

Creating the perfect *blend*

MIXING IS THE MOST COMMON PROCESS IN THE FOOD, PHARMACEUTICAL AND CHEMICAL INDUSTRIES AND ALSO THE ONE THAT CAN HAVE THE MOST DRAMATIC EFFECT ON PRODUCTIVITY, PRODUCT QUALITY AND ENERGY USE.

One reason for the complexity of mixing technology is that it embraces substances in all physical states and in all combinations of them. There are also a number of objectives.

For example, do you want to blend, disperse, emulsify, suspend solids or assist mass and heat transfer? Then there is the large number of variables, such as vessel size and shape and impeller type, size and speed, which can affect the results of the process.

Fortunately, the past decade has seen much development work on the computation of flow patterns in mixing vessels. As a corollary of this, mixer manufacturers have increasingly taken to computer aided design and manufacture (CAD/CAM) and introduced the principles of fluid dynamics into the design stage, so reducing the risk associated with building working models.

This has taken much of the 'black art' out of the process and replaced it with science, since computer modelling can also be used in matching the right mixer to a given process. Manufacturers can now be much more sure of their ground when discussing needs with the end user.

The result is more rapid progress in the decision making process and an increased likelihood of scale-up success. Unfortunately, it does not mean the need for trials is eliminated: theory aids choice and design, practice proves it. For this reason, suppliers with test facilities or loan machines are recommended for all but simple mixing tasks and especially for new applications.

Increased demand for bespoke processors is also driving developments. Fierce competition on supermarket, sweet shop and drug store



Continuous processing: Romaco FrymaKoruma's new plant for semi-solids such as toothpaste

shelves means constant product innovation, often with new and sophisticated formulae which may have properties requiring customised solutions. Many a mixer manufacturer will be prepared, at a cost, to help out, and eventually the lessons learnt from the exercise will filter through to that company's proprietary equipment.

Payback for updating

As such, there is steady flow of new products and technologies being introduced to the market and the payback for updating the mixing process can be considerable – in terms of both efficiency and quality – if a more appropriate product or technology is introduced.

A new mixing processor is not, therefore,

only to be considered when a new line is to be installed or an existing machine has come to the end of its useful life. Perhaps more than any other part of the processing function, mixing should be subjected to a cost-benefit ratio analysis at regular intervals to determine whether the pay-back time for updating the process would justify the capital spend.

However, there are a number of criteria which must be considered when determining the right product for the job, the complexity of which will vary depending on whether the machine is a replacement or for a new product line.

Indeed, given the array of different mixing systems available – agitators, saw tooth blade, closed rotor, rotor-stator – and the number of variables that can affect the process, how does

one ensure the best solution for the job in hand? Assuming there is no professor of fluid dynamics readily available, or that the job is merely a repeat of an already successful application, the first stop has to be with the suppliers.

There are a number of established players which, as mentioned above, fund R&D departments and, given that an order could be in the offing, will offer access to them for tricky applications. Loan machines may also be available to test applications before making a purchase commitment.

The first consideration is configuration: do you need a batch or in-line mixer? Batch mixing is most common in the higher added value process industries where limited volumes are being produced, whereas in high volume chemical applications, for example, an in-line solution may be more appropriate.

An in-line answer may also be recommended if improvements to an existing process are being sought.

Mixing action required

The next major question is what type of mixing action is required? In general, for liquids of similar viscosities, low shear operations are the most appropriate, while for liquids of differing viscosities, high shear mixing may be necessary. Similarly, when particles are in suspension, it is likely that shear will provide a more uniform, stable product.

In the food, pharmaceutical and cosmetics industries, a common task is the creation of emulsions and for these a degree of shear is desirable in order to promote stability. However, forming a stable emulsion from a number of immiscible liquids, which may be of widely differing viscosities, while successfully dispersing and activating functional ingredients such as stabilising agents, can be a daunting task.

If solids are involved, will they dissolve fully and are any of the components heat sensitive? There is also a possibility that the shear force-generated could damage the components or the resulting emulsion.

According to Silverson Machines, conventional agitators can give satisfactory results across a broad range of viscosities in many applications, but their effectiveness tends to be limited to simple duties such as blending liquids of similar viscosities, maintaining in-tank uniformity and promoting heat transfer.

For more demanding duties, says Silverson, an agitator is, at best, only effective as a 'process aid', supplementing the action of

equipment with a more positive action. So for activities such as forming an emulsion or suspension, dispersion and hydration of powders – such as thickeners or stabilisers – and blending liquids with widely differing viscosities, another approach must be considered.

The company suggests that in the food, pharmaceutical and cosmetics industries, the chances are that a high shear rotor-stator mixer is the most efficient option for the more demanding applications. It argues that the advantages of the rotor-stator over conventional agitators stem from the multi-stage mixing/shearing action.

As materials are drawn into the workhead by the high speed rotation of the rotor blades, they are subjected to intense hydraulic and mechanical shear, then forced out through the stator at high speed and projected radially back into the mix.

Indeed, Silverson has developed a range of multi-stage in-line mixers to provide higher shear than its standard models, so giving lower particle sizes, finer emulsions, single pass processing and faster processing times. The mixers employ two concentric sets of blades and teeth running against two separate stators, an arrangement which Silverson says allows users to optimise mixer configurations to suit individual processes. Five models with power ratings from 2 to 60hp are available for capacities from 1000 to 100,000 litres an hour, based on product of water viscosity.

As material passes through the workhead it is subjected to increasing rates of shear. The inner rotor subjects the product to an initial mixing action, reducing the size of large particles and producing a uniform pre-mix.

The inner rotor also acts as the prime mover for the product, forcing it into the outer multi-bladed rotor-stator assembly where the greatly increased tip speeds and shear rates complete the mixing cycle by producing a completely homogeneous product.

The design of the multi-stage mixer is said to quadruple the number of shearing actions per revolution of the rotor, resulting in substantially faster mixing times by reducing the number of recirculation passes required. This also increases the number of products that can be processed in a single pass.

Ultra-hygienic mixers

Silverson has also just announced a series of ultra-hygienic in-line mixers, said to be the first of their type to gain certification from EHEDG

Maximising effectiveness in powder mixing plant

Since overall efficiency in powder mixing operations may well depend more on the time taken to fill, empty and clean the machine than actual processing time, a particularly flexible solution is to use an IBC as a detachable mixing vessel.

In this way, explains powder handling specialist Matcon, the tumble blending equipment is fully utilised, handling one IBC after another, with no dead time for formulation or cleaning. It also allows small volumes to be handled more economically.

However, mixing capability can be a limiting factor although, as Matcon points out, recent developments in IBC tumble blending – introduction of high shear, liquid injection and so

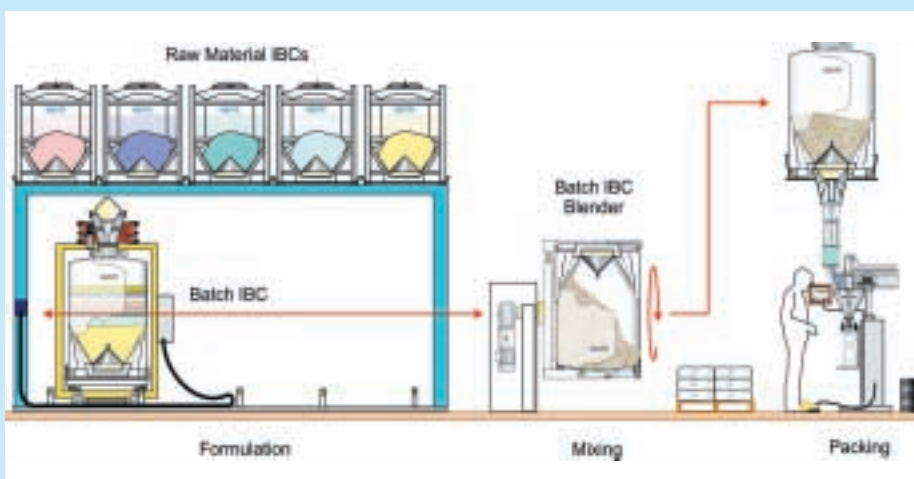
(the European Hygienic Engineering and Design Group) for hygienic construction and enhanced performance. Like other Silverson rotor/stator mixers, each machine can carry out a wide range of work including emulsifying, homogenising, disintegrating, suspending, dissolving, dispersing, blending, particle size reduction, de-agglomerating and reaction acceleration.

Features include interchangeable single or multistage rotor/stator arrangements as standard, resulting in substantially faster mixing times and finer particle size, says Silverson. The mixer's outlet can be configured to tangential self-draining or vertical self-venting positions as required, and the units also feature ultra hygienic single or double mechanical shaft seals.

Ytron-Quadro is now the UK supplier of vacuum mixing units from French manufacturer VMI Rayneri. Equipment includes the Trimix, which is said to allow the handling of complex rheologies in a single vessel, and can be supplied in versions suitable for vacuum or pressure. It is fitted with side-scraping mixing arms, a contra-rotating central mixing system and a bottom-entry high-shear homogeniser.

According to Ytron-Quadro managing director Dudley Bradley, the intensive movement in the vessel ensures a homogeneous mix and efficient heat transfer. Vessel sizes range from a 5 litre laboratory unit to 20,000 litres.

But the core Ytron-Quadro mixing range remains the Ytron Y directed jet mixer, the



Minimising dead time: IBC tumble blending for powders avoids cleaning and formulation on the mixer

forth – are broadening the scope of the process.

While there is no single answer for all processes, using multiple blending technologies and applying the 80/20 rule can produce a highly efficient and flexible process, the company explains:

“This would suggest using an IBC blending approach where it can be used and using an

alternative mixing technology – such as a high shear vertical mixer – where IBC blending may be less effective.”

Since fewer products would be used with the high shear vertical mixer, there would be less filling, less emptying and less cleaning required for both processes, giving the equipment much higher utilisation and effectiveness.



Instantaneous shear: Tools for the Ytron ZC powder incorporation unit

Ytron ZC powder incorporation unit and the Ytron Z in-line emulsifier. The latter can be used to process those creams and lotions which are either a water-in-oil or oil-in-water emulsion. The inline process, says Mr Bradley, produces a more consistent, superior quality emulsion in less time than conventional in-tank high shear mixers.

The single-pass processing also creates a more consistent emulsion, he claims, with longer shelf life and stability, since there is less likelihood of phase separation.

Dudley Bradley points out that when carbomer and polymer powders are dispersed as rheology modifiers or structure-building agents in personal care products, in-tank technologies will often produce insufficient shear to reliably reduce particle size and so-called “fish-eyes” or clumps of powder. Alternatively, processing times may have to be extended to ensure uniform dispersion. Quite apart from the cost and operating implications of this, he argues, over-processing may also reduce the effective viscosity of the product.

Powders drawn down

Ytron-Quadro says that its Ytron ZC unit addresses these issues. A significant vacuum in the reactor housing, created by the interaction between rotor and stator, ensures that powders are drawn down into the reactor head. Here, particles are subjected to intense mechanical shearing prior to hydration into the liquid stream.

The Ytron Y is typically used in the batch dilution of “high active” surfactants. In a recent installation, two side-entry units were supplied to dilute 70 per cent sodium lauryl ether sulphate (SLES) in batches of 30,000 litres. Other applications can include the thorough mixing of colour into viscous creams, gels and lotions.

Meanwhile Romaco FrymaKoruma has turned its attention to continuous processing of semi-solids such as toothpaste, hair care products and mayonnaise and built a number of

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different rigs, from pilot plants of 100-200kg/hour capacity to production plants of 1000-4000kg/hour.

In general, says FrymaKoruma, a continuous plant needs to have a production capacity above 1000kg/h to be efficient and cost effective. However, smaller production systems could be needed by the pharmaceutical industry, the company suggests, because of steadily increasing regulatory requirements.

"Once the process has been developed and critical parameters identified, the equipment can be monitored automatically, with lab testing reduced to a minimum. Residence times within the plant and correct sizing ensure that the required product quality and quantity is achieved, even when operating at less than 50 per cent capacity," the company points out.

"Realising that the potential to further raise productivity in batch processing is limited, we turned to the development of continuous processing as a logical alternative. The challenge we faced was in manufacturing equipment which would also guarantee process safety, dosing accuracy and consistent quality standards," explains Patrick Weisser, engineering manager for FrymaKoruma.

He says that to guarantee process safety, dosing accuracy and consistent quality standards, all important parameters are under online control throughout the process, with fully automated dosing and monitoring.

"After each step factors such as temperature, viscosity, flow rate, pressure, density and even pH value can be checked, with information continuously available on the operator panel," he explains. "If any parameter drifts outside the pre-set tolerances, the system will immediately and automatically stop for readjustment. Finally, data about the entire process is retained for the record or for analysis."

The new plant is said to offer users a high degree of flexibility in feeding active ingredients and additives, with the capability to introduce these at every phase of the process. It allows either one or two wetting steps and heating or cooling of the product, if required, while any entrained air is eliminated by a de-aeration process. Coriolis flow meters, accurate to ± 0.5 per cent, are employed for liquids while loss-in-weight feeders, also accurate to ± 0.5 per cent, are used for dry ingredients.

Mixed product is pumped to an inline homogeniser for final processing and fed into the finisher-skid where flavours or colours are added. It is then ready to be transferred to a

High shear mixer handles fruit juice batches

Independent fruit juice blender David Berryman, Dunstable, has bought a Ytron-Quadro all-stainless high shear mixer, with stainless steel motor, to handle batches of fruit juice bases up to 1200kg with ingredients such as pectin, ascorbic and citric acids and preservatives.

The Ytron-Y ByPass machine is able to deal effectively with ingredients that include dry powders by the use of an integral feed chute that delivers ingredients directly to the mixing head below the liquid level.

This ensures ingredients are instantly wetted, suspended or dissolved to achieve an homogeneous mix. It is equally effective for both dry ingredients and liquids, even those of high viscosity, with the negative pressure created by the rotating mixer head helping to draw the ingredients into the mix.

Features of this Ytron-Y ByPass mixer are a special mixer head to help the high shear mixing action and a stainless steel motor from Marlin Stainless.

According to Ytron-Quadro managing director Dudley Bradley the Marlin stainless motor



Stainless motor: Ytron-Y ByPass all-stainless high shear mixer at David Berryman

is a 'natural' partner for his mixers. "With total corrosion resistance and no paint to flake the risk of batch contamination is completely eliminated. Being smooth bodied there are no crevices to harbour material, facilitating easy hosedown cleaning – which is no problem with the motor being IP66 rated."

Nick Eckert, managing director at David Berryman adds: "With everything we do hygiene is paramount. So this totally stainless mixer-motor package is an ideal solution. It performs really well, achieving effective mixing of all ingredients quickly and quietly and is easy to clean with a high pressure hose."



Mobile mixer: Custom unit built for E2V by Adelphi Coldstream

buffer tank, or sent directly to a filling line.

German manufacturer IKA has taken a modular approach which means that its series 2000 mixers are available in a range of sizes to suit most batch and continuous applications, including laboratory units. These use the same shear

zones found in all sizes of the machine, providing the opportunity for accurate scale up to production equipment.

The modules operate in a vertical position thus allowing complete emptying, are available with CIP and SIP capability and have FDA certification.

Represented in the UK by Bramigk & Co, IKA has also introduced its Master Plant, for emulsifying, homogenising, powder incorporation, dispersing and melting. Process times are reduced by the heatable/coolable spiral contra-rotating agitator, as well as by a jacketed vessel. High viscosity products, up to 100,000 mPas, can be processed without additional pumps and the working volume of

the vessel can be reduced by an optimised circulation loop, effectively reducing the vessel volume to 15 per cent of its total capacity.

Powders can also be incorporated without the need for a vacuum in the vessel, says Bramigk, while sizes range from 10 litres to 4000 litres

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and indeed beyond for bespoke designs.

Adelphi Coldstream, which specialises in bespoke mixing vessels, has recently built a plant for E2V Technologies to manufacture a co-precipitate of triple carbonate in an inorganic mix, achieving a certain particle size and shape for a specialised device. The mobile double heated vessel and mixer assembly consists of a 20 litre and 50 litre water jacketed vessel with lid mounted stirrers and a control panel for independently controlling the speed of both mixers and heating for each vessel.

Stainless vessel range

A standard range of 316L stainless vessels are held in stock at Adelphi in volumes from 1 to 240 litres while bespoke mixing and storage vessels up to 1000 litres can be made.

CC Automation, which has recently become a PPMA member, is now supplying mixing systems from two German specialists, Miromatic and Novapac.

Miromatic builds MRA mixing and dosing systems for products such as yoghurts, probiotic drinks, fruit and savoury flavoured curds, mayonnaise and fresh fruit salad and has supplied most of the leading dairies including Müller UK, Danone, Campina, and Onken. The process avoids any shearing action, so maintaining the integrity of delicate particulates while the equipment is fitted with a sterilised duct for aseptic applications.

Novapac, which makes rotary cup fillers and horizontal form-fill-seal machines, also produces the Niromix range of homogenisers for milk, meat and vegetable products, pharmaceutical and personal care products.

A rotating blade cuts, mixes and emulsifies the products while a scraper rotates in the opposite direction and clears dead zones. Options include mixing performed under vacuum and preset temperatures, double walled with steam or hot water heating, formula management, weighing control and full CIP.

New from Grunwald UK is a stainless magnetic mixer and motor package that eliminates seals – and any risk of leakage – with the drive taken through the vessel wall to the mixing assembly by a magnetic coupling.

Introduced by Advanced Engineering (Mid-



In-bin mixing: Above: IMA Vima Cyclops system. Below: Syspal Euro-bin Tumbler



dleton), Rochdale, the Magnamix is suitable for vessels from 10 to 20,000 litres and employs an IP66 rated variable speed motor to allow cleaning via steam and high pressure hoses. The mixing head is self-cleaning and allows access for cleaning devices such as static sprayballs and rotary spray heads.

Tumble mixing for food

Tumble mixing for powders is an established process within the pharmaceutical industry but Syspal has extended its use to food processing.

The company's Euro-bin Tumbler uses a standard 200 litre stainless steel tote bin as a mixing bowl and allows delicate products such as salads, pastas, cereals and vegetables, to be

handled with little or no breakage. The product to be mixed simply stays in the tote bin itself, reducing downtime for loading, discharging and cleaning.

Syspal says that feedback from several food processors has shown that the machine can reduce mixing time dramatically. In one test, with different coloured cooked rice, a single operator was able to mix a batch in less than a minute, compared with 10 minutes taken by two operators to complete the process by hand.

Pharmaceutical powder handling equipment from Italian manufacturer Vima Impianti is now distributed by IMA UK and includes dispensing systems, powder and tablet IBCs, bin blenders, column lifters, bin docking stations, transfer systems and various types of washing systems for bins and other components.

The Cyclops bin blender from Vima is described as a simple, flexible, compact, and efficient bin blending system that can be installed 'through the wall' with minimum intrusion in the processing room, so reducing the area to be cleaned and any risk of cross-contamination.

Mixing efficiency is said to be increased by a two-step reversible rotation, and by an optional dual blending inclination. A typical Cyclops installation is capable of handling batch sizes up to 1500kg including the IBC itself.

An alternative is the Vima Canguri bin blender, which retains the same through-the-

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wall approach, but will operate with a customer's existing IBC designs. Batch sizes up to 2000kg can be handled.

For a slightly different approach, Vima also designs and manufactures the Hercules range of column bin blenders. There are two general models within this system: the Midi, which is capable of handling IBCs up to 600kg with top support anchor and 300kg as a floor anchored only installation, and the Maxi, which can handle IBCs up to 1000kg.

Mixing via screw conveyor

However, vessels may not always be necessary for some mixing duties according to Spiroflow, which says its flexible screw conveyors – stainless steel spirals rotating within food grade plastic tubes – can be used to mix ingredients continuously and eliminate the need for conventional mixers.

Several components can be homogeneously mixed and conveyed at the same time says the company, both functions being achieved by the rotating spiral, at rates up to 40 tonnes an hour.

Individual conveyors can be provided for the components of a mix and may be arranged radially to feed to the main conveyor in which the mixing takes place. Alternatively, it is possible to install one conveyor within the rotating spiral of another, so that the material from the first conveyor is delivered into the centre of the stream of material in the second and the mixing action is enhanced. In either case material can be fed by weight or volume.

Spiroflow has a test centre where the relative

rates of spiral rotation for the different feeder conveyors can be established for different materials. These ratios can then be maintained through motor speed control inverters while memory in the control system enables changes from one mix formula to another to be made quickly. It is also possible to add a liquid ingredient to powder or granular components.

Spiral screw conveyors are typically accurate to ± 0.5 per cent, says Spiroflow.

Product transfer in mixing and blending processes often needs to avoid additional shear and so many equipment manufacturers have opted for the Maso Sine Pump which, apart from avoiding shear, is said also to offer smooth laminar flow, easier flow control through lack of pulsation during pumping, and accurate control of product flow,

Also, by changing speed, the pump can handle products that increase in viscosity during the mixing and blending process. Applications include food, pharmaceuticals, healthcare and cosmetics industries.

Finally, Watson-Marlow Bredel is launching its new 720 series of IP66 cased peristaltic pumps for general industrial metering or transfer duties. Said to offer a smaller footprint than other pumps with a similar flow rate, the new 720 series includes single channel flows up to 2000 litres an hour, or a maximum of 4000 litres an hour through two individual tubes.

The 720 pumps feature Watson-Marlow Bredel's LoadSure pumping elements which use industry standard cam and groove connectors to provide long tube life. ■

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For full details of all PPMA members able to supply mixing equipment, consult the PPMA machinery finder service, tel: 020 8773 8111, or visit www.ppma.co.uk

Bakery mixers for all applications

JBS Master Baker is now in partnership with Hollmec to market the Taiwanese Chanmag range of spiral and planetary bakery dough mixers throughout the UK.

A typical installation is at North Elmham Bakery near Dereham in Norfolk, where owner Norman Olley recently chose an 80kg capacity Chanmag spiral mixer to replace an old machine for rolls, bloomers and coburgs.

For high-output operations, JBS Process Engineering is the UK agent for Shaffer, the USA manufacturer of standalone mixers and fully automated, integrated mixing systems. Shaffer mixers are available with high-speed roller bar, and single or double sigma arm agitators.

Shaffer's latest product is the dough reclaim



Dough mixer: An example of the Chanmag range

slurry system, a process used to return normally discarded scrap back into the mixer, eliminating the costs of scrap and those of related handling.