Variable speed via electronics: Developing the drive

A GENERATION OF ENGINEERS HAS GROWN UP TAKING ELECTRONIC VARIABLE SPEED DRIVES FOR GRANTED. THEY ROUTINELY FIT AND FORGET THEM TO MACHINES, INTEGRATE THEM INTO PLANT-WIDE PROCESS CONTROL SYSTEMS AND RETROFIT THEM TO FIXED SPEED EQUIPMENT. NEVERTHELESS, THE TECHNOLOGY AND THE MARKET ARE STILL DEVELOPING, WRITES BOB DOBSON.

There were at least half a dozen new inverter drives launched in the UK last year by major players in the automation field. This is some going for a technology that was well developed 20 years ago and which you might expect to have plateaued or even be in decline by now.

While drives have not had a history of absolutely constant growth, they have not been that far off. The reason for this success is quite simple: there are a lot of motors in use around the world and if even only a small percentage of them are fitted with variable speed drives, that represents a significant demand.

In fact about 10-15 per cent of motors are currently used in conjunction with a drive. It would be inappropriate to consider a drive for probably half of all installed motors, but this still leaves room for plenty more potential growth.

The machine building and manufacturing industries were the first to take up the variable speed drive in significant numbers. Initially they tended to be used for simple tasks such as gently ramping centrifuges up to full speed. The next step was to use them for specific tasks, say to run a mixer at slow speed during unloading. From here more intricate 'speed profiles' were developed, with machines running at different speeds at various points of their operating cycle.

The next and probably most critical step was to use drives to synchronise two or more axes within a machine, for example to give X-Y positioning for automatically placing finished products onto trays.

This stage really took off as a result of the 'digital revolution' when almost all electronic equipment, industrial and otherwise, switched from analogue to digital format. Analogue drives had been notoriously difficult to maintain in synchronism with one another, while the new digital units could do it perfectly.

Digital characteristics

Today's sophisticated use of drives is nearly all based on their digital characteristics of being highly controllable, able to react to incoming signals and able to generate their own output signals to keep the central controller informed of status.

The capabilities of the technology have been steadily increasing, as has the range of sizes available. The manufacturers referred to various internal control strategies (V/F, PWM, open loop vector, flux vector and servo); to the users these were breakpoints on the price/performance curve. Long before the start of the new century drives were an established part of the engineer's canon.

Variety: *Drives come in many different sizes and various control strategies*

However, one or two sectors initially stood firm and refused to see the benefits of variable speed drives. The most surprising one of these perhaps was building services, an area where large numbers of pumps and fans are installed and where significant energy savings could be made in running costs. The reason for this, in the UK at least, is that developers do not usually occupy their own buildings.

The tenancy agreements between owner and occupant are almost invariably concerned solely with lettable space and make no reference to running costs, so there is no commercial reason to go to the expense of fitting extra equipment such as drives. That said, things are changing: organisations, particularly in the public sector, are increasingly being audited for energy efficiency and environmental impact, so drives are slowly gaining a toehold in building services.

Energy efficiency is currently one of the great driving forces in industry, and is likely to remain so for many years. Previously it was common to leave motors running constantly and bypass them when they were not needed – which was often the majority of the time. Now the favoured approach is to fit a drive so that motors can be reduced in speed, set to idle or stopped altogether on demand. The potential energy saving is enormous: 70 per cent of all

the electrical power generated in the UK is used to run motors, and savings soon add up.

However there is a drawback to the increasing use of drives: increasing occurrence of interference or 'noise' in the mains. Drives, like many other pieces of equipment, invert or chop the mains' AC waveform, which can create noise. In multi-drive installations this can build up to be a significant issue that has to be dealt with by the use of filters.

Most drive manufacturers have a range of optional on-board filters for their drives, although another solution is to use a single central filter to deal with all the interference generated by a machine, line or plant.

Which option you choose is based on the circumstances of the individual application, but OEMs in particular need to be aware that the legislation in this field varies significantly from country to country: in Europe for instance the legal principle is that operators should not allow their equipment to corrupt the mains, whereas the American approach is that people should protect themselves from whatever noise is present.

Communications

It has long been a given that drives can maintain accurate speed profiles for the motors or axes they control. With that said, the key to their wide take-up is their ability to communicate – to send and receive control signals. This allows drives to react to changing circumstances and needs.

For instance, flow demands placed on pumps and fans in cooling systems will vary with the ambient temperature; materials such as batter change viscosity markedly with mixing, a mixer that can sense this and change speed accordingly will optimise the process; assembly machines typically have many axes that work in a stop-go mode in sequence with one another, so the drives need to talk amongst themselves; conveyors need more power to maintain speed as they become more heavily loaded.

Communications therefore is one of the key abilities of a drive. Most drives are fitted with RS232 and RS485 ports as standard features and there is now an increasing demand for fieldbus connectivity as well. With so many different fieldbus protocols in use, most drive manufacturers have gone down the route of providing plug-in control cards or modules, to tune drives for the protocol required for the application.

Ten years ago as the fieldbus wars raged, most equipment manufacturers backed a single protocol and hoped it would eventually win out over the others. Drive manufacturers tended to favour CANbus, as it had dynamic and deterministic abilities well matched to their perceived application needs. But as the OEMs and end-users came to accept fieldbuses, it became apparent that no single protocol would win out. Instead each would be used where it had advantages and often larger installations would include several different protocols controlling different sections.

PLC functionality

A drive is effectively a dumb beast; it needs to be told when to speed up, slow down, switch on or switch off. To do this there must be some form of 'intelligence provider' working in conjunction with the drive. Typically this is done with an associated PLC (programmable logic controller), which can 'read' incoming signals and make decisions on how to adjust the drive.

Some manufacturers build PLC functionality into their drives to make them intelligent. This can be a useful feature, but it does have its limitations in terms of cost, size and programming.

To resolve these a common solution is to build 'dumb' drives then insert a 'personality module' which configures the unit for use with say a pump, conveyor or lift. But the capability of the personality module is limited, so you often end up needing a PLC anyway.

Setting up any drive can also be an involved business. About ten years ago autotuning was developed to reduce the time required getting drive and motor in harmony, but still today a number of parameters relating to the actual application need to be set.

Set-up parameters divided

More recently drives manufacturers have started dividing the set-up parameters into two groups: the front group is the half-dozen or so basic parameters that have to be set while a second group is used for fine tuning to particular applications.

Parameters within the second group can often be left alone because they are irrelevant to the application, and by presenting them separately users are less likely to be confused into thinking they are critical.

One commercial trend that is currently quite prevalent is combining the sales effort for drives with motors. The argument in favour of this is that the drive and motor will be perfectly matched, so efficiency and reliability will be high and the motor will not run hot.

Small drive: *Sub-kilowatt drives are getting popular for small machines and light duty axes on larger ones*

However, common sense tells us that just because a drive and a motor carry the same supplier's logo does not mean they will automatically be well matched, especially in these days of conglomerate groups, company acquisitions and rapidly developing technology. To be on sure ground the buyer needs to do as much research as if procuring drive and motor from different sources!

An interesting variation is the combined motor-drive or variable speed motor. A number of these were developed and launched about seven years ago, the thought then being that they would eventually account for about 10 per cent of all drive sales. Instead they seem to have developed as a niche product. For instance, they are popular in remote pumping stations but have not yet made many inroads with machine builders.

Drives are still developing and are still finding new uses. Machine builders therefore need to keep up with the subject if they are to select the best drive for each application.

And if you think that you understand the various control strategies (V/F, PWM, open loop, vector), be warned: the manufacturers are now getting ready to introduce 'matrix' drives and redefine existing perceptions. ■

Servo drives improve bottle handling on shrinkwrapper

Faster and more flexible: *Europack collator and shrink-wrapper equipped with servo drive*

Europack has introduced a new collator and shrink-wrapper for glass bottles, making extensive use of servo drives from Lenze to increase output and achieve frequent changes of product and pack size.

One of the design objectives was to reduce the amount of handling previously carried out by pneumatics, with the servo drives able to achieve improved bottle-handling characteristics in terms of acceleration and deceleration.

Also the machine build and commissioning have become simpler, as Europack technical director, David Burlingham explains: "The machine was running up to design speed within eight hours of installing the operating program. With pneumatics it would have taken us two weeks."

The new Europack machine was produced initially to allow a glass bottle manufacturer to wrap bottles unsupported in a variety of collation sizes – from 20 to 250 bottles depending on size – for transport to users, typically breweries. The machine also had to have the flexibility to handle round, oval, square or even triangular shaped bottles and produce a completely enclosed pack, to avoid risk of contamination and particularly to allow safe manual handling.

The use of Lenze servo-driven geared motors for seven axes of movement has achieved the target of fast and easy pack changes with the re-datum operation taking only a few seconds. The Lenze positioner servo drives handle individual motion profiles tailored for each bottle with the result that handling is smoother and maximum machine output increased up to about 300 bottles a minute.

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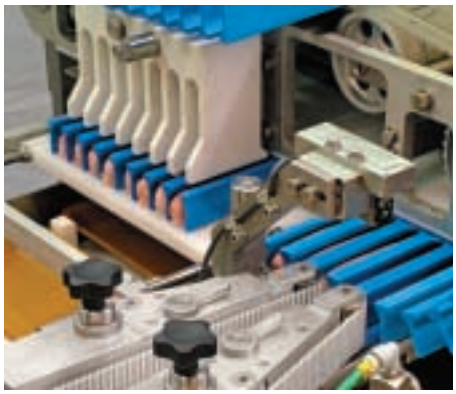
Collator handles 600 sausages a minute

Gainsborough Craftsmen has chosen Sigma servo drives from Omron Electronics for its latest range of high-speed sausage-collating machines.

Able to collate up to 600 sausages a minute in formats to suit a variety of packaging formats, including flow-wrap, tray and bunch packaging, the machines work by feeding individually cut sausages into pockets created by sets of fingers on a vertical racetrack collator.

The infeed transport operates continuously, and a servo mechanism is used to position the sets of fingers so that the sausages can be accurately received. To maximise throughput in a compact machine, two sets of fingers are used, which alternately occupy the same working space. Each set of fingers has its own servo drive system.

To avoid collisions between the sets of fingers, and eliminate risk of damaging the sausages as they enter, precise operation of the servo systems is essential, as is sustained high-speed operation to accommodate the machine's considerable throughput.



Collating machine: *Individual sausages are accepted into pockets created by sets of fingers*

"Prior to using Sigma-series servo drives from Omron, we used equipment from another automation supplier," says Mark Leeson, technical director of Gainsborough Craftsmen. "Quite frankly, we struggled constantly to get the performance we needed. Since switching to Omron drives, however, these problems are completely solved."

He continues: "Not only were we provided with virtually immediate delivery of all the equipment we needed for the two machines we were then building, Omron's engineers also converted the machine design for us, working to a tight timescale."

The latest versions of Gainsborough Craftsmen's sausage collators use products from Omron for all major control functions. While the specification varies according to the end user's requirements, a typical machine incorporates five Sigma-series servo drives with MC402E motion controllers for the collator mechanism itself, along with two Omron inverter drives for the two infeed conveyors.

Overall control is provided by an Omron CS1 programmable controller, with intuitive operator interface functions via an Omron NS-series HMI terminal, which incorporates a large, high-resolution colour touch-screen.

To date, Gainsborough Craftsmen has supplied over 20 sausage-collating machines fitted with Omron equipment. High levels of reliability have also been achieved, says the company, in spite of arduous operating conditions in which machinery is subject to regular washdown with powerful detergents.

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