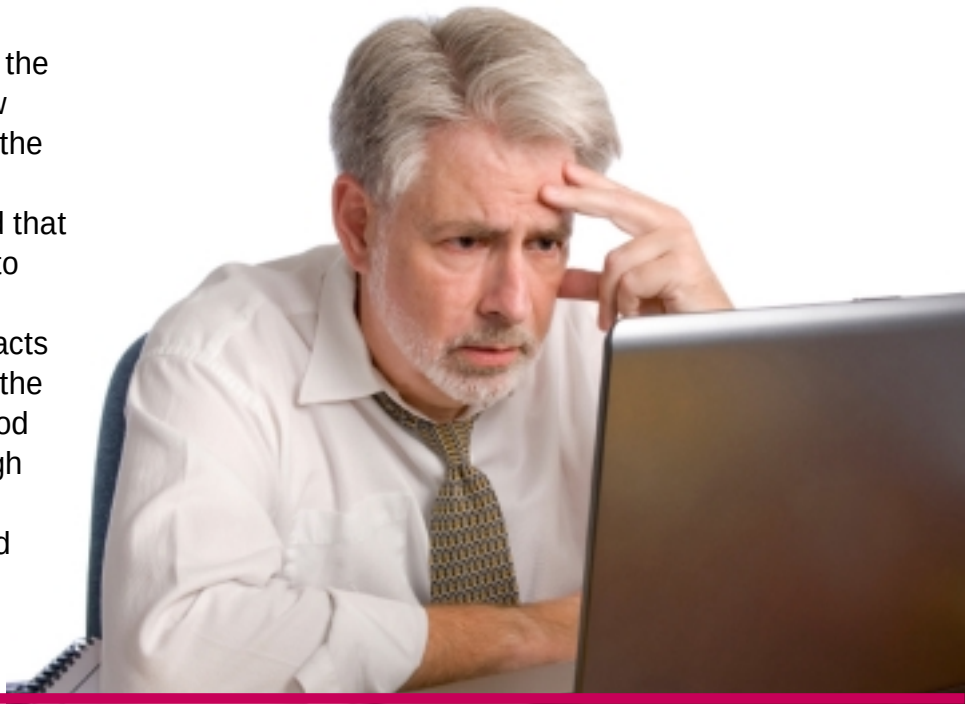
As the need to conserve resources grows

can the Martec product recovery solution reduce both product and water waste in process industries?

Being told that one third of the food that we put into the shopping basket will end up unused and wasted provides a reality check for many British households who are now taking a real interest in the environmental impact of what they do. The morality of destroying unwanted food apart, potentially one third of the weekly food budget is being wasted, according to WRAP, the Government-backed agency charged with highlighting and reducing areas of waste in keys areas of the economy. Waste does not stop at the supermarket checkout. Just a few steps up the food chain, there is the produce that has been lost while manufacturing the prepared food that will be taken home and allowed to slip out of condition, uneaten. Waste at the consumer level impacts upon the household budget. For the companies manufacturing the food that will find its way on to the high street shelves, however, there is another tier of waste encountered before a single pack reaches the retailer.

Manufacturers are keen to reduce waste in their production processes. We examine one of the more interesting ways of helping manufacturers across a spectrum of industries sustain their operating margins by minimising product waste and reducing their water intake.



Materials lost during the production process eat into the manufacturers' profitability and therefore competitiveness, and increase their environmental impact if allowed to go unchecked. Having advanced from artisan production methods a century ago, many types of food production now rely on highly controlled factory methods which ensure consistency of recipe and rigorous health standards: these measures are effective, if the small number of product recalls each year is any indication.

That impressive level of control is achieved through automation, and so production of foods such as desserts, recipe dishes, condiments, dairy products and many others involves passing both ingredients and the finished product along a network of pipes during manufacturing before they reach the packing stations which bring together product streams, further ingredients and packaging materials.

At the end of a production batch, when the line has to switch to another product or has been halted for the day, the process will leave behind it a pipe full of food-grade material which has a tangible value.

Recovering that material in most instances should be considered an economic and environmental necessity. The unit cost of sauce ingredients may be measured in pence per litre, but if there are a thousand litres potentially lost in the pipes, and perhaps four or more product changes every day, the value of food to be recovered starts appearing as a significant overhead.

Product recovery solutions

The sensible food manufacturer will be happy to implement any product recovery system that is consistent with the hygiene and Good Manufacturing Practice (GMP) guidelines that they use in manufacture. But the impact on bottom line profitability comes not only from the additional food yield; it also comes from reduced water and effluent charges.

Food may be a highly emotive topic when waste is being considered, but product recovery systems are an increasingly important component of manufacturing technology in many other areas of flow-line production.

Materials lost during production eat into the profitability and therefore competitiveness. Food manufacturers are happy to implement any product recovery system that can recover food-grade material and is consistent with the hygiene and Good Manufacturing Practice (GMP) guidelines that they use in manufacture. But the impact on bottom line profitability comes not only from the additional food yield; it also comes from reduced water and effluent charges.

In healthcare, for example, there are viscous products like toothpaste and sun cream, which are produced to high standards of hygiene.

In other areas of flow-line production, paint manufacturers, for example, have clear economic reasons for wanting to recover product from pipelines and minimise the large amounts of water or other solvents that would be required to clean the network.

Origins in oil industry

The technology which has emerged over the past decade or more to improve operating efficiency in food and pharmaceuticals traces its origins to the petrochemicals sector, where there has been a longstanding demand for product separation and recovery in pipelines. The oil industry pioneered the use of close-fitting metal bungs which ran inside pipes to separate out different grades of oil product.

Food production and bottling plants like the one above which manufactures barbecue sauces face multiple problems in the present climate. It is essential that producers can avoid wasting ingredients and, when they have to clean pipelines, the amount of water that is used, and then cleaned is kept to the minimum.

Flexibility in the Martec Plug – the 'Marplug' – was achieved in part by a change from nylon to polyethylene, a less rigid material. Designing the one-piece plug as a central spindle with vanes protruding from along its length, provided a greatly enhanced performance. The flexible vanes of the Marplug are slightly larger than the pipe diameter, ensuring a seal. With typically eight of these vanes along the device, the likelihood of material escaping past it is significantly reduced.

The squealing sound of a metal plug scraping along a metal pipe gave rise to the name 'pig' for the recovery tool, a term that was retained when a more sophisticated version of the oil industry device found its way into food, drinks and pharmaceuticals manufacturing.

Martec technology

Designing the technology to recover fluid materials from pipes during production has been the raison d'être of Martec of Whitwell Ltd, one of only a handful of companies in the UK specialising in this market.

The technology traces its origins to the petrochemicals sector, where there has been a longstanding demand for product separation and recovery in pipelines.

A glance at some of the savings that can be achieved would suggest that the company is applying its skillset at a time when waste of product materials can no longer be justified and environmental factors circumscribe every decision.

As is often the case when a technique crosses application boundaries, the first recovery systems in the food and drinks sector simply drew on the oil industry experience and used a metal sphere as their 'pig'.

But a rigid object making limited contact with the pipe walls proved a less than ideal recovery tool for the food industry: material could squeeze past the ball, for example, while the seal – such as it was – broke at full bore offtakes where a pipe splits into others of the same diameter. Issues of food loss and hygiene had to be resolved. Problems such as these often contributed to 'traditional' pigging systems having a poor reputation.

Improving the concept

The Martec operation grew out of the demand for a better recovery tool: back in 1997, the company's founder, Walter Suttie set out to deliver improved results and left one of the existing vendors to form his own business. He had identified the constraints on the use of a rigid pig.

One of the problems was its susceptibility to dents and other imperfections in the

The product recovery plug which the founder of Martec designed and patented was flexible so that it could more easily follow the curves of a pipe network while maintaining greater contact with the pipe wall. Other vendors' plugs, however, were solid and almost totally inflexible, a major limitation.

pipework. Given that the device had to be a close fit to the pipe, anything less than a perfectly circular cross section could prevent its smooth passage.

A quick look at the pipework within any normal food manufacturing environment tells us that dents and other pipe imperfections are the norm rather than the exception.

Engineers talk in terms of an interference fit to describe how tightly one component moves within a socket or a recess of an almost identical size. The early pigs were approaching an interference fit but even this allowed fluids under pressure to pass around the solid sphere or cylinder.

The fit became even less secure when the pig's surface encountered any roughness or protrusion in the pipe's inner surface. The fine lines that were scratched into the plug's surface allowed even more fluids to pass by, reducing further the tool's effectiveness.

Walter Suttie made two fundamental changes to the pig. Most significantly, what he designed and patented was flexible. And because it was flexible, the new plug could more easily follow the curves of a pipe network while maintaining greater contact with the pipe wall.

While other vendors had been evolving from the sphere to the cylindrical plug, their tools were solid (usually nylon) and almost totally inflexible.

A more flexible approach

Flexibility in the Martec Plug – the 'Marplug' – was achieved in part by a change of material from nylon to polyethylene, inherently a less rigid material. Designing the one-piece plug as a central spindle with vanes protruding from along its length, was where the Derbyshire-based company was able to provide a greatly enhanced performance.

The flexible vanes of the Marplug are slightly larger than the pipe diameter, ensuring an effective seal. With typically eight of these vanes along the device, the likelihood of the material in the pipe escaping past it is significantly reduced even when dents, flow plates, and junctions are navigated.

In part as an aid to interconnection, industrial pipework conforms to one of a very limited number of international standards, allowing the Marplug to be built in a manageable range of sizes.

As Jonathan Harper, the Martec MD observed, one of the first groups within the food and drink industry to opt for processing that involved pipes was the dairy sector; its smooth pipes and connecting joints were designed to avoid the pitfalls of trapped milk products; an important factor with such a perishable commodity.

'Dairy Standard' pipe in diameters from 1 to 4 inches has therefore been adopted extensively by food and drink manufacturers. Outside the UK, the food industry has adopted a mixture of Dairy Standard and the German DIN standard pipes.

What is known as 'Schedule' pipe is another process industry standard to which the

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While the intellectual asset of Martec resides in the design of the Marplug and the infrastructure that manages its transit, its growing revenue stream lies also in the implementation of the device in complete recovery solutions. Within the food and process industry, integrators have opted for the complete Martec product recovery system. The company sells a solution on the back of its understanding of production practices.

Marplug has been sized: here the conduits are typically iron pipes welded along their length. These are not ideal for food transport given the opportunities for food particles to become trapped but are nonetheless a definable standard adopted by several of the non-food manufacturers served by Martec.

Negotiating way out of tight corners

Harper illustrated another determining factor in the design of product recovery plugs, Schedule pipes have sharper bends than other standards, it appears. “The Marplug has had to be designed to go round very tight corners in Schedule networks. We would normally be looking to a minimum radius of 1.5 times the pipe diameter so that for a 2 inch pipe, the tightest curve would have a 3 inch radius.

“In practice, what we can do is give the plug a longer centre section – but with the same number of vanes - to accommodate the tighter bends. The plug has to be able to do its job efficiently, leaving no residue, without the option of opening up the pipe for additional cleaning as hygiene standards across most production processes do not allow that.”

While the plug is at the heart of the recovery process, it has to function as part of a complete product recovery system. No matter how elegant and streamlined a new railway train might appear, for example, it has to be operated safely within the infrastructure of rails and ‘passenger access facilities’ (ie platforms at stations) provided by Network Rail.

Since the Marplug runs down a pipeline between batches of ingredients or finished product, it needs its own infrastructure that will allow it to be driven along the pipe and then drawn back to be parked unobtrusively as the next batch of ingredients starts its journey towards packaging.

How is the plug to be propelled down the pipe, for example and how can we be sure where the plug is? Can it be parked behind a sealed door that allows any remaining Korma sauce to be removed from its convoluted surfaces before being sent down the pipe again to recover Thai curry?

The implications of cross-contamination do not need to be spelled out to anyone who has ordered tea from an office drinks dispenser immediately after hot chocolate has been served. And so if product recovery is to be safely implemented in a food factory all these issues need to be carefully managed.

Complete recovery solutions

While the intellectual asset of Martec resides in the design of the Marplug and the infrastructure that manages its transit through the pipes, its growing revenue stream lies also in the implementation of the device in complete recovery solutions.

Jonathan Harper outlined the company’s strategy. “Within the food and process industry, integrators have opted for our complete product recovery system. We sell a solution on the back of our understanding of production practices.

“It means that we have had to accommodate the complexities of the cleaning processes and regimes which apply at batch changeover or the end of day. And we make sure that our systems can be CIP cleaned.”

Industrial users of water pay not just for the volume of water consumed, but the actual cost to the supplier of bringing waste water back to a condition at which it can be returned to the public network. The water companies charge for cleaning on the basis of the amount of processing they undertake.

End-to-end solution

In practice, that means designing an end-to-end solution which goes so far as rationalising the number of pipelines between the holding tanks and the filler stations. According to Jonathan Harper, "Reducing the number of pipelines makes the cleaning task easier: there are fewer pipes from which product has to be recovered, and the final traces flushed out.

"Designing the network more efficiently allows raw materials and finished products to be diverted easily between locations in a factory.

"When a transfer has been completed, the Marplug is despatched from its launch station and passed down the line. What we use to propel it depends on the viscosity of the substance and how uniform its flow through the network has to be.

"If the material in the pipe is on its way to a filler station, for example, the travel rate of the plug must be varied to ensure that the speed at the filler remains constant as the volume steadily decreases."

Harper believes that the Marplug is unique in this respect – the multi-vane seal allows water to be used as a propellant which in turn allows a drive pump to control the rate of delivery of the recovered product very accurately. Competitors use compressed air, which is almost impossible to control.

Reducing waste on shelves.

Recovering products that would otherwise be wasted is perhaps the obvious use for the Marplug, but through intelligent control of the plug's propulsion through the production line network, it can materially contribute to the shelf life and quality of a food product.

Away from the domestic kitchen environment, industrial food manufacture is often highly dynamic, with food being cooked and cooled 'in flight' as it passes through heat exchangers en route from the ingredient stage to the filler stations.

The temperature of the product has to be regulated at key points in the network to ensure food safety and organoleptic quality. If food can be cooled more rapidly because it is being driven at the correct speed through the heat exchanger, it has a longer shelf life.

From the retailer's perspective this is positive because the 'best before' window increases and less food has to be destroyed through being out of date. Manufacturers meeting retailer needs tend to be the most successful in the long term.

Above left: A Martec DIN 125 Launch Station in use at a high profile food manufacturer.

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Pressures on Martec's clients are financial and environmental. The stakeholders want to see profitability at least maintained at a time when commodity prices are constantly rising, while none of the companies involved can be seen to be consuming more scarce resources than they absolutely need to do. Given the Blue Chip nature of the company's customers and the contribution that product recovery is making on multiple counts, Martec appears to be in the right market at the right time.

Using water to propel the Marplug behind the food in the pipeline is only part of the solution: by steadily varying the rate of water injection used to move the plug, the remaining food in the pipeline network is fed through the heat exchanger at a constant rate.

Financial or environmental?

The Martec MD is not unnaturally an enthusiast for the solutions he is selling. But how much of the company's current success is due to UK industry's near obsession with being seen to be 'going green' by its stakeholders rather than the minutiæ of saving a few pence per litre having taken the Marplug and its delivery system on board? The economic case is worth closer examination.

Justification for the Martec solution would appear to rely on recovering ingredients irrespective of their intrinsic cost. The company makes a case on the back of typical piece of pipework in a food production plant. A 2 inch diameter pipeline 60 metres long would not be an unreasonable starting point for the calculation. At even 15 pence per litre and 4 changeovers each day, it can be shown that the savings in material costs alone are around £80,000 per annum.

Account for water savings

But the savings in water needed to clean out the pipe also have to be taken into account. Industrial users of water pay not just for the volume of water consumed, but the actual cost to the supplier of bringing waste water back to a condition at which it can be returned to the public network.

The water companies make their charge for cleaning on the basis of the Chemical Oxygen Demand (COD) of the water discharged and the weight of suspended solids that it contains. The higher the COD rating, the greater the cost of treatment.

There is a huge variation in the amount of oxygen needed to 'detoxify' the effluent: the COD rating even for typical recipe dish sauces can vary from under 500,000 units to more than 1 million units per litre.

How much the water companies charge per million COD units varies quite considerably across the UK. A food company saving its £80,000 in the London area would be saving an additional £20,000 - £25,000 per annum in water charges: in the South West, however, that water component would be nearer £120,000. The 15 pence per litre of product at the outset can therefore materialise into an annual saving of at least £100,000 in London; £200,000 in more remote parts of the country.

Reducing capital expenditure

The Martec team summarises its business case by arguing that by becoming involved in the design of a manufacturer's pipe network, the capital expenditure costs are reduced. The payback period is cut as a consequence and operating costs such as effluent treatment charges fall dramatically. And in terms of the products in the pipeline, the yield improves. As Jonathan Harper noted, "It makes the manufacturing process more efficient and reduces those companies' carbon footprint."

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Where does that scenario leave the developer from Derbyshire – does it have the physical resources to service the growing demand for its product recovery solutions?

The MD talks in terms of corporate expansion; of structuring the company to respond to the growing number of enquiries it is receiving from the UK and Europe.

Given the Blue Chip character of the company's customer base (some do not want to be identified for competitive reasons) and the contribution that product recovery is making on multiple counts, Martec appears to be in the right market at just the right time. §