Seen to be clean

The main challenge in CIP appears to lie in the control software, so that the process can be seen to be clean. But the effectiveness of CIP systems can vary, writes Mick Whitworth.

More and more equipment is being offered with the facility for clean-in-place, either as a standard feature or at least an option. But does it always live up to expectations? According to one supplier of machinery to major food manufacturers there are still some serious doubts over the complete effectiveness of built-in CIP, at least in some applications.

Robin Turner, technical manager of M&P Engineering, says the jury is still out on whether CIP is worth incorporating in any machines with significant dirt traps, such as piston fillers.

"I don't think anyone has come up with a 100 per cent effective system for every type of machine," he says. "Every piston filler has internal seals, and the only foolproof way to clean them is to open up the piston and take them out."

He continues: "If you look at it coolly, if you run a cleaning fluid through the machine, it will get into the seals and you'll get a form of cleaning. But not 100 per cent. It may sound negative, but we're not prepared to include something on our machines unless we're convinced it works."

Robin Turner is not alone in thinking that the effectiveness of CIP needs sometimes to be treated with caution. Last year, in a paper on the cleaning and sterilisation of industrial freezers, Dr Paul Stewart of BOC Edwards Pharmaceutical Systems and consultant John Snowman declared: "When validating CIP systems it should not be claimed the system is 100 per cent efficient, but that it provides a more effective and repeatable cleaning action than that which can be obtained manually."

This sober view of the effectiveness of CIP needs to be uppermost in every designer's mind, as consultant Neil Moralee of NEM Business Solutions point out. He advises both consumer goods manufacturers and equipment suppliers on hygiene, and says lots of CIP systems don't live up to expectations.

Shortage of experience

In general he blames a shortage of engineers with hands-on experience of manufacturing processes, and in particular a lack of appreciation of the need for flow and temperature.

On one sandwich filling line he examined, cleaning fluid was being pumped into machines at a temperature of 63deg C, but did not see the heat exchanger again, and was steadily cooling as its went through the system, raising the risk of microbial growth.

In processing lines themselves, pumps and valves are often the prime hiding places for bugs, and are among the hardest areas for CIP. Where there is a pump there is usually a seal, and these are notoriously difficult to deep clean without disassembling. Indeed, according to Neil Moralee, increasing use of multi-port valves to route product towards different lines is increasing the risk. "In practice, a lot of seals are not really being cleaned," he says.

Divert CIP fluids

If CIP is not really possible on some kit, users are left with the slower option of removing, cleaning and reinstalling valves or pistons at every cleandown or changeover – a process that will typically take half an hour or more – and using valves to divert CIP fluids around the trouble spot.

With pumps, of course, one option is to rethink the type being used. According to Watson-Marlow Bredel, more processors, particularly those in the food sector, are turning to peristaltic or 'squeeze tube' pumps for their ease of CIP.

Peristaltics provide the ability to clean-in-place without the need for a bypass valve: once the rollers that squeeze product through the pump are backed off the pipe, it springs back to its full bore and the CIP fluid will move through at the same rate as it does through the rest of the system.

"Most CIPs rely on the full velocity of the fluid going through the system to create the necessary turbulence to ensure thorough cleaning," points out Dave Johnson, Watson-Marlow Bredel's business development manager.

"The velocity is generally higher than the pump, so most pumps have a valve to bypass them, although you generally run the pump at the same time to make sure the CIP fluid goes

Key features of a CIP system

- The number one requirement is a satisfactory clean of any surfaces that come in contact with the product. This means removal of residues from the last production run and reduction in surface micro-organisms to target levels.
- Cleaning is achieved through the application of thermal energy (heated fluid), chemical energy (detergents) and kinetic energy (by creating turbulent flow in pipes or using spray devices in vessels and other equipment).
- Where detergent washes are used, the system includes detergent dosing pumps and a heat exchanger to deliver cleaning fluid at the right temperature and detergent level for the right length of time. It must also be capable of removing all traces of detergent at the end of this phase.
- The system should minimise use of energy and fluid, and also keep production downtime to a minimum. There should ideally be little or no manual intervention by operators.
- The cleaning process should be capable of validation to prove it performs within specification every time.

Source: Suncombe

through it. But the pump would then be inspected separately.

"It's not the sole reason for pump choice – there are so many other criteria in terms of flows, pressures, material being pumped, and so on – but we have certainly sold pumps where the end user is happy to use ours because of the ease of CIP."

Getting rid of the bypass system gets rid of some of the cost and complexity and also gets rid of the bug crevices and traps, he says, adding that the cleaning process is then fully automated, so the user can "guarantee" the cleanliness of the pump without having to rely on a separate inspection.

Good at handling solids

"Peristaltics will take any fluids that other pumps will, but are particularly good at handling solids such as fruit without shearing. The limiting factor is products at very high temperatures, over 110deg C, where one is restricted by the elastomer."

John Holer, head of food hygiene at Campden & Chorleywood Food RA, has carried out studies into CIP. He says the last couple of years have seen more developments in the general cleanability of process equipment, rather than specific CIP technologies.

One example comes from German company Grunwald, whose rotary cup fillers are distributed in the UK by Corporate Packaging. It claims to have developed a new dosing system which eliminates the need for any special cleaning regime.

Its Easyclean unit has been designed as a piston valve filler and can be assembled on all Grunwald cup filling machines. "There are no hidden corners or edges," says a spokesman, "so continuous production is possible over several shifts without the need for CIP cleaning. In practice up to 60 hours production is possible before a cleaning of the filler is required."

At Masterfil, export sales and administration director Stephen Gillinson confirms a steady drift towards clean-in-place across cosmetics and toiletries as well as food, although 'pure' CIP connected to a ring main remains much more a feature of the liquid foods industry, he says. Masterfil offers full CIP as an option on all its fillers, and Mr Gillinson says users in the dairy sector in particular would almost invariably choose this option.

Increasingly, Masterfil is covering both internal and external CIP with, for example, sprayballs in the tanks and the filling zone, with used liquid collected in a built-in sump.

"People are still buying piston machines, but many of our machines are now based on flowmeters, because they provide a straight-through system offering very good accuracy," says Stephen Gillinson, who points out that even non-CIP machines are becoming more cleanable.

Nozzles pop out

"We've got a machine on the shop floor at the moment which is going to a cosmetics company and both the nozzles and pistons pop out at the push of a button." Piston machines are being

Mobile CIP: *Suncombe launched this unit at last year's PPMA Show*

Peristaltic: *Watson-Marlow Bredel 800 series pump showing both 'squeeze' rollers on the tube*

Ready for cleaning: *With the top roller locked off the tube reutrns to full bore for cleaning*

Benefits of CIP

- Reliable cleaning of equipment.
- Prevention of product contamination.
- Prevention of batch cross-contamination.
- Minimising operator involvement and manual handling of chemicals.
- Minimisation of fluid and energy waste.
- Minimisation of process interruption.
- Compliance with statutory regulations.
- Compliance with Good Manufacturing Practice.
- Ease of validation.

Source: Suncombe

Clean installation: *Typical 'clean' filling line (above) from Masterfil where the machine must be capable of being cleaned in place, but on which nozzles and pistons (below) are immediately removable*

manufactured with the built-in facility to clean above and below the piston, he adds.

Validation has become a key requirement in CIP according to Suncombe, which sells standalone CIP systems and spray devices for installation in equipment such as tanks, vessels, mixers and blenders.

"It must be shown that a system is capable of delivery a consistent, reliable, measurable and controllable performance every time it's operated," says director Dave Adams. In Suncombe's book, this means a combination of automatic cycling with PID control of all the critical parameters in a clean: temperature, detergent concentration and delivery pressure.

Electronic and printed records of these critical measures can provide hard data on the running of the system. Print-outs of alarms or faults can also be provided, enabling any problems that occur during the CIP operation to be identified and recorded.

Suncombe's own systems are 'self-diagnostic'. If a critical parameter is not met, the timer for that step in the cleaning sequence will halt until the parameter returns to the acceptable range. If it fails to do so in an acceptable time, an emergency is raised and the system is put on hold.

At Masterfil, electronic control is again an important option. "We often supply our machines with a programmable PLC," says Stephen Gillinson. "This stores information such as filling speeds, conveyor speeds and other information relevant to the filling cycle, but each profile can also have a specific cleaning cycle installed. And in the pharmaceutical industry we often supply flowmeters with PLC-controlled cleaning cycles to tie in with their CIP programs and systems."

Suncombe's Dave Adams says fully automatic systems, which minimise the involvement of operators by running through an automatic cleaning sequence, are the most popular standalone systems. They usually involve a number of steps, including a pre-rinse, one or more detergent rinses and one or more final rinses.

An operator is only needed when it comes to "establishing the CIP route", he explains. In other words, inserting flowpieces, manoeuvring any mobile vessels or other kit, and starting the automatic cleaning sequence via the controls.

Wheeled into place

Last year's PPMA show saw Suncombe launch its MobileCIP model, which reduces the requirement for routing pipework by enabling a complete CIP system to be wheeled into place next to any piece of packaging or processing equipment. It has built-in heating, variable flows and pressures, detergent/solvent control and the facility to recirculate the CIP fluid.

Another portable and self-contained twist on the conventional CIP system is offered to the food industry by Rutland Handling. Its models 400 and 600 provide continuous washing and drying of food conveyors of 400mm or 600mm width respectively.

With the basic models, potable cold mains water is heated to 60-65deg C before being sprayed on the belt, and the system also allows for a water/sanitiser mix. Built-in air knives are then used to dry both sides of the belt before it leaves the CIP unit. Alternative versions of both the 400 and 600, designated 'MS', are aimed at

Cleaning conveyors: *Rutland system continuously washes and dries food preparation conveyors*

users who already have a ring main for piping predosed sanitised water around the plant.

Working happily with cold water at normal mains pressure, these units are 556mm or 756mm wide, depending on the belt width, and both are 1500mm long. This is "the only fully portable and totally sealed continuous cleaning unit on the market", according to Rutland, and can keep belts clean during operation without either emitting steam or raising the ambient temperature.

Validation is vital

But while new CIP technologies are emerging, there is agreement that the issue of validation is vital. And it is probably here that more money needs to be spent – both in understanding what is happening inside process equipment, and in improving the monitoring and control software to feed that information back to the user.

Two years ago Campden & Chorleywood Food RA carried out a feasibility study to see whether computational fluid dynamics, or computer modelling, could be used to assess the effectiveness of CIP. "The answer seemed to be that it could," says John Holer, "but it needed investment in the software to get closer to understanding what was happening at the boundary wall, which is where CIP happens."

So it's less about understanding what happens to the fluid in a full bore pipe, more about what is happening on the surface of the pipe and at twists, turns, valves and so on.

Neil Moralee believes there is little wrong with process machinery now, or with the various probes and other devices used to measure flow rates, temperatures and CIP detergent concentrations. What problems exist are in the software employed to understand this data.

"A decent PLC is probably only £200 or so, and the rest of it is standard equipment," he says. "It's the way the software is written."

Monitoring needs to be constant. Otherwise, he points out, "the data gathered is just a snapshot, not a constant record. But anyone in a hygiene-critical industry such as chilled foods knows that even a temporary change in temperature can be enough to cause major problems."

So the challenge for equipment suppliers now may not be in re-engineering pipes, pumps, nozzles and valves, but in re-engineering the software that controls them and the passage of fluids, so that processes are not just clean, but also seen to be clean. ■

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