Mixing it with the best

Dean Palmer reports on a breakthrough in chemical dispensing, which assures the correct mix ratio before the point of application is reached

POINTERS

- Failsafe's new meter-mix-dispense technology is designed for two-part chemicals, including adhesives, and ensures only the correct mix ratio reaches the point of application
- The system has a very high accuracy level, down to two decimal places for mix ratios, and is self-diagnostic
- 3M has shown a keen interest in the technology and Ford has asked its systems integrators to use the technology on its Aston Martin range

A British company has, once again, solved a design problem which could have far-reaching benefits to many sectors of the manufacturing industry. Failsafe Metering based in Kettering has developed unique and patented metering-mixing-dispensing technology for single and two-part reactive chemicals, including adhesives, that virtually guarantees the correct mix and ratio before reaching the point of application or end product.

Failsafe's 'Pulsmeter' is an entirely new principle of liquid metering based on the fundamental property of liquid under pressure. That is, as liquid is subjected to high pressure, it becomes hydraulic, producing its maximum density per unit volume. In this hydraulic state, the new technology then uniformly divides the liquid into precise, volumetric units which can then be electronically checked for existence and accuracy.

Pulsmeter starts with the simultaneous metering of a small 'dot' of both liquid parts. In the case of a two-part adhesive, this would consist of the resin and the hardener, typically metered in ratios from 1:1 up to 10:1. Each 'dot' is automatically qualified in terms of its minimum volumetric size (squeezed at high pressure to minimum density or maximum weight per minimum volume) prior to being fired rapidly forward to, and combined within, a dispensing head from which the output forms a 'shot' or flow.

Each 'dot' is qualified and, if correct, generates an electronic signal to a PLC. The result is a digital method of metering liquids. The metering is highly accurate and failsafe – the output is either correct or the system shuts down immediately, without any incorrect 'mix' reaching the point of application.

Failsafe's technical director Phil Thompson was responsible for the design of the system. He demonstrated to *Eureka* the principles of one of the firm's adhesive dispensing working units.

A unique design

There are two transfer pumps, one for the resin and one for the hardener, which take the raw material from the storage containers, through hoses, to two ports on the metering unit. The two ports line up with two inlet ports on the inlet valve manifold. Two chambers are loaded up with resin and hardener and when the slots in these chambers are presented to (in line with) these ports, liquid transfers onto the next valve metering block.

A metering shuttle device then waits for the liquid pressure to be presented to its face, then pushes across and hits an adjustable contact stop. Thompson suggested that this stop is better than using a sensor as there can be no overrun with a dead stop.

Simultaneously, the other port opens and displaces an exact volume ahead of it. The two products are pushed across, one on each side of the machine. Every time the shuttle is pushed across, it displaces a pre-determined volume of liquid into the dispense manifold. Then the inlet valve rotates through 180°, presenting the liquid pressure to the opposite end of the metering block. This displaces the pre-determined volume of liquid into the manifold.

Each time the shuttle makes contact with the stop, a sensor probe sends an electronic signal to a PLC (supplied by Schneider Electric). A signal from each side of the machine must reach the PLC in the correct sequence, otherwise the system recognises that an error has occurred and shuts down. Thompson said these signals are occurring several times a second.

"The bores on the metering and inlet blocks have no seals around the piston. So the surfaces have to be machined to very high accuracies, down to 5 microns to ensure no liquid passes through."

An electric motor (supplied by Lenze) drives a gearbox and pulley arrangement which in turn drives the two shafts that drive the metering units. The system demonstrated to *Eureka* was one of two robot cells on permananent display at Failsafe's site in Kettering (supplied by Kawasaki and Toshiba) which were integrated with Pulsmeter.

A local panel building firm, Stratos Control Systems, helped Failsafe develop the electronics on the system. "The PLC, inverter and human machine interface display were supplied by Schneider," said Thompson.

Failsafe's self-diagnostic system uses pressure transducers to continually monitor and check for degrees of component wear providing a countdown to scheduled service. The system is automatic and does not require an operator.

There are operator instructions on the HMI and a visual display that warns the operator when to service the machine. There is also no need to disconnect hoses for samples and the machine was designed by Thompson to have a 'quick knock-down' time of between 15 and 30 minutes. He explained: "The standby test at the end of a production run means that the machine is checked before the start of the next run. During the production run, the system is continually checked for accuracy."

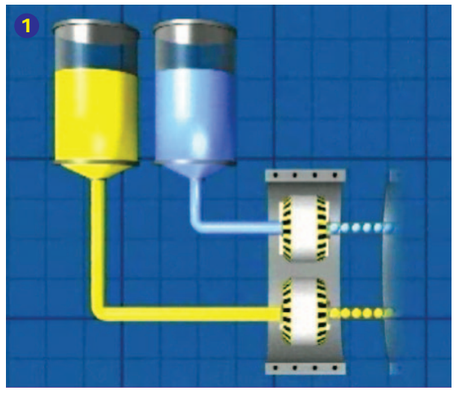
The accuracy of the system is very high, down to two decimal places. The software is set up to automatically record historical production data, a running log, total number of shots, service history on the machine, component wear and so on. The software also supports the InterBus network. and Thompson said his firm plans to develop modem links to enable firms to perform diagnostics on the machine from a remote location across a network.

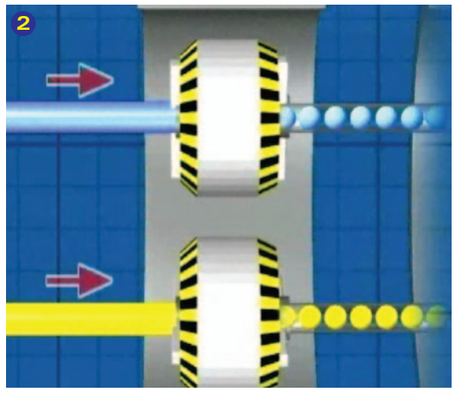
It's a significant breakthrough, particularly when you consider the high levels of batch traceability required by many production environments today. Automotive and aerospace are two sectors whose design engineers are constantly looking for ways of improving their designs without sacrificing traceability. This might include replacing traditional fasteners with new, high strength adhesives. These OEMs need to be able to trace any failures in their end product all the way back to the supplier and its production process. So, as a supplier, possessing adhesive dispensing technology that virtually guarantees no incorrect mix or ratio finds it way into the OEM's end product, is likely to give that company a clear competitive edge over other suppliers.

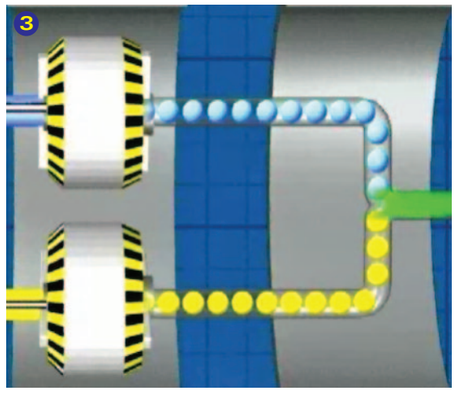
> "I was toying around with a revolver one day when it occurred to me that maybe I could machine gun dots or shots of adhesive and check each one for existence and accuracy and then use that principle to meter liquids in a way that was completely failsafe"
>
> **Laurie Penn, MD Failsafe Metering**

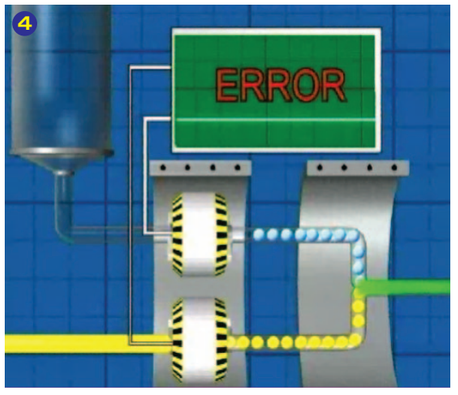
And that is why Failsafe has had incredible interest already from material resin manufacturers. 3M were first to take an interest. Bernard Sikkel, senior specialist automotive Europe, offered to test Failsafe's technology. 3M's lab technicians quickly concluded that they were happy to introduce Pulsmeter to Ford and other major automotive customers.

Ford then got wind of the new technology and sent one of its Jaguar senior production engineers to Failsafe's site. "Ford loved the technology, especially









Failsafe's technical director, Phil Thompson (above) and the Pulsmeter mixing, metering and dispensing process (left)

the fact that the system didn't allow incorrect mixes to reach the point of application, but it wanted us to develop the concept further so that operators didn't have to stop the production line every time an incorrect mix or error was detected. Ford wanted an early warning system to allow scheduled maintenance and so 3M's Sikkel suggested that a method of batch sampling and storage would be useful, which led to the development of the 'Q-pac'," said Thompson.

Q-pac enables the operator to collect QA samples from Pulsmeter and keep a record of raw material resin for batch traceability. The operator uses a valve on the dispensing head, sets the machine to a pre-sequence which then diverts a pre-determined volume of liquid through a twin cartridge fitted just upstream of the nozzle. This cartridge can then be removed and checked. The sample represents the normal flow of liquid during the production process.

Aston Martin's (owned by Ford) technical adhesives specialist, Dr John Hill, then heard about the technology and, according to Thompson, was so impressed with Failsafe that he asked his systems integrator Automation & Machine Tools of Coventry, to produce a new robot cell at the UK-based Aston Martin production plant for its adhesive application process. Another supplier, Design Services Engineering of Nuneaton, subsequently ordered machines from Failsafe for Aston Martin's body panel maker, Mayflower of Coventry.

A 'Eureka' moment

The idea for Pulsmeter came from Failsafe's MD, Laurie Penn. "The metering, mixing and dispensing industry has never got it quite right. I wanted to develop a better method based upon typical dispensing problems that manufacturers were having. One day, I was toying around with a revolver when it occurred to me that maybe I could machine gun dots and shots of liquid and check each one for existence and accuracy and then use this principle to meter liquids in a way that was failsafe."

Penn's aim was to develop technology that solved the typical problems firms face when dispensing two-part chemical liquids – especially those that require batch traceability. Adhesives, polyurethanes, silicones, acrylics, polyesters and polysulphides are all relevant. In fact, any firm that uses a liquid whose function is to bond, seal, encapsulate, coat, thermally insulate, dome, mould, prototype or impregnate a component, should be interested in the new technology.

Penn has been at the forefront of two-part application since 1965 – a time when manufacturers weighed out each chemical constituent by hand. Since then, he has designed a series of groundbreaking systems.

In 1971, he invented and patented the relatively simple, yet versatile 'Posiload' metering pump for use within his newly-developed 'Twinflow' metering, mixing and dispensing machines. In 1975, he pioneered the high pressure metering, static mixing and injection of high ratio polyester for Resin Transfer Moulding for production of the Matra car. And, from 1978 to 1984, he developed the first, patented, two-part 'Supermix' coaxial cartridge technology.

He then founded Failsafe Metering in 1999, and in 2000, the company became ISO registered and won a DTI Smart Award for funding innovation.

Thompson added: "Most manufacturers are faced with constant uncertainty over the reliability and integrity of their dispensing systems. Whether a product is bonded with an adhesive manually, or whether it is bonded automatically by a machine, the reality is that these processes are not fully failsafe."

He went on to say that, in his experience, some two-component users check their meter-mix-dispense machine ratio only once a day. Other users check the dispensed volume of a mixed shot or bead per product once a day and many single and two-part resin robotic applications are unsupervised. "Independent of supervision, on average, a Failsafe meter-mix-dispense machine automatically checks, assures and records each part of the mixed ratio as correct at a rate of 100 times per minute."

Many quality control departments cannot guarantee that the samples taken from dispensing machines truly represent the quality of the rest of the production batch. The process, he said, is sometimes a case of 'trial and error', can be subject to drift, and can result in, at best, scrapped product, or at worst to disasters in the field.

The cost of Failsafe's system, including transfer pumps, PLC, inverter drive, gearbox and motor, HMI and software is between £10k and £50k. A scaled down version, with simplified HMI and software, is currently under development.

Potential applications are vast. Thompson mentioned electronics potting, wind generation turbine blades, lubrication and injection of grease into engine bearings, boat building, extrusion of windows, agricultural vehicles and textile bonding.

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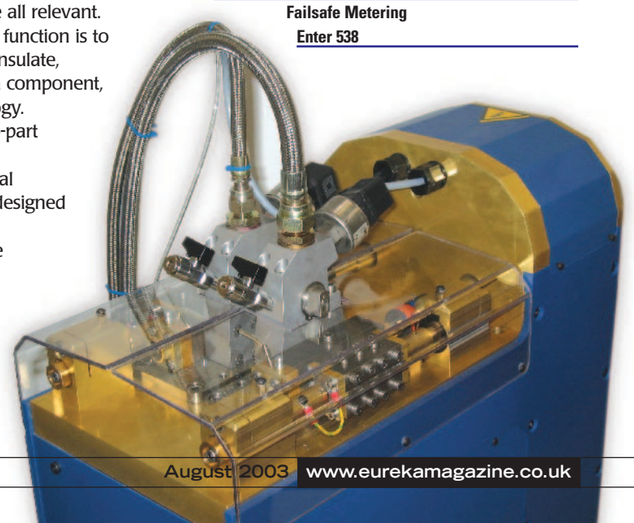

The Pulsmeter system (opposite) at Failsafe's site in Kettering