard posts) and energy recovery. For many years there was no market for Sealed Air's waste plastic containing nylon materials. However, through the development of recycling techniques, and increasing international markets for this type of waste, very little of this material is now sent to landfill.

Concluding Comments

Sealed Air cheese pouches show what is possible when applied polymer technology, good design and leading edge innovation are combined to deliver process and end-user benefits. Intelligent thinking by Sealed Air has managed to address a significant area of unnecessary waste generation in the cheese industry.

The cheese pouches are also an excellent example of packaging that can play a meaningful role in providing product protection and food safety along with maximised efficiency in logistics. Design for efficient and responsible materials consumption is a strategy that has delivered multiple benefits and positive outcomes for Sealed Air and its customers.

Vacuum-packed cheese pouches (left) compared with traditional carton packs. Vacuum-packing has allowed 140% more bags to be packed on a single pallet.

The essence of innovation

About the product

The Fisher & Paykel DishDrawer® dishwasher is a revolutionary major appliance. It has been acknowledged as one of the few whiteware products that has embodied the essence of design innovation. Environmental improvements include; component durability, energy and water efficiency, recyclability and overall materials efficiency. The DishDrawer® has been a global success for Fisher & Paykel and showcases New Zealand design capability.

Water efficiency

The double DishDrawer® is two totally separate, independently operated drawers. Each drawer uses half the amount of water and detergent of a conventional dishwasher.

Supply chain efficiency

Fisher & Paykel has worked closely with innovative New Zealand plastics manufacturers in the development and improvement of DishDrawer® components. A collaborative redesign of the drain hose resulted in production waste being cut from 32% to zero. The cutlery basket is now made from 100% recycled plastic from reground rejected polypropylene DishDrawer® tubs from the Fisher & Paykel Dunedin factory, and the spray arm was redesigned to enable more efficient manufacturing methods that use fewer resources.

Energy efficiency

Each drawer uses half the electricity of a normal dishwasher. An 'economy' wash option is also available that reduces all wash/ rinse temperatures and reduces the amount of time used, saving energy. A 'delay start' option allows the user to delay the start of the wash by up to 12 hours to take advantage of off-peak power supplies. An efficient fan drying system uses negligible amounts of energy compared to a conventional dishwasher.

End-of-life product stewardship

Since 1993 Fisher & Paykel has been taking back old appliances from retailers in New Zealand for recycling. The recycling centre currently deals with about 25,000 old washers, dryers, cookers, refrigerators and freezers a year. Significant amounts of packaging are also returned to Fisher & Paykel for re-use or recycling.

Design for Environment

Environmental factors are often considered by Fisher & Paykel at the concept design stage. Design for Environment measures implemented by the company include; goals to eliminate brominated flame retardants; changing grades of ABS to reduce emissions of styrene monomers during processing; trialling lead-free solder for printed circuit boards; eliminating cadmium from product design; and marking plastic components to enable easier identification.

DishDrawer® BY FISHER & PAYKEL

The essence of innovation

Iconic Status

The Fisher & Paykel DishDrawer® dishwasher is a revolutionary major appliance. It has been acknowledged by the design community, industry peers and consumers as one of the few whiteware products that has embodied the essence of design innovation.

The DishDrawer® shows what is possible when lateral thinking is encouraged and supported. Driven by customer insight and a deep understanding of how people interacted with dishwashers, the DishDrawer® transformed functionality and aesthetics through improvements in technology and design.

Flexibility in use improved dramatically and without compromising high levels of energy and water efficiency. Innovations also extended to various Design for Environment outcomes including component durability and longevity, disassembly and recyclability and overall materials efficiency.

The continuing global success of the DishDrawer® highlights how the essence of innovation, as pursued by Fisher & Paykel and its suppliers, has been able to create an enduring product that delivers significant economic and social benefits as well as reduced environmental impacts.

About the Product

New Zealand's Better By Design programme provides one of the most insightful descriptions of the drivers behind the design of the DishDrawer®.

The Fisher & Paykel DishDrawer® was first conceptualised in 1987 when two young designers at Fisher & Paykel's Dunedin plant came up with the idea after being charged with upgrading the existing dishwasher.

Fisher & Paykel designers knew that they had to come up with something radically different to compete with European dishwasher products that enjoyed huge economies of scale. The project to redesign the dishwasher was a ground-up rethink, rather than an upgrade.

It was a consideration of ergonomic factors that led to one of the design team suggesting that the door of the dishwasher should go. Inspiration from the resulting design came from nearby filing cabinets used to store crockery and pans for the cooking lab.

The designers' belief that each drawer should be the same and able to accommodate dishes and utensils from an eight-person meal, resulted in a space less than 100 mm high in each machine for a motor, wash pump, drain pump, heater, filter and spray arm. The company used the

innovative electronic motors developed for the SmartDrive washing machine. It was the right principle but needed to be produced at a fraction of the size.

On top of these redesign parameters, sustainable design requirements were added to the brief, resulting in greatly reduced water use, and design for disassembly.

Two essential elements, among many, of the DishDrawer® story stand out:

i) It was the first Fisher & Paykel innovation to be driven by end-user experience rather than product and/or production technology. It was empathy for lifestyle, personal convenience and human interface that created the challenges that product designers rose to.

ii) The fact that the product was immediately recognisable as different from and better than competing products had the effect of re-branding Fisher & Paykel on the international market. Buyers were now willing to look twice at the SmartDrive washing machines and the refrigerators, where the innovation was under the surface, because they came from the company that created the DishDrawer®.

The Fisher & Paykel DishDrawer® was launched in 1997.

About the Company

Fisher & Paykel design, manufacture and market a range of household appliances in New Zealand, Australia, Oceania, Asia, Europe, Canada and the US. These appliances are developed with a commitment to technology, design, user friendliness and environmental awareness.

Products include domestic refrigerators, freezers and refrigerator/freezers, top loading automatic washers and clothes dryers (electric and gas), free standing electric ranges, wall ovens, gas and electric hobs, BBQs and dishwashers.

Fisher & Paykel was established in 1934 by Maurice Paykel and Sir Woolf Fisher to manufacture designs under licence. They soon realised that by making appliances under licence the company would be destined to make a more expensive version of others' products. Because they were unable to compete on price, Fisher & Paykel pursued niche markets by exploiting technology. The company claims to be the first to commercialise plastic liners and polyurethane foam insulation in refrigerators.

Fisher & Paykel expresses its culture in four words: 'style, integrity, care and innovation'. The company has a strong commitment to research and development that includes an environment in which people are encouraged to develop new ideas and a Board of Directors which gives these ideas the time and resources to meet long-term goals.

In the late 1960s the company saw the need to find a way of producing short runs of various models through common manufacturing machinery: the idea of being able to make every model just in time.

Flexible machinery brought with it the notion of manufacturing cabinets using prepainted steel. In tandem with the Japanese steel mills, appliance-grade pre-painted steel was developed that enabled coiled steel to be processed through lines of machinery that could notch and pierce various sizes and shapes. The first product to incorporate this technology was the compact dryer. This technology carried over into refrigerators and washing machines and is now standard across all of Fisher & Paykel's appliance range.

Having learned about electronic drive systems through flexible manufacturing equipment, Fisher & Paykel applied the knowledge to driving appliances. The world's first whiteware appliance using Brushless Direct Current Motors was introduced in the 1980s. This design later gave way to the development of the SmartDrive clothes washer. The next platform innovation was the DishDrawer® dishwasher. This too was an evolution of the washer technology – using smart electronics to control brushless DC motors that could be constructed to fit in a minimum of space.

The Market – Some Facts and Figures

- The company's revenue from appliances increased from $500 million in the 1997/1998 financial year to $853 million for 2003/2004, and 150 additional staff have been added for DishDrawer® development and production alone.

- Perhaps most markedly, the operating profit before interest and tax for appliances has leapt from $11.5 million in the 1997/1998 financial year to $102 million for 2003/2004.

- This bottom line increase is significantly greater than the increase in the total number of units produced, due in large part to the price premium products, such as the DishDrawer®, command.

- With 19 patents in 27 countries, the DishDrawer®'s uniqueness continues to be a strong competitive advantage.

Sources: www.betterbydesign.org.nz and www.fisherpaykel.co.nz

Environmental Properties, Features and Benefits

The scale and diversity of environmental improvements embodied in the DishDrawer® reflect a strong life cycle approach to product development.

Energy and water efficiency

Some of the more noteworthy outcomes relate to improved energy and water efficiency and include:

Flexibility

The double DishDrawer® is two totally separate, independently operated drawers. This allows delicate dishes to be washed in one drawer and pots and pans in the other drawer on a heavy programme. In a conventional dishwasher the entire dish load is subjected to one programme, whereas in the DishDrawer® the dishes can be split up according to dish load or soil type. This takes better care of dishes and saves energy.

Convenience and efficiency

The DishDrawer® caters for small loads. Each DishDrawer® holds half the capacity of a conventional dishwasher, which eliminates the practice of running a dishwasher half full. Breakfast or lunch dishes can be taken care of immediately, saving time, energy and money.

Cost saving

Each drawer uses half the amount of water, energy and detergent of a conventional dishwasher, so it costs less to run. The 'economy' option is available on all wash programmes. This option reduces all heated wash/rinse temperatures and reduces the amount of time used, hence saving energy. The 'delay start' option allows the user to set up the dishwasher and then delay the start of the wash from 1 to 12 hours, taking advantage of off-peak power supplies.

***Connecting to cold water** (New Zealand, Australia and United Kingdom Only)*

The DishDrawer® has its own concealed element which enables it to heat up the water. If a dishwasher is connected to hot water, the water needs to be heated twice as there are energy losses as it travels in the pipes to the dishwasher, hence making hot water connections less energy efficient.

Energy efficient drying system

Immediately after the final rinse, water is drained from the drawer and the drying system begins its operation. The fan pulls air through the drawer where it absorbs water from the dish load. The moisture laden air is mixed with air from the room and then removed from the DishDrawer® so dishes are dry at the end of the programme. The fan uses negligible amounts of energy compared to a conventional dishwasher, where the main element cycles on and off for a period of time, using lots of energy.

Additional environmental aspects – product and company wide

The environmental properties, features and benefits associated with the DishDrawer® are directly and indirectly the result of various environmental initiatives underway at Fisher & Paykel. The following summary provides a glimpse of how environmental performance and sustainability relate to key aspects and life cycle stages.

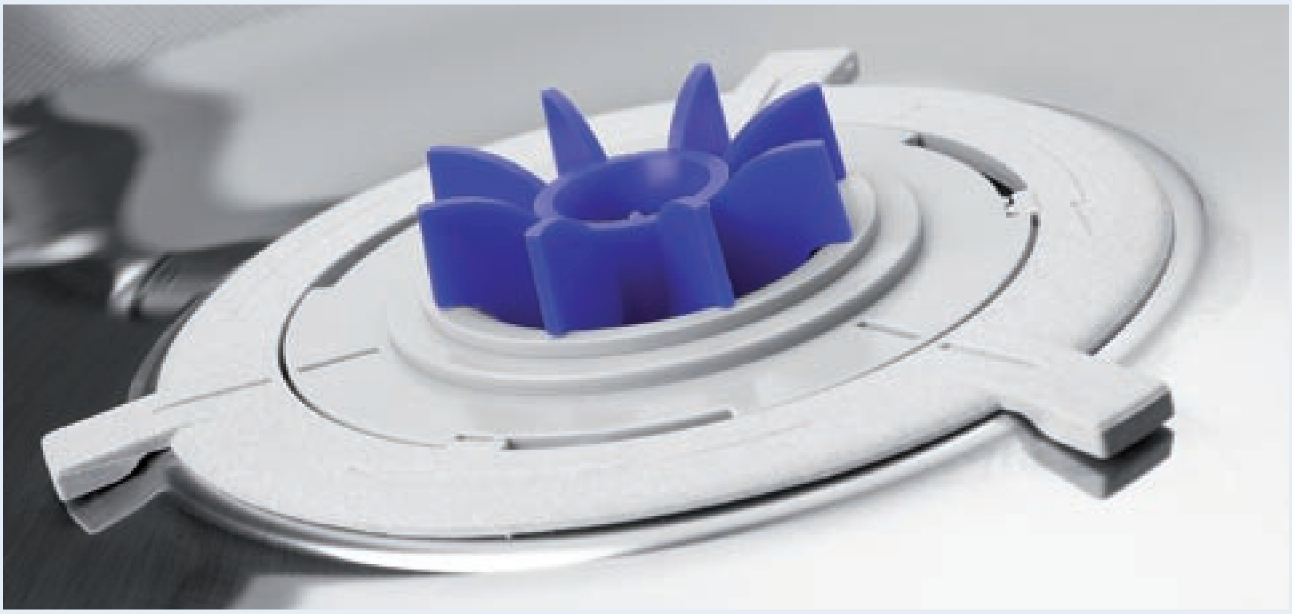
Design

At Fisher & Paykel, design is all done in-house. The designers tend not to generate multiple concepts, though they may explore a variety of different options for sub-systems. Laboratory- and field-testing are very important in developing new products. Market research and focus groups are not widely used and are unlikely to be used at all if the objective is a technical one, such as meeting a lower water, or energy, consumption target.

Environmental factors are often considered at the concept design stage. Usually a design project includes the following objectives:

that the product:

- is easier to use;
- gives the customer a real option (over a conventional product);
- uses less energy;
- uses less water;
- costs less (i.e. fewer parts, less expensive material, lower warranty cost - more reliable, longer life);
- takes up less space (for sub-assemblies rather than total appliances);
- is quieter; and
- fills a gap in the Fisher & Paykel line-up.



What drives design at Fisher & Paykel is the in-house culture of engineering excellence. For example, independent of the European Restriction of Hazardous Substances (RoHS) Directive, Fisher & Paykel materials engineers are looking to eliminate all brominated fire retardants – not just the two in RoHS, and not just for products destined for Europe. Brominated flame retardants inhibit the recyclability of plastics from end-of-life electrical and electronic products.

Consistent with corporate sustainability programmes, Design for Environment (DfE) is implemented wherever possible.

Design for Environment (DfE)

A range of Design for Environment measures have been implemented at Fisher & Paykel, including new methods that are being trialled and evaluated. A sample of DfE and materials related initiatives includes:

- avoiding the use of scarce resources in products wherever possible;
- setting goals to eliminate brominated flame retardants;
- changing grades of ABS to reduce emissions of styrene monomers during processing;
- trialling lead-free solder for printed circuit boards;
- eliminating cadmium;
- working towards the phase out of hexavalent chromium in steel pre-treatment;
- wherever practicable, avoiding construction techniques that combine incompatible materials that make end-of-life disassembly and recycling difficult; and
- marking of plastic components to enable easier identification, sorting and recycling at end of life.

End-of-life product stewardship

Fisher & Paykel's view of product stewardship includes life cycle focus, collaboration and cooperation with other stakeholders, and balancing environmental protection with sensible economic management. An important factor of product stewardship at Fisher & Paykel, is the geography of ownership and production. Fisher & Paykel is a New Zealand-owned company with local production facilities.

In 1993 Fisher & Paykel started taking back old appliances from retailers in New Zealand as a pilot study into the recycling of whole appliances. The pilot project gave insights to the process of recycling. The recycling centre currently deals with about 25,000 old washers, dryers, cookers, refrigerators and freezers a year. The majority of appliances recycled each year are from customers trading in an old appliance. The spirit of recycling goes beyond appliances themselves with much of the packaging returned to Fisher & Paykel for re-use or recycling.

The recycling centre also handles waste from Fisher & Paykel's factories. As well as the packaging that components come in, all paper, scrap and off-cuts from the production facilities are collected and sold. Fisher & Paykel recycling centre in Auckland takes back expanded polystyrene (EPS) and arranges for it to be recycled by a local polystyrene recycler.

Cleaner production

Fisher & Paykel's cleaner production initiatives include:

- eliminating production paint shops – which inefficiently painted large empty white boxes with high solvent wet paint – initially by switching to powder coating which eliminated solvents and then by using pre-painted galvanised steel.
- at the electronics factory, working to eliminate hot air levelling of solder after soldering, which saves energy;
- dramatically improving quality control – the 'first past yield' figure has increased from 48% to 96%, thus cutting rework and scrap;
- investigating the waste stream from the Auckland factories and recycling as much material as possible, resulting in a reduction in waste to landfill of 40% in 2004;
- recycling all injection moulding rejects and sprues in-house. The policy is that, wherever practical, all new injection moulding tools will be hot runner, which eliminates the generation of scrap material;
- eliminating the use of CFCs for cleaning in the circuit board assembly process and avoiding the use of HCFCs;
- trialling VOC-free fluxes for circuit board assembly; and
- working to eliminate hexavalent chromium. This is used by steel suppliers as a pre-treatment before painting.

Collaboration with Suppliers

The DishDrawer® also represents a valuable case study in how the brand owner has gone through a productive process of collaboration with key suppliers in order to fulfil technical, functional and environmental objectives.

In particular, Fisher & Paykel worked with two suppliers to develop and refine various components of the DishDrawer®. Talbot Plastics Limited (TPL) and Elastomer Products Limited (EPL) have contributed to the product-wide design and manufacturing solutions required to make the DishDrawer® an overall success.

Environmental initiatives at Talbot Plastics Ltd

TPL is a custom plastic injection moulder, tool and die-maker that was established in 1972. The company employs over 100 people and operates 28 moulding machines ranging from 22 to 680 tonnes. TPL also has an in-house toolroom that uses the latest in mould design and machining

technology to provide customers such as Fisher & Paykel with highly specialised design advice. In 2006 TPL was awarded the Enviro-Mark DIAMOND standard for compliance with the requirements for health, safety and environmental issues.

TPL contract manufacture a number of components for the DishDrawer® including the cutlery basket, spray arms, drain filters and rotors. The following summary gives a sense of some of the very practical and technical environmental outcomes and initiatives directly associated with TPL's work on components for the DishDrawer®.

Cutlery basket

Fisher & Paykel's Dunedin manufacturing plant could find no beneficial use for reject polypropylene tubs from their DishDrawer® production line. They were disposing of approximately 4–5 tonnes of polymer every month.

TPL was using the same polymer to manufacture the cutlery basket for the DishDrawer®. Each discarded tub contained enough polymer to manufacture 50 cutlery baskets. TPL worked with Fisher & Paykel to set up a system to utilise the rejected material. Material is now transported to TPL via a reprocessor, and the quality of this material is controlled by working closely with the reprocessor. As a result, cutlery baskets are now produced from 100% reground (recycled) material from Fisher & Paykel.

The system has been extended to all reject components that cannot be reprocessed into the original part. The recovery system now processes around 100 tonnes of polymer a year that was previously destined for landfill, and converts it to first grade product. This closed-loop recycling system saves about $18,000 per annum in waste disposal charges and also saves about $350,000 per annum in raw material and colourant costs. The cutlery basket won Gold at the Plastic Industry Design Awards in 2006.

Spray arms

Initial designs of the spray arm for the DishDrawer® were complex because the curved shape of the weld meant that a special adhesive Teflon layer had to be used in the welding tool. Hot plastic would occasionally drip onto the Teflon and burn holes in the material. This meant that the Teflon layer had to be removed and replaced almost daily. Replacing the adhesive Teflon required the machine to be shut down to cool before removal, and then reheated to its operating temperature. This resulted in a down time of 12 hours.

Talbot worked with Fisher & Paykel designers to redesign the part so it had a straight weld line. This allowed an adjustable, flat layer of Teflon to be used instead of the adhesive Teflon. The benefits included no down time, less energy used in reheating the machine and the use of simpler tooling. These all resulted in material, time and cost savings.

The spray arm was also redesigned to improve performance (and therefore water efficiency) by using a valve that reduced surface tension at outlet holes of the spray arm. This reduced the need for a primer pump.

Drain filters

The DishDrawer® drain filter was originally solid plastic with small holes. Fisher & Paykel and TPL worked together to redesign the component to make the draining more efficient. Thus some of the plastic was replaced by a stainless steel mesh.

When TPL first started making the new filter, the steel mesh was formed and punched, and then plastic was moulded around it. Due to processing issues there was a 50% reject rate. TPL worked with Fisher & Paykel to redesign the process to reduce the reject rate. The metal mesh was imported, cut and punched to shape, but not formed. Instead, the mesh was formed at the Talbot plant immediately prior to going into the plastic moulding machine to have the plastic moulded around it.

By undertaking these two critical stages at the same facility they were able to reduce the reject rate from 50% to 20% immediately. With further refinement the reject rate is now down to less than 2%. The cost of the component has been halved as a result.

Rotors

The DishDrawer® rotor was originally manufactured in the US but Fisher & Paykel were dissatisfied with the inconsistent quality coming from their American contract manufacturer and, as production volumes increased, the supplier could not meet demand quickly enough. This meant that occasionally the parts had to be air freighted to New Zealand.

Fisher & Paykel looked to TPL to provide a local solution. The challenge was that the magnets being moulded into the component rapidly wear out the plastic moulding tool and lead to the quality inconsistencies experienced by the US supplier. TPL had to come up with a way to extend the life of the tool.

Using a wire-cut eroder enabled TPL to develop a modular tool in which inserts could be easily replaced as they wore out. Not only was the quality consistency improved, but the initial cost of the tool was cheaper and the need for tool replacement was dramatically reduced. Modular tooling design came from previous experience working with Fisher & Paykel on plastic oven- and stove- knobs.

Environmental initiatives at Elastomer Products Ltd

Elastomer Products Ltd (EPL) produces plastic components for the Fisher & Paykel DishDrawer®. EPL have been making the drain hose for the DishDrawer® for several years and have worked closely with Fisher & Paykel over this time to improve the performance of this component.

The drain hose for the DishDrawer® is one of those parts of the product that we take for granted. But the drain hose has a story behind it that highlights how the environmental footprint of a plastic product can be improved through manufacturing efficiencies.

The drain hose is made of corrugated polypropylene. At certain intervals in the corrugation there are flat spaces. These flat spaces are designed to fit with the locations of clips on the DishDrawer®. These flat spaces are not regularly spaced and therefore each length of pipe has to be manufactured and cut to an exact length.

EPL was finding that lining up all the flat spaces in their continual extrusion manufacturing process meant that for every length of 3.4- or 3.8-m pipe they made they had to cut away 1.2 m of pipe. This was the equivalent of making eight lengths of pipe for every six. The waste pipe was reground and put back into the manufacturing process, but this took time and energy.

EPL's design engineers worked out that they could prevent the waste by reducing the length of the final drain hose by just 60 mm. By redesigning the product only slightly, EPL was able to reduce the amount of material being wasted from 1.2 m to just 25 mm per length of pipe. Waste went from 32% to less than 1%.

Reducing this waste also reduced the amount of energy they had to use to reprocess the waste material. And, not having to produce such long lengths meant that manufacturing times were significantly reduced and utilisation of machinery was maximised.

As well as delivering environmental benefits, the changes reduced the cost of producing the drain hose by almost 30%.

As a result of this design improvement Fisher & Paykel and EPL are implementing a further design change to eliminate the flat areas on their drain hoses by using a different clip system on the DishDrawer®. This design change means that EPL can operate a continual drain hose extrusion process with no need for waste off-cuts. The drain hose manufacturing process has gone from 32% waste to zero waste through simple design changes.

A redesign of the plastic cuff that connects the drain hose to the DishDrawer® has also resulted in significant environmental gains. The cuff was a complicated design with a 45 degree bend, requiring complex tooling with hydraulic cores. Pacific Plastics Ltd worked closely with Elastomer Products and Fisher & Paykel to refine the design of the cuff. The new, less-complicated design has improved manufacturing efficiency by 100%, resulting in significant energy and material savings.

World Class Packaging for the DishDrawer

Complex products such as the DishDrawer® need high quality packaging to safely transport to the end user. Long Plastics Ltd worked closely with Fisher and Paykel to design and develop packaging of a suitable standard for the DishDrawer®. The packaging design chosen for the DishDrawer® consists of expanded polystyrene and polyethylene shrink film. The result has been minimal damage during transit and reduced packaging costs. Long Plastics Ltd has worked closely with Fisher and Paykel to refine the expanded polystyrene packaging to minimise the amount of material used, to improve strength and durability and to ensure ease of use and stackability during the packaging and transport phases.

Concluding Comments

The Fisher & Paykel DishDrawer® is unmatched in terms of design innovation, functionality, appliance aesthetics and environmental performance. Company culture appears to have played a critical role in stimulating and supporting the creation of a unique dishwashing machine that is enjoying global success and recognition.

In many respects, Fisher & Paykel has approached environmental performance and sustainability issues in a humble manner, relying on the merit of the product and its performance to underscore a diverse range of very tangible features, outcomes and initiatives.

Whether it translates to energy and water efficiency, or product and component longevity, or design for disassembly and recycling, Fisher & Paykel has moved beyond the rhetoric of Design for Environment and improved environmental performance, and invested time, funding, creativity and mind-power in a way that delivers real-world eco outcomes.

The DishDrawer® also provides an example of how plastic component manufacturers in New Zealand lead the way in working with brand owners to develop efficient and innovative parts that add to the value of the overall product. By working closely with brand owners local component manufacturers can develop significantly more efficient and cost-effective manufacturing methods.

The DishDrawer® has yet to be eclipsed by any other dishwasher after nearly ten years. A key to this success has been Fisher & Paykel's persistent design approach that seeks to maximise innovation and relevance to end users. Pursuing such goals inherently requires attention to environmental considerations, and these have been achieved without the fanfare often associated with overtly eco-oriented brand owners and their products.

An unmatched material with high utility

About the product

EPS is an iconic product in New Zealand because its insulation properties have revolutionised the efficiency with which our fresh produce is stored and transported to markets on the other side of the world. More recently the construction industry has used EPS as an efficient insulation material under floors, in walls and in ceilings.

Energy efficiency

EPS has exceptional insulation properties due to its microcellular closed cell construction. It has been estimated that the effective application of EPS insulation could cut CO^2 emissions from building use by up to 50%.

Embodied energy

The energy used to manufacture expandable polystyrene and convert it to insulating material is insignificant compared with the energy it saves over the life cycle of a building. The energy required for the manufacture of a cubic metre of EPS is 151–269 kWh or the equivalent of burning 15–27 litres of fuel oil. The same amount of energy is saved in less than six months when that volume of insulating material is used for thermal insulation.

Recycling

Post-consumer EPS can be compressed, granulated and re-extruded back into solid polystyrene for the production of simple products. In New Zealand compressed polystyrene is shipped to Asia where it is recycled into new polystyrene products such as coat hangers and computer casings.

Durability

EPS is dimensionally stable and is able to deliver constant thermal resistance and insulation for the lifetime of a building. Also, of all materials used for insulation applications EPS is one of the most resistant to the adverse effects of moisture. Because it does not decompose it will perform for decades or even centuries.

EXPANDED POLYSTYRENE INSULATION

An unmatched material with high utility

Iconic Status

The unique characteristics of expanded polystyrene (EPS) have helped to revolutionise a number of existing applications as well as enabling new and innovative uses across various commercial, consumer and industrial sectors. The benefits of EPS include its excellent thermal insulation properties, its light weight, and its cost effectiveness in a wide range of applications.

EPS is a highly efficient material because 98% of its volume is air. At the end of its life it can potentially be recycled back into polystyrene.

Despite being a relatively mature polymer, it continues to capture a growing range of applications on a global scale. At a time when energy efficiency and carbon neutral approaches are becoming more significant, EPS has much to offer the building and construction sector. Expanded polystyrene is increasingly being used as an effective insulation material which is straightforward to work with and has significant environmental performance benefits.

About the Product

First introduced in Germany in 1952, expanded polystyrene, or EPS, is a lightweight, rigid, plastic foam insulation material produced from solid beads of polystyrene. A cost-effective, easy-to-use and easy-to-process material, it performs as a thermal insulator, is moisture resistant and potentially recyclable.

EPS is manufactured from styrene monomer derived from crude oil. EPS is created by polymerising styrene in the presence of pentane, a blowing agent, to create white beads. When the beads are heated with steam the gas expands to form perfectly closed cells of EPS. These cells occupy approximately 40 times the volume of the original polystyrene bead.

Pentane is a common hydrocarbon that is not implicated in ozone depletion or global warming; after manufacture the pentane quickly leaks out of the insulation and is replaced by air. The EPS beads are then moulded into appropriate forms suited to their application such as insulation boards, fresh produce boxes, loose fill packaging and customised shapes for the building and packaging industry.

EPS insulation boards are used under floors and in walls and ceilings to insulate buildings from the extremes of heat and cold. It is easy to install and long lasting.

EPS in coolstores

EPS has played an important and somewhat overlooked role in New Zealand's strong agricultural export industry.

EPS insulation has been used in almost every coolstore facility that handles fresh produce in New Zealand. From freezing works, to dairy companies to seafood companies – if there is a coolstore it is more than likely it is lined with EPS insulation. This technology revolutionised the efficiency with which fresh produce was stored and the markets Kiwi produce was able to reach in perfect condition.

At the peak of coolstore construction in the 1980s and 1990s more than 750,000 m^2 of EPS per annum was being installed in New Zealand.

Some Facts and Figures

- Approximately 7,000 tonnes of EPS were manufactured in New Zealand in 2006. Nearly 70% of this was used in construction products with the remainder used primarily in packaging applications.
- EPS currently represents approximately 10% of the insulation market in New Zealand and its market share is increasing.
- EPS comprises 2% polymer and 98% air and is therefore a highly effective thermal insulation material.
- With its flexible production process, the mechanical properties of EPS can be adjusted to suit different applications.
- EPS can be manufactured in almost any shape or size, and is compatible with a wide variety of materials.
- EPS offers the best price/performance ratio of all insulation materials.
- There are about 12 companies that manufacture EPS insulation in New Zealand. Details of these companies can be found on the Plastics New Zealand website www.plastics.org.nz .

Environmental Properties, Features and Benefits

Embodied energy

The energy used to manufacture expandable polystyrene and convert it to insulating material is insignificant compared with the energy it saves over the life cycle of a building.

According to the European Manufacturers of EPS (EUMPS, 2006), the primary energy required for the manufacture of a cubic metre of EPS is 151–269 kWh or the equivalent of burning 15–27 litres of fuel oil. This is approximately the same amount of heat saved in six months or less when that volume of insulating material is used for thermal insulation. Energy continues to be saved as long as the building is in use.

Insulation and energy efficiency

Decisions about insulation can significantly influence the environmental impacts of a building. In an uninsulated home, about 42% of the heat escapes through the ceiling and another 24% escapes through the walls. Surprisingly, only about 10% is lost through the floor. About 12% heads out through the glass in your windows and another 12% is lost through draughts or when doors are opened and closed. Source: www.consumer.org.nz (Consumers' Institute of New Zealand).

Because insulation reduces energy consumption, it provides ongoing environmental benefits throughout a building's life. Insulation also improves human health. A University of Otago study concluded that when homes are properly insulated, there are significant health gains such as reduced respiratory problems (Howden-Chapman et al., 2004). EPS is used as an insulating material in walls, floating floors and concrete slabs.

EPS has exceptional insulation properties, with a thermal resistance ('R value') of 1.31 per 50 mm of thickness for S class material, as defined by AS 1366 part 3: 1992. This makes it ideal for wall and under-floor insulation and external cladding of buildings. The insulating properties of EPS, derived from its microcellular closed cell construction, provide one of its most important and widely used applications.

EPS plays a positive role in reducing carbon dioxide (CO^2) emissions. Domestic and industrial consumption of fossil fuels for heating is recognised as a significant contributor to the global output of carbon dioxide. It has been estimated that the effective application of EPS insulation could cut CO^2 emissions from buildings by up to 50%.

What is R value (m^2K/W)?

Heat travels from warm to colder areas. The ability of insulation to resist this heat movement is known as its R value. The higher the R value the more effective the insulation. The R value depends on the type of material and how thick it is.

The R value can refer to the thermal resistance of a material, or assembly of materials such as the wall of a building. It is used to find the overall thermal resistance of an assembly of materials by simply adding individual component R values.

Due to its cellular structure EPS is dimensionally stable, and will not settle over time. EPS used and installed correctly does not deteriorate with age and as such is able to deliver constant R values for the life of the building. As a result, this reduction in CO^2 emissions lasts the full lifetime of a building.

The relevance of the k value (W/mK)

The comparison of thermal conductivity can be measured by the 'k' value. The k value specifies the rate of heat transfer in any homogeneous material. If a material has a k value of 1, it means 1m³ of material will transfer heat at a rate of 1 Watt for every degree of temperature difference between opposite faces. The k value is expressed as 1 W/mK. The lower this value is, the less heat the material will transfer.

Most importantly the following chart shows the k value of a number of common materials, and demonstrates that EPS has a low thermal conductivity compared with other materials.

Typical k values (W/mK)

Brick	1.150
Glass	1.050
Concrete	1.250
Plaster Board (19 mm)	0.225
Wood	0.144
Compressed wood	0.060
Fibreglass	0.050
EPS-Class SL	0.039
EPS-Class VH	0.034

The lower the value, the higher the insulating ability.

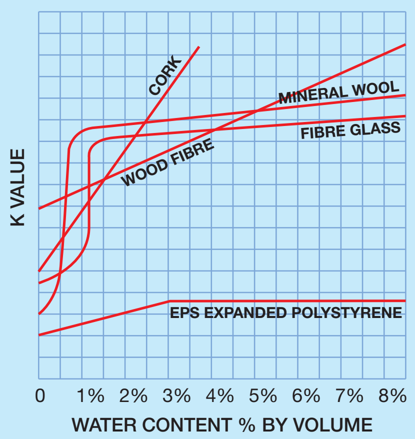
The relevance of R value (m^2/W)

The 'R' value, or thermal resistance of a material, expresses the ability of a particular thickness of that material to resist heat flow. It depends on the thermal conductivity of the material and how thick it is. The higher the value, the more effective a material is for insulation. An R value can be applied to a single insulating material or to an assembly of materials such as the wall or floor of a building by simply adding individual component R values.

All new houses in New Zealand are required by law to have thermal insulation. Mandatory R values for insulation depend on where the insulation is placed in the house and the construction type.

The effect of moisture on insulating materials

Of all materials used for insulation applications, EPS is one of the most resistant to the adverse effects of moisture. Condensation, which may build up within any insulation material under critical vapour flow conditions, only marginally affects the thermal performance of EPS. Even if condensation develops through improper use, EPS will retain its dimensional stability and superior insulation values. The Water Content chart demonstrates the effect of moisture on k values of several commonly used insulation materials.



Technical data from, ASHRAE and International Institute of Refrigeration, "The Effect of Moisture on Insulating Materials..."

Durability

The durability of building materials, including insulation, is a very important environmental consideration. More durable materials are environmentally superior to less durable ones because they do not need to be replaced with virgin materials. Most insulation materials will perform very well over lifetimes measured in decades or even centuries. EPS is highly durable because it resists degradation by water and does not decompose.

Flammability

All EPS used in construction products in New Zealand contains a flame retardant conforming to AS 1366, part 3 - 1992. The flame retardant reduces the flammability and spread of flame on the surface of EPS products, to such an extent that it is classified as 'flame retardant' according to the European Standard DIN 4102. If ignited with a flame, the EPS extinguishes itself as soon as the ignition flame is removed.

The flammability of EPS construction products is reduced with surface coatings, such as plaster, and metal cladding as in sandwich panels. Non-flame retardant EPS, typically used in packaging, will sustain combustion and the resultant fire spread at a rate of about 3 cm per minute over the surface. This is comparable to other combustible solid materials. EPS does not catch fire spontaneously, and small sources of ignition will not ignite it.

Human health

EPS presents no dangers to human health during installation and use. It does not irritate skin or mucous membranes, is biologically inert and does not produce any pathogenic dust.

Recycling and disposal

EPS can be recycled in several ways. Within the manufacturing plant, internal waste can be ground and mixed in various proportions with virgin material in the production of EPS blocks and mouldings. Post-consumer EPS can be compressed, granulated and re-extruded back into solid polystyrene for the production of simple products. Approximately 200 tonnes of EPS were collected for recycling in New Zealand in 2004 (Plastics New Zealand Recycling Survey, 2005).

Some New Zealand EPS manufacturers are taking back surplus EPS insulation or off-cuts from their major customers. A recycler – New Zealand Plastic Recycling Ltd – collects polystyrene and shreds and compresses it, removing all the air from the product. This reduces the volume by a 60:1 ratio. Compressed polystyrene is shipped to Asia where it is recycled into new polystyrene products such as coat hangers and computer casings.

A full list of plastics recyclers in New Zealand is available at www.plastics.org.nz.

If disposed of to landfill, EPS products do not degrade into harmful substances, are not water soluble and do not give off any water soluble substances which could lead to contamination of leachate. It will therefore not contaminate groundwater or generate methane emissions. Landfill operators encourage the recycling of EPS by placing a high disposal fee on this product because it is lightweight and does not compact down in the landfill.

Concluding Comments

EPS is a unique material with a diverse range of positive features and applications, from packaging through to building insulation.

A significant environmental benefit associated with EPS is its ability to significantly improve thermal insulation performance in buildings. This translates into cost savings, reduced carbon emissions over the lifecycle of the insulation and improvements in human health.

EPS is sometimes an under-valued and misunderstood material, when the reality is that its life cycle environmental performance demonstrates noteworthy socio-environmental benefits. The future of EPS seems well assured given the positive range of features and inherent characteristics it delivers to all of its applications.

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K-LINE IRRIGATION SYSTEM BY RX PLASTICS

All-terrain water saving simplicity in plastic

About the product

The K-Line Irrigation System combines Kiwi innovation and practicality to produce an easy-to-use irrigation system made of robust polymers and durable components. It is simplicity at its best – delivering water and energy savings to the farming community and reducing their environmental impact. In the future we will see more of this iconic product irrigating the countryside both in New Zealand and throughout the world. Currently more than 130,000 acres are being watered by this system.

Durability

The K-Line system is made of a series of tough one-piece plastic rotomoulded ‘pods’ protecting small sprinklers. The pods are firmly attached to heavy walled (32- and 40-mm) low density polyethylene (LDPE) pipes. These LDPE pipes are designed to withstand the effects of freezing and sunlight, while remaining flexible and strong.

Ease of use

The K-Line irrigation system is designed to maximise ease of use by eliminating the need to shift the system several times a day. An all-terrain vehicle can move the sprinkler lines along set watering patterns, saving labour and time. The K-Line’s modular construction and low cost allows farmers to add sprinkler lines as required and stage their capital expenditure.

Water efficiency

The K-Line system distributes water at low pressures using a ‘slow absorption method’ for up to a 24-hour period to allow maximum absorption into the soil, reducing run-off and pooling. This allows K-line to use less water much more efficiently. For example, delivering 5 cm of rain-equivalent through the traditional gun system results in 10 cm of soak into the ground. Delivering the same 5 cm of water through the K-Line system results in a 30 cm soak into the ground.

K-LINE IRRIGATION SYSTEM BY RX PLASTICS

All-terrain water saving simplicity in plastic

www.rxplastics.co.nz

Iconic Status

Water is an increasingly precious resource. Using it efficiently and responsibly has become a major priority in many countries around the world, especially in the agricultural and horticultural sectors.

RX Plastics – a New Zealand-owned plastics manufacturing company – has teamed up with Jon Kirk, a Waimate farmer, to produce a landmark product, when it comes to user-friendly irrigation systems. The K-Line irrigation system is an example of the simplest ideas being the best.

This all-terrain irrigation system is being used on farms throughout New Zealand with the benefits of more effective water management and reduced pumping costs.

K-Line is a simple farming solution invented by a Kiwi and developed by a Kiwi plastics company. Ease-of-use features that are mindful of New Zealand farming practices, combined with water efficiency advantages and product durability make K-Line an iconic product that delivers significant environmental benefits.

About the Product

Jon Kirk, a farmer from Waimate, New Zealand, had used various pasture irrigation systems over his 30 years of farming and wasn't happy with the results. He found traditional systems to be too labour-intensive, awkward to shift, and too expensive to run and maintain. They also wasted water because they produced too much run-off and ponding. These concerns prompted Jon to invent the revolutionary and highly cost-effective K-Line Irrigation System.

The K-Line system comprises a series of tough plastic 'pods' housing small sprinklers that are firmly attached to flexible low density polyethylene (LDPE) pipes. These form the above-ground part of the system. The system can be run on low pressure and is designed to distribute water using a 'slow absorption method' for up to a 24-hour period, firstly, to eliminate the need to shift irrigation several times a day and, secondly, to allow maximum absorption into the soil, reducing run-off and pooling. As a result of using the K-Line irrigation system, Jon Kirk has irrigated 30% more of his farm using the same amount of water and pumping resources as before.

K-Line uses less water much more effectively. K-Line is also very flexible. Variables such as running time per day/night, rotations, application rates etc., can be easily adjusted to

suit a particular farm management style. Stock can also continue to use the paddocks being irrigated.

Each paddock has its own sprinkler line, customised to suit the size and shape of the paddock, and the lines run simultaneously, depending on water supply. However, they don't need to run all at once. The farmer may choose to run only what's needed, or what's available depending on water constraints. The small, flexible, strong, lightweight lines can be shifted very quickly with a four-wheeled motor bike, by simply driving across the paddock.

About the Company and the Market

RX Plastics is a New Zealand-owned plastics manufacturer that has been operating for 30 years. The company specialises in plastic water products for the agricultural, horticultural, irrigation, infrastructure and municipal markets.

As well as the K-Line irrigation system, RX Plastics manufactures and distributes a range of other products including:

- pipe systems for water supplies, sewage disposal and road drainage;
- pipe fitting systems – compression, threaded and lateral fittings;
- storage tanks;
- stock water troughs; and
- sewage treatment systems.

RX Plastics operates from three different manufacturing plants within New Zealand, utilising three different plastic manufacturing processes – extrusion, injection moulding and rotomoulding.

The K-Line product has become a very popular irrigation system in New Zealand with estimates of more than 130,000 acres (52,000 hectares) now being watered by the system. In particular, the strong growth in dairy farming across New Zealand has underpinned substantial growth in the system's popularity and adoption. Its effectiveness and value have been recognised overseas with the K-Line system now being exported to Australia, USA, Canada, South Africa and South America.

Environmental Properties, Features and Benefits

The K-Line system boasts several key advantages. While there are obvious environmental features and outcomes, the product is also highly cost effective and designed to maximise convenience and ease of use for farmers.

This case study shows how intelligent and informed thinking can result in a simple innovation with multiple benefits, including:

- water efficiency;
- product durability;
- low cost; and
- ease of use.

Each of these benefits is summarised below, helping to explain why K-Line has been proven such a success in both local and overseas markets.

Water efficiency

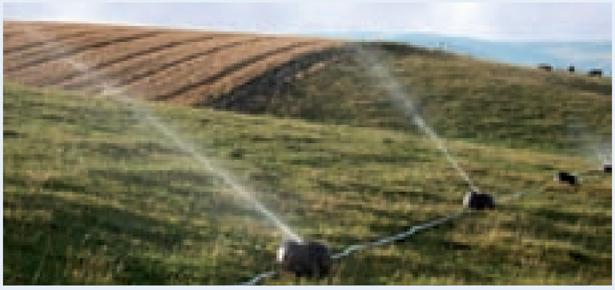
Large irrigation systems waste water by causing pooling and run-off. The K-Line system avoids this by distributing the water at a lower pressure. It works on a slow absorption basis, which means that water is delivered at low-pressure and has an effect similar to soft rain, delivering the water slowly and gently. Absorption into the soil. is maximised. If water is applied lightly to the ground there is more lateral movement of the water through the soil, resulting in better soakage and distribution of water in the soil.

For example, delivering 5 cm of rain-equivalent through the traditional gun system results in 10 cm of soak into the ground. Delivering the same 5 cm of water through the K-Line system results in a 30-cm soak into the ground.

The application rate for K-Line is less than 5 mm/hr, compared to more than 15 mm/hr for large irrigation systems. The lower water pressure also means that less energy is required for pumping.

The K-Line system is also very precise, avoiding dry ends and preventing wastage caused by irrigating over fences and on to roads.

"With current irrigation pumps there is a lot of run-off and fertiliser can end up being flushed out of the soil. Also a lot of water finishes up in the groundwater system. But with K-Line one of its major benefits is its super-slow soak time, because the size of the sprinkler is so small and water is distributed slowly. Soil that is being irrigated has time to absorb it and the water is used more economically."
Jon Kirk, Waimate farmer and K-Line inventor



Durability

The K-Line system had to be robust to meet the demanding requirements of a product which is regularly transported around the farm and manually handled. The one-piece K-Line pod is made from polyethylene and is extremely hard wearing. It includes an integral weighted base which is highly durable and designed to protect internal sprinkler components.

The special heavy walled (32- and 40-mm) K-Line tubing is made mostly of LDPE that withstands the effects of freezing and sunlight, while remaining flexible and strong.

Special heavy duty fittings are designed to withstand the stress of line movement while the sprinklers are operating. The distinctive green lines indicate pipe size and assist in orienting the pipe during installation.

> *"It's simple, it's basic, there's not much that can go wrong. The only moving parts are the pumps, the sprinkler heads, and the bloke on the bike moving the line."* George Harper, RX Plastics

Low cost

The initial capital cost of a K-Line system is often less than half the price of putting in bigger systems. These cost savings are achieved by saving on underground work and doing away with the need for big guns or booms. Installation can largely be done by the farmer.

In addition, the K-Line irrigation system is based on a number of small sprinkler lines, rather than one or two large sprinkler lines or travelling irrigators. The installation of the system can therefore be staged to spread capital expenditure over an extended period.

Maintenance costs are also reduced because the only moving parts are the sprinklers, pumps and valves.

Another benefit is the reduction in energy and other operational costs associated with only needing to distribute water at low-to-medium pressure without the need for heavy duty pumps.

Ease of use

One of the major benefits of the K-Line irrigation system is its labour-saving simplicity.

An all-terrain vehicle (ATV) can be used to easily move the sprinkler lines around the paddock without the need to switch the system off. Sprinkler lines can be simply towed via a set pattern to their new position in the paddock. The tough pods skid over the ground without flipping. The sprinkler lines can be relocated very quickly using an ATV that tows the K-Line behind it at speeds of up to 20 kph. Each line takes only 5 minutes or so to shift and because shifting times are flexible, control is given back to the farmer.

The flexible design of the K-Line system also means it is able to be shifted across both flat and undulating land with ease.

> *"With a gun you have to watch it moving along the paddock almost like a child, never letting it out of your sight or else there is the danger your paddock could flood. But you can leave K-Line to its own devices knowing it will do the job. It's reliable and gives farmers peace of mind."*
> Jon Kirk, Waimate farmer and K-Line inventor

Concluding Comments

The K-Line irrigation system is one of those products that truly connects simplicity with clever thinking to address issues that really matter to farmers and the environment. Whether it is the fundamental objective of saving water or the human value of improved farm management practices, the K-Line system has addressed such considerations in a highly practical way.

The K-Line's benefits work across the life cycle, from the robust polymers used to manufacture the unit and components being durable, through to all the water and energy saving benefits related to improved moisture distribution and reduced energy consumption in pumping.

The simple beauty and elegance of the K-Line system stems primarily from being conceived and informed by Jon Kirk, the inventor. Jon and RX Plastics have created a product that integrates his extensive technical knowledge as a farmer with RX's manufacture-to-market expertise. There is no substitute for practical experience on the land when it comes to designing durable irrigation systems that are cost effective and straightforward to install and use. This intimate understanding of the task at hand and the environment within which the product must perform has also delivered an icon that consumes water and energy in an efficient and sustainable manner.

ICE CREAM CONTAINERS BY TIP TOP

Intelligent materials substitution

About the product

Tip Top is a 70-year-old iconic Kiwi brand. New Zealanders are fanatical about ice cream. We consume more per head of population than anywhere else in the world. And the blue 2-litre tub is readily identifiable as a Tip Top innovation. What is not commonly known is that Tip Top have redesigned the plastic tub to make it more efficient and better for the environment.

Lightweighting

By changing the type of plastic used to make the blue ice cream tub, Tip Top have decreased the weight of each tub from 55g to 42g. This material saving equates to more than 4.5 million ice cream tubs being taken out of the waste stream.

Production efficiency

Shifting from high density polyethylene to polypropylene tubs has meant less energy is used in manufacture and it takes less time to process them.

End of life

All Tip Top ice cream tubs are labelled with the Plastics Identification Code to help with recycling. Councils throughout New Zealand are increasingly beginning to collect polypropylene at the kerbside.

Re-use

Ice cream tubs are robust enough to be in big demand with home handymen, community groups and mechanics.

ICE CREAM CONTAINERS BY TIP TOP

Intelligent materials substitution

Iconic Status

Tip Top is undisputed as a national icon in New Zealand. As a 70-year-old company, its brands are both well known and well loved. Tip Top is New Zealand's leading ice cream company and a market leader in all of its categories.

An important part of Tip Top's success has been its attention to materials efficiency and smart packaging. In 1999 the company redesigned its 2-litre high density polyethylene (HDPE) blue ice cream tub to make it more efficient. The new polypropylene (PP) pack is 24% lighter, saving 195 tonnes of material each year. It can be processed at lower temperatures than HDPE, saving both energy and cost. The square shape is also very efficient for distribution because the tubs can be tightly packed into boxes for transport to retailers.

When empty, the tubs are often re-used by householders as all-purpose storage containers, but PP is also starting to be included in kerbside recycling programmes in New Zealand.

About the Product

When Tip Top was established 70 years ago, they began by producing quarts (1 litre), pints (600 ml) and bulk ice cream for dairies, all packed in cardboard boxes. In later years they developed single-serve ice creams such as the Eskimo Pie, the Topsy and the Jelly Tip. The famous 2-litre blue plastic tub, a revolution in the ice cream industry and a sales hit for Tip Top, was introduced in the 1960s. The packaging didn't change again until 1999, when Tip Top collaborated with packaging manufacturer Huhtamaki to redesign the pack.

Huhtamaki (www.huhtamaki.com) makes plastic packaging for a wide variety of uses and had developed materials and technology in Australia for the use of polypropylene (PP) for ice cream containers. PP is manufactured from propylene gas, a by-product of petroleum refining, and one of the most widely used polymers. Previously there had been issues with PP becoming too brittle when frozen. This issue was primarily overcome by improvements in polymer technology.

Huhtamaki worked closely with Tip Top to develop the new product, with a lengthy period of trials and testing. The lid of the Tip Top containers is still LLDPE due to problems with brittleness during handling. In Australia ice cream containers are already 100% PP, making them more recyclable and Tip Top is also planning to move in this direction in New Zealand.

Company Background

In 1935 Albert Hayman and Len Malaghan opened an ice cream parlour in Manners Street, Wellington.

The story of where the name Tip Top came from is a bit of folklore. Hayman and Malaghan were discussing business over a meal whilst travelling in a train dining car one evening. They overheard a fellow diner commenting that his meal was 'tip top'. Albert and Len immediately decided that they would like to hear people say that about their ice cream, and so the name for their newly founded ice cream business was born.

The popularity of Tip Top ice cream grew rapidly. In 1936 a second ice cream parlour was opened in Wellington, and another one in Dunedin. The same year, Tip Top Ice Cream Company was registered as a manufacturing company. By 1938 Tip Top was manufacturing its own ice cream and was successfully operating stores in the lower half of the North Island, and in Nelson and Blenheim.

By 1963 the company had expanded to such an extent that a parent company was formed, General Foods Corporation (NZ) Limited. In April 1997 Tip Top was purchased by a West Australian food processor, Peters & Brownes Foods from Heinz Watties. This merger of Peters & Brownes and Tip Top created the largest independent ice cream business in the Southern Hemisphere with combined sales of $550 million.

On 18 June 2001 Tip Top Ice Cream became part of Fonterra Co-operative Group, New Zealand's biggest company and ninth largest dairy business in the world.

Tip Top now has around 400 staff and produces approximately 50 million litres of ice cream per year.

Kiwiana – quintessentially Kiwi

Some things are just quintessentially Kiwi – items, objects, images and people that immediately remind us of who we are, of our essential Kiwi-ness. Our distinctively New Zealand objects and items are often described as 'kiwiana', defined by Te Ara (the Encyclopaedia of New Zealand) as items of popular culture thought to be unique to New Zealand, such as the paua-shell ash-tray.

Many New Zealand brands can be said to be quintessentially Kiwi: the Buzzy Bee, the Four Square Grocer, Edmonds Cookbook, Watties, Swanndri and of course Tip Top ice cream.

Market Overview – Facts and Figures

- The global ice cream market is estimated to be worth around $US11 billion.
- Approximately 23 million litres of New Zealand ice cream production is exported, mainly to Japan and Australia (The New Zealand Ice Cream Manufacturers Association, 2006).
- New Zealanders are reported to have the highest per capita consumption of ice cream of any country – 26 litres per annum, followed by the United States, Australia, Finland and Sweden (Canadian Dairy Information Centre, 2002)
- Tip Top fill about 15 million 2-litre ice cream containers per year. This includes manufacture for supermarket house brands and Cadbury. About 7–8 million units of iconic Tip Top blue containers are produced per annum.

Environmental Properties, Features and Benefits

Tip Top is a signatory to the NZ Packaging Accord, a voluntary agreement between the packaging supply chain and the government to reduce the environmental impacts of packaging. The company is acutely aware of its responsibilities under the Accord and this drives the product development team to consider environmental aspects in the development of their products.

Production efficiency

Tip Top ice cream containers were made from HDPE until about 1999. PP has a lower melt point than HDPE so can be moulded faster. This results in a more efficient manufacturing process, energy savings and lower costs of production. PP is also harder and stiffer than HDPE and therefore requires less material to deliver the same structural properties. As a result, PP allows for a lighter weight product to be developed.

Lightweighting

Changing the polymer used for the ice cream tubs meant the amount of polymer could be reduced. The weight of the Tip Top ice cream tub fell from 55 g in HDPE to 42 g in PP. This represents a 24% material reduction. With 15 million containers being produced by Tip Top every year, a 13 g reduction per container represents 195,000 kg, or 195 tonnes, of reduced material use per year. This equates to taking over 4.5 million tubs out of the waste stream.

Transport and storage efficiency

The square design of the ice cream tubs means they are efficient for transport and storage. It minimises the amount of 'air' being transported. The square design is also efficient for storing and displaying the product in stores.

End of life

The plastic identification code is used to label the resin type on all Tip Top ice cream tubs and lids. More importantly, PP is increasingly collected and recycled at kerbside in New Zealand. Almost 1500 tonnes of PP were collected for recycling in New Zealand in 2004. Waste during the manufacture of the tubs is also minimised due to the use of hot runners, which do away with the sprue that comes from plastic manufacturing.

Re-use

Post-consumer PP tubs are re-used by many households as general purpose storage containers. Scouts, garages, and many other organisations also re-use large quantities of ice cream tubs.

Concluding Comments

Tip Top is a landmark New Zealand company and its commitment to environmental improvement is matched with real world practicality. The company's intelligent approach to materials substitution within the context of lightweighting has managed to deliver significant production and material efficiencies.

The Tip Top story also demonstrates how focused efforts on one aspect of a packaging design project can make a difference, particularly through close collaboration with specialist stakeholders and packaging suppliers such as Huhtamaki. The combination of skills and expertise around a common product or objective can nearly always achieve worthwhile environmental outcomes.

The role of design in this process should never be underestimated and appears to have had a major influence in the case of tub and lid redesign at Tip Top.

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The polymer upon which our cities are built

About the product

The value of polyvinyl chloride, or PVC, is often underestimated or overlooked. PVC is widely used in the building and construction industry to provide the essential infrastructure for water supply, sewerage and communications within our cities and towns.

PVC pipes have excellent technical qualities and are used in a range of demanding applications. They are easy to install and their resistance to corrosion and abrasion makes them highly durable. As a result, they require little maintenance.

Recycling

PVC pipe has a long life cycle, meaning there are not large quantities that need to be recycled. In 2004 over 2,400 tonnes of PVC were collected in New Zealand for recycling. Some PVC pipe manufacturers operate business-to-business recycling programmes for off-cuts and surplus pipe. Collected material is recycled into new PVC pipe. New Zealand manufacturers of PVC pipe recycle almost 100% of their in-house production waste back into PVC pipe.

Durable and long-lived

PVC is resistant to weathering, chemical rotting, corrosion, shock and abrasion. PVC pipe has been rated as having a service life exceeding 100 years when used underground. PVC in the ground is virtually inert and does not corrode or break down. PVC pipe therefore does not need to be replaced as often as other materials, saving energy and resources.

Removal of hazardous substances

Lead is no longer used as a stabiliser in PVC pipes for drinking water. The use of lead in PVC pipe has been phased out by the industry on a voluntary basis and replaced with organic-based stabilisers, tin and calcium zinc.

Embodied energy

PVC requires less energy to manufacture than other materials. This means it has a lower embodied energy compared to other polymers and common building materials. It is the least energy intensive of all thermoplastics.

Material efficiency

PVC manufacturers have improved design efficiency to reduce the amount of PVC used in PVC pipes. These improvements have allowed for reductions in pipe wall thickness and therefore lightweighting of the product. It has been estimated that between 30 and 50% less material is used in modified PVC pipe compared with standard PVC.

PVC CONSTRUCTION PIPE

The polymer upon which our cities are built

Iconic Status

As with so many other materials, technologies and processes that are concealed from the everyday gaze of society, the value of polyvinyl chloride or PVC is often underestimated or overlooked. PVC is widely used in the building and construction industry to provide the essential infrastructure for water supply, sewerage and communications within our cities and towns.

PVC pipes have excellent technical qualities and are used in a range of demanding applications. They are easy to install and their resistance to corrosion and abrasion makes them highly durable. As a result, they require little maintenance. They have superior hydraulic efficiency which means that less power is required to transfer water from one elevation to another.

About the Product

PVC is a polymer which is made from approximately 50% sodium chloride (common salt) and 50% crude oil or natural gas. PVC was first produced in 1872 and is by far the most important polymer used in building and construction applications. It has been a material of choice for over 60 years because of its technical versatility, performance and cost effectiveness.

The physical properties of PVC allow designers a high degree of freedom when designing new products. PVC can be cut, shaped, welded and joined easily in a variety of styles. Its light weight reduces manual handling difficulties and adds to the ease with which many of its applications can be installed.

Primarily due to its cost, technical and performance characteristics, PVC is used in a wide range of building and construction applications. It has exceptional chemical resistance properties and can be used above or below ground for the transport of many substances including oil, drinking water and gas. PVC pipes are also used as ducting (conduit) in the telecommunications industry for carrying cables and wiring.

The extrusion processes, plus the fact that PVC is light in weight, allows long sections of pipe to be made, minimising the number of joints. This directly reduces the cost of assembly and the risks of leakage common with some other materials. PVC has replaced clay as the material of choice in the sewer, storm, drain and DWV (drain waste and vent) markets over the last 25 years.

Some Facts and Figures

- Within the plastics industry, PVC has a global market second only to low density polyethylene (LDPE).
- Approximately 60% of the global consumption of PVC is for construction products (Cousins, 2002).
- Almost 40,000 tonnes of PVC product was manufactured in New Zealand in 2005, and around 75% of this was for the construction industry (Plastics New Zealand, 2006)
- PVC pipes can be manufactured up to 1320 mm in diameter. In New Zealand the largest size manufactured is 630 mm.
- In buildings PVC is used mainly for non-pressure pipes such as stormwater (gutters and downpipes) and sewer pipes. Other plastic types are used more commonly for hot water and pressure systems.

- In civil construction PVC represents more than 95% of the open-cut sewer market. For open-cut water mains pipe PVC makes up more than 80% of the market.
- There are three companies that manufacture PVC pipe in New Zealand: Marley New Zealand Ltd, Iplex Pipelines Ltd and RX Plastics Ltd.

The Evolution and Enhancement of a Technology

Recent innovation in pipe design has led to the availability of new products such as modified PVC (PVC-M) and oriented PVC (PVC-O) pipes. PVC-O product is made by the re-alignment of the PVC molecules through a process of bi-axial orientation. This greatly enhances the strength of the pipe and therefore its performance in conveying liquids under pressure such as potable water. This in turn has allowed the wall thickness of PVC-O pipe to be reduced by up to 50% without affecting its pressure rating.

PVC-M is similar to traditional PVC-U pipe material but an impact modifier has been added which allows it to be manufactured with a thinner wall. This has contributed to both material savings and improved hydraulic properties. The important aspect of PVC-M is that the optimal combination of strength and ductility is produced by optimising the formulation and processing conditions so that the full benefit of the modifier is achieved.

PVC-M was introduced to the UK water industry about 10 years ago and to South Africa shortly after. PVC-M pipes were first produced in New Zealand in 1996 and have been used in Australia since 1997.

Environmental Properties, Features and Benefits

A diverse range of features and properties make PVC a good environmental choice for construction pipe applications.

Strength and light weight

PVC's abrasion resistance, light weight, good mechanical strength and toughness are key technical advantages for its use in building and construction applications.

Fire resistance

The rigid PVC used for pipes is difficult to ignite and stops burning once the source of heat is removed. Compared to its common plastic alternatives, PVC performs better in terms of lower combustibility, flammability, flame propagation and heat release. The combustion products of PVC include carbon dioxide, carbon monoxide, water and hydrogen chloride, although, apart from hydrogen chloride, the toxicity of emissions is no worse than for other materials (Coghlan, 2001). Newly developed PVC formulations (FR-PVC) have significant advantages in terms of lower acid emissions, smoke generation and enhanced fire resistance.

Good insulation properties

PVC is a very good electrical insulator and is therefore an excellent material to use for applications such as insulation sheathing for electric cables. It is also a good heat insulator, providing thermal efficiency in applications such as window profiles, resulting in improved energy efficiency.

Relatively low embodied energy

PVC has a lower embodied energy, especially compared to other polymers and common building materials. It is the least energy intensive of all thermoplastics.

Embodied energy is the term used to describe the amount of energy required to manufacture a product, including raw material extraction. A 2002 study of embodied energy in piping systems was conducted by the Australian CSIRO (Commonwealth Scientific and Industrial Research Organisation). This study found that PVC pipes, and in particular PVC-O pipes, provide a better embodied energy solution than other materials in many situations. Within virtually all of the scenarios examined, the PVC pipes produced lower embodied energy results than any other piping material.

Non-renewable resource use

Over 50% of PVC's feedstock is derived from salt, an abundantly available resource, which means that PVC consumes proportionately less non-renewable fossil fuel than other polymers.

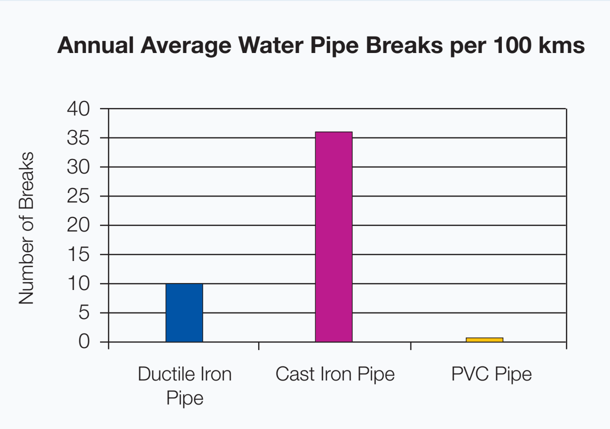
Material efficiencies

Product development and innovation by NZ manufacturers is improving design efficiency and reducing the amount of PVC used in products. Modified PVC (PVC-M) and oriented (PVC-O) pipes are such examples. Improvements in the physical performance of PVC over the last 30 years have allowed for reductions in pipe wall thickness and therefore lightweighting of the product. These improvements have been reflected in constant revisions to the Australia/New Zealand Standards for PVC pipe wall thickness.

It is estimated that between 30 and 50% less material is used in modified PVC pipe compared with standard PVC. This percentage depends on the pipes' end use.

Design for durability and long life

90% of PVC applications are designed for medium- or long-term use. PVC is resistant to weathering, chemical rotting, corrosion, shock and abrasion. PVC pipe has been rated as having a service life exceeding 100 years when used underground. PVC in the ground is virtually inert and does not corrode or break down. This compares with the performance of some non-plastic alternatives that typically need more frequent replacement and therefore consume more energy and resources.



Source: National Research Council of Canada, 1995.

PVC pipes significantly reduce water losses arising from pipe failure. Tree root penetration of pipeline systems causes blockages and cracking and can result in seepage into pipelines, flooding of sewage treatment plants and sewage leakage out of pipeline systems. The CSIRO conducted trials comparing the resistance of clay, concrete and PVC pipe joints to tree root penetration, under accelerated conditions over a 32-month period. Whereas PVC showed no attack by tree roots, there was severe attack on the other pipes, both through the joints and the pipe wall, with joints actually being broken (Vinyl Council of Australia, n.d.). Another study investigated the service life of different pipe materials in gravity sewer systems and found that unlike other materials, PVC pipes had not deteriorated after 25 years of service (Whittle and Tennakoon, 2005).

The longevity of PVC pipe means that materials do not have to be replaced, energy does not have to be spent removing and replacing worn out pipe, and damage caused by leaks and breakages is minimised. PVC is inert to a lot of materials including disinfectants used in the treatment of potable water.

Good mechanical properties in terms of creep, viscoelasticity and fatigue

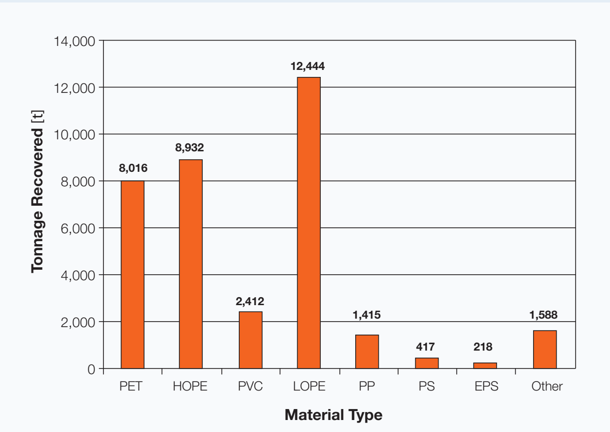
These mechanical properties are very important and are maintained over prolonged periods of time. The visco-elasticity of the material permits an exceptional behaviour concerning the interactions between the pipe and the surrounding soil.

Removal of hazardous substances

Stabilisers based on metals such as lead have, in the past, been added to PVC to provide UV and heat protection. Lead in PVC pipe has always been safe and has met stringent World Health Organisation water quality guidelines. New technology has meant lead is no longer used as a stabiliser in PVC pipes made in New Zealand. The use of lead in PVC pipe has been phased out by the industry on a voluntary basis in preparation for the Australian and New Zealand Standards which are due to be ratified in late 2007. Lead has been replaced with organic based stabilisers (calcium derivative), tin and calcium zinc.

End of life

PVC is a thermoplastic and therefore can be fully recycled. In 2004 over 2,400 tonnes of PVC were collected in New Zealand for recycling. Some recycling programmes for PVC pipe exist in New Zealand. These are typically business-to-business recycling programmes between suppliers of PVC pipe and their large construction clients. This collected material is recycled into new PVC pipe according to the specifications of the pipe manufacturing standards.



It is important to note that relatively little end-of-life PVC is available from building and construction applications because it has a long life and most of the material is therefore still in service. Because of its long life, PVC pipe is not being removed from the ground in any large quantity. When it does eventually need to be removed, recycling programmes could be established along the lines of programmes already being implemented in Europe (TEPPFA, 2006). The PVC industry in Australia has run successful recycling trials for PVC construction and demolition waste (Vinyl Council of Australia, 2006). PVC scrap from building and construction sites is rarely recycled because the quantities involved are minimal compared to other materials such as bricks, timber and tiles.

New Zealand manufacturers of PVC pipe already recycle almost 100% of their in-house production waste back into PVC pipe. This means that there are minimal volumes of PVC going to landfill from the PVC manufacturing process.

At the end of a PVC product's useful life, if not recycled, it can be safely deposited in landfill. PVC is resistant to water and to most chemicals and its degradation in landfills will be very slow. A CSIRO study concluded that additives in PVC, such as lead-based stabilisers, cause minimal environmental impact in landfill because the material is inert (Coghlan, 2001).

Life Cycle Assessment and PVC

PVC and its environmental performance has been well researched worldwide. At least 60 life cycle assessments have been conducted on PVC since 1985 (Vinyl Council of Australia). Almost half of these LCAs have been on building applications of PVC.

The Natural Step, UK, made the following observation in 2000:

There have been many life cycle analyses carried out upon various applications of PVC; probably more than for any other material. Inevitably they are of differing credibility. Some of the conclusions also appear to depend on whether the sponsor is an environmental pressure group or industry. However, the overall weight of them suggest that PVC is no more environmentally unacceptable/unsustainable than alternative materials, including 'natural' ones, in the short to medium term. This reflects the general unsustainability of many aspects of modern society (Everard and Monaghan, 2000).

A 2004 review of environmental life cycle assessments (LCA) of PVC for the European Commission (PE Europe, 2004) found that PVC can offer environmental benefits equal to or better than those of other materials for a variety of applications. Their review of pipe LCAs found varying results. Some studies reported clear advantages for concrete; some for polymer pipes such as PVC and polyethylene; and, some concluded that the material used makes no difference to the overall environmental impact as long as cast iron is not used.

The product application is more likely to determine the life-cycle environmental impact than the material used in the pipe. The Commission also noted that the environmental impact of pipes can be reduced by using less material (lightweighting) and by maximising durability.

Concluding Comments

The functional and performance benefits of PVC pipes are unequivocally positive. It is a product that has a long and trusted history in the building and construction industry.

While often overlooked or unseen, PVC pipes have enabled the design and operation of durable infrastructure systems that support our cities and farms. And while PVC was first created in 1872, producers have continued to innovate and produce improved and more versatile variations that further reinforce its value.

What emerges as a significant socio-environmental and economic benefit of PVC pipes is their relatively long life cycle and all the associated outcomes associated with a product that is highly durable, cost effective and technically superior.

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