Productivity and quality mix for The perfect blend

THE MOST COMMON PROCESS CARRIED OUT IN THE FOOD, PHARMACEUTICAL AND CHEMICAL INDUSTRIES IS ALSO THE ONE THAT CAN HAVE THE MOST DRAMATIC EFFECT ON PRODUCTIVITY, PRODUCT QUALITY AND ENERGY USE. SELECTING THE MOST APPROPRIATE MIXING TECHNOLOGY FOR SPECIFIC APPLICATIONS IS THEREFORE CRUCIAL.

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 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.

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.

Cost-benefit analysis

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

For demanding applications: *Silverson has introduced a new multi-stage rotor-stator mixer* offing, will offer access to them for tricky applications. Loan machines may also be available to test applications before making a 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.

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.

Degree of shear

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, formulating a stable emulsion from a number of liquids which may well be immiscible and of different densities, while maintaining the required viscosity, is 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 just introduced 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 new 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.

Range of paddle mixers

Meanwhile, Game Engineering has launched a new range of paddle mixers and coaters, the GPM and GPC ranges, with 400, 600, 800, 1000, 1200 and 2000 litre models as standard, although other sizes are also to be available. The new models are capable of blending solids, powders or liquids and incorporate a sealing system on the hydraulic bomb doors which is said to ensure spillage-free operation.

The GP range can be used as part of a three tier mixing or fats coating system, with top feeder hopper and bottom discharge hopper, to create continuous batch mixing or coating.

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 continuously mix ingredients and eliminate the need for conventional mixers.

Mixed by rotating spiral

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 arrange for the addition of a liquid additive to powder or granular components.

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

Sleaford Quality Foods, which supplies dried fruit, vegetables, herbs and spices, has installed a Matcon IBC Batch Blender system to help raise production capacity by 400 per cent without employing extra labour.

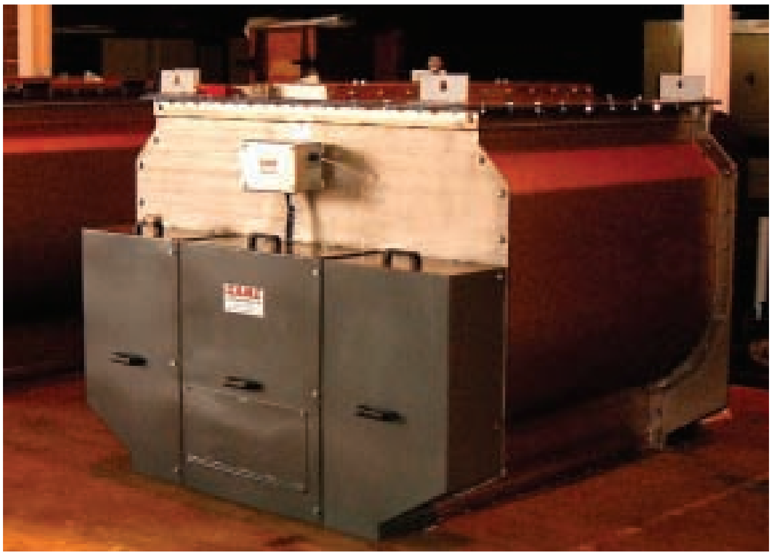
Matcon points out that fixed mixers – which are also in operation at Sleaford's Lincolnshire plant – generally have the disadvantage of low utilisation, typically less than 10 per cent, as a result of the dead time during loading, feeding the packaging machinery and subsequent cleaning.

In contrast, the Matcon IBC Batch Blender allows all non-mixing operations to take place off line, since an IBC is used as the mixing vessel, held and rotated within a tumbling frame. As a result, buffers of IBCs charged with ingredients, IBCs with contents that are blended, and empty IBCs ready for washing can be built up, allowing the blending operation itself to run at the highest possible utilisation.

Pharmaceutical powder handling equipment from Italian manufacturer Vima Impianti is now distributed by IMA 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.

In-IBC blending: *Matcon mixer (left) and filling system (above) at Sleaford Quality Foods*



Paddle mixer range: *Game Engineering has announced the GPM and GPC ranges*

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 Titan bin blender, which retains the same through-the-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.

Reflex Nutrition, Hove, has recently doubled capacity for its sports nutritional products – including the new sports drinks Reflex Advantage – with the purchase of a 3000 litre U-Trough mixer from Winkworth Machinery.

U-trough mixer

Set up in 1996, the company increased production capacity during 2002 with a 1500 litre Winkworth U-Trough mixer, adding 5lb tubs to its range. The machine is suitable for powders, granules, pastes or creams and features an interrupted spiral mixing blade, customised lid and pneumatically operated outlet valve for rapid discharge.

The new mixer is to be dedicated to volume production for large tubs, with a maximum production capacity of 1200kg an hour.

Mixing and blending systems from Laska of Austria and Inotec of Germany – now available in the UK from Union Food Machinery – include vessels with paddles, ribbons and z-arms, or combinations. Capacities extend from 130 litres to 6 tonnes, with installations made in baby food, melted cheese, ready meals, pet food, confectionery, pharmaceuticals, as well as general industry.

Facilities such as vacuum, water dosing, cooling, weigh cells and double jackets are also available and the Inotec near infra red analysis system can also be combined where required to give control over product uniformity.

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.

Mixing for beverages

Demand from beverage producers for higher outputs has led Krones to introduce a 60m^3/hour version of its Contiflow mixer, already available with maximum outputs of 15, 30 and 45m^3/hour. Each Contiflow is now also readily adjustable between 33 and 100 per cent of maximum output, so automatically matching itself to the filler speed within these limits.

This minimises stops and starts where, as Krones points out, the biggest control deviations occur.

"Thanks to appropriately dimensioned buffer tanks and an injector constructed on the venturi principle, it is now possible to bridge filler standstills of up to three minutes without halting the dosing function," says the company.

"Some 90 per cent of all filler-related stops are remedied in approximately one minute, so production is kept almost continuous at different output levels."

In contrast to previous designs, de-aeration is now performed in a singe horizontal tank instead of in two vertical tanks. This configuration ensures a large gas compartment and a correspondingly large infeed height for the pump extracting from the vacuum, so preventing any cavitation, and improving de-aeration performance overall.

Carbonation is now handled by an injector designed on the venturi principle.

Krones points out that while this carbonation device has given excellent service in numerous machines, the injector is able to operate only in a narrow output range, and has therefore been used solely in intermittently operating machines.

"This disadvantage is eliminated by circulation carbonating, which ensures a constant volume flow through the injector," explains the company. "Only the quantity not passed into the buffer tank is returned to the intake connection of the circulation pump, so ensuring that the flow conditions in the injector are constant at every machine output."

The CO_2 is added via a control valve and a mass flow meter, with current water and syrup volume flows forming the reference variable for the CO_2 dosing.

Minimising stops and starts: *Krones Contiflow is now adjustable between 33 and 100 per cent of maximum*

Four lines from one mixer

Swiss manufacturer Miteco – represented by Caval Processing – has developed the Multimix-Multiblender which provides flexibility by allowing up to four filling lines to be fed simultaneously with different beverages from one piece of equipment.

Each unit consists of one water feeding line, or string, and several syrup or concentrate strings, which reduces the instrumentation and control equipment necessary to a minimum. Out of these input components, the unit continuously blends the different final, non-carbonated beverages for several fillers.

Each input component is measured via a dedicated mass flow meter, which again is cross-checked by a Miteco controlling algorithm.

"This means that the product leaving the Multimix-Multiblender is always within the requested specifications, independent of any stop and go from the filler," points out Caval. "Another very important feature is the possibility to sanitize (CIP) each production string independently."

One production unit can handle a broad range of filler capacities. Installed units are now handling filling lines from 10,000 l/h up to 30,000 l/h within one unit. ■

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

Choosing the right mixer

MIXING ITSELF MAY STILL OFTEN BE AN ART BUT THE MIXER DESIGN IS A PRECISE SCIENCE. POWDER PROCESSING AND HANDLING SPECIALIST KEMUTEC OFFERS THIS RUNDOWN ON MIXER SELECTION.

Ultimately, the choice of mixer is made on the grounds of price, delivery, and confidence that the supplier's mixer will do the job. Although reference plants and testing will confirm the process performance, mechanical performance may not be so easy to assess.

Tests may be conducted on a machine several times smaller than the actual model to be purchased and, while scaling up for process considerations should be no problem to the specialist supplier, scaling up for mechanical considerations is another matter altogether!

Visually, mixers appear much less complicated than many other pieces of process equipment, but failure to consider the mechanical design adequately will result in a machine prone to breakdown or inconsistent performance and ultimately, poor output and product quality.

The drive: This should be capable of starting the mixer under full load, since mixers are stopped in mid process either intentionally for inspection or accidentally and 'digging out' is a hard and time consuming task, especially from larger capacity machines.

Direct drives: Direct on-line (DOL) starting of electric motors is preferred giving two to three times additional torque on starting.

Slip ring and 'soft-start' options are a consideration if some loss of start up torque can be tolerated.

Star Delta can be used if the mixer can be left running with the 'odd' accidental stop.

Fluid couplings or centrifugal clutches are helpful to get a big mixer started under full load.

Indirect drives: Use of V-belts permits some 'fine tuning'.

More drastic agitator speed changes are necessary for differing applications or unexpected physical changes to the characteristic of the mix due to site conditions.

Variable speed drivers are expensive and require more power even under zero load. They should only be considered where frequent speed changes are necessary.

If a few fixed speeds are adequate then consider two or three speed motors or a belt pulley change system for simplicity.

For trouble free loading and unloading, inching motors are often fitted at the opposite end to the main drive unit with a clutch arrangement, which disengages one motor as the other is engaged. These low power motors have high ratio gearboxes and permit exact positioning of the blender inlet and outlet relative to their connection points.

Agitator glands and seals: Some 90 per cent of powder mixers have traditional stuffing boxes. Special care has to be taken when designing seals for mixers operating under pressure, vacuum, elevated or reduced temperatures.

Performance considerations: Ensure the packing material is compatible with the mix.

Employ the optimum number of packing rings.

Packing should be of the correct cross section.

Compression of the packing should be capable of easy adjustment.

Lubricate where possible.

Air purging of the seal to the product side of the packing to prevent ingress of product into the packing.

Maintain regularly.

Stuffing boxes or seals which readily split in half are essential for rapid disassembly and thorough cleaning in applications where any risk of cross-contamination between batches is unacceptable.

Bearings: Good quality, correctly sized bearings mounted in substantial housings and properly maintained should ensure no problems with the essential elements. Bearings should incorporate their own seals to prevent the ingress of airborne dirt and dust and be mounted outboard of the glands to ensure that any leakage through them is not forced into the bearings themselves.

Loading the mixer: Considerations when choosing the loading method:

The mixing process: from the simple mixing of two free flowing powders loaded manually, to complex multi-ingredient formulations and automatic loading.

Mixing conditions: processes requiring heating, cooling, vacuum, or pressure.

Sealing arrangements to contain the mixer contents and maintain conditions in the trough.

Requirement for hinged lids, minor ingredient feed hatches, access manholes, and dead plate sections.

Operator friendly/safety considerations:

All lids and access hatches must be interlocked to immobilise the agitator while they are open unless fixed safety grids are fitted beneath them to prevent access to the moving agitator.

Lids and grilles should be counter-balanced or fitted with support stays to keep them open during cleaning or whilst ingredients are added.

Large heavy lids should be opened with the help of pneumatic cylinders.

Where dusty products are loaded manually, loading hoods connected to an extraction system reduce unnecessary mess and avoid the need for operatives to wear respiratory protection.

Agitator trough and vessel design: Agitators should be robust enough to withstand repeated starting under full load where applicable. Agitators also play a very important part in mixer discharge.

Second only to the agitator, in terms of the effectiveness of the mixing action, is mixer trough shape. Wherever possible, mixers operating under pressure or vacuum should be cylindrical in shape and have dished ends. Otherwise the trough has to be built with much ribbing to flat surfaces. The most common mixer trough is the traditional U trough mixer, while other proprietary designs include the C, Omega, vertical cone and cylinder.

Blenders come in all shapes but the more traditional types are double cone, drum, oblicone, and V cone.

Materials of construction are mainly a function of the process requirements, the ingredients, and the standards of hygiene required. Solutions can be found in material thickness, material specification, special linings and renewable parts. Care should also be taken with mixers operating at other than ambient temperature. Running tolerances must accommodate expansion/contraction and, in extreme cases, stress relieving of the main welded and formed components.

Outlet type: Critical factors to be considered:

1. Does a dead pocket at the outlet create a process problem?
2. Is it essential to discharge totally at the end of the mixing cycle?
3. Discharge time and the effect on mixed product during this cycle.
4. Leakage and product flowability.
5. Total or part discharging of a batch.

Solutions to be considered:

1. Flush fitting a plug outlet with the plug contoured to the trough of the mixer.
2. Using the bomb door to drop the products en masse.
3. Use of an iris diaphragm valve for part discharge.

Cleaning methods: These vary greatly and include vacuum cleaning, brushing, scraping, air jetting, high pressure water or steam, and solvents. Seals and other contact parts must be designed to withstand the cleaning regime as well as that of the process. Many automated systems incorporate CIP (clean in place) equipment. Typically in mixers, this is achieved through spray bar or spray nozzles strategically placed within the mixing vessel. Consideration must be given to how the mixer will be dried out before the next batch is loaded which is obviously more of a concern to those mixing dry materials.

Users should bear in mind that many mixers are designed specifically to meet their needs and contain non-standard components which, in the event of unexpected failure, may take time to replace. Accordingly they should ask their mixer supplier to identify these items so that they can consider holding such components in stock. ■

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