A new regular column on safety matters by PPMA technical consultant Martin Keay starts this month

Safety with sync on servo drives

The use of several drives, synchronised via software, in place of a single drive and a complex mechanical power transmission system, has provided many benefits to machine users and has also made machines easier and quicker to build. So with such a win-win combination it is not surprising that servo technology is steadily becoming the rule rather than the exception on new machinery.

However, alongside these benefits have come some safety concerns, prompted by anecdotes and rumours of mechanisms moving under power in ways not envisaged by the programmer and in some cases when the machine guards were open. How can this happen?

Let's compare two machines with an identical function. In one, the three mechanical assemblies that make up the machine are all driven through mechanical power transmission components by one drive (the conventional machine). In the other machine the three mechanisms each have separate drives which are controlled by software, (the servo machine).

Software controlled drive systems, particularly servo drives, are becoming the norm. But emergency stops can raise safety issues for both operators and machine components.

Power disconnected

Typically, when a guard door is opened or an emergency stop button is pressed, electrical power is immediately disconnected from the drives on a machine (which is termed a category 0 stop in EN 418). If this is done on our conventional machine, it will stop with all three mechanisms in synchronisation. However, if power is removed from our servo machine, synchronisation between the three mechanisms will be lost.

On some servo machines loss of synchronisation during an emergency stop is not a problem, and so traditional electro-mechanical methods of preventing the machine starting up when the guards are open can be used. However, in other servo machines, loss of synchronisation during an emergency stop may cause collisions between the mechanisms or clashes with the product, so adding to the hazards, which is clearly something that needs to be avoided.

One method of preventing loss of synchronisation in an emergency stop is to ensure that all emergency stops are controlled stops. In other words, if a guard door is opened, or an emergency stop is pressed, the machine slows rapidly, but in a controlled fashion, and only when the machine has come to a stop is power removed from the drives (which is termed a category 1 stop in EN 418).

For example, Omron achieves this on its motor controllers with separate 'logic' and 'power stage' power supplies. One output channel of the emergency stop relay is connected to the motion controller. When the emergency stop is actuated, the Omron controller can bring all axes to a halt and remove the enable signal to the drives using software.

Logic power supply

The Omron controllers then remove power to the power stage of the drive on a short, typically 100ms time off delay on one channel of the emergency stop relay connected to the servo power stage contactor. When the doors are closed and the emergency stop relay is reset, the Omron controller can resume from where it stopped. The logic power supply is under power at all times.

Omron favours this approach because it combines the speed and convenience of the software shutdown and recovery, with the certainty of the power being removed.

However, the snag with a controlled stop is that the machine could run for a short time after a guard door was opened. This snag can be easily overcome by fitting locks to the machine's guard doors which prevent access to the machine until it has come to a complete halt and power to the drives has been disconnected.

For example, guard locking is incorporated as a standard safety feature in Cermex's new TS range of servo drive operated shrinkwrappers. Keeping the guards locked until the machine has stopped not only prevents operators coming into contact with moving parts, but also prevents the guards being used to stop the machine.

Mechanical failures

Opening a guard to stop a machine was once common practice and on a conventional machine has little influence on its safety. However, on machines fitted with digital drive controllers, anecdotal evidence suggests that repeated rapid decelerations can lead to mechanical failures, which may result in additional hazards.

Cermex is not alone in fitting guard locking to servo driven machines and it is likely that this will become common practice in the future.

So, now we have got our servo machine to stop in synchronisation, what next? On our conventional machine, intervention by an operator when the machine is stopped is most unlikely to disturb the synchronisation between the three mechanisms. However on our servo machine the removal of damaged packs or debris will almost certainly alter their alignment.

On some servo machines where there are no risks of mechanisms colliding this is not a problem. Once the machine guards are shut, the resolvers in the drives alert the controller that the synchronisation has been disturbed. The drives are repositioned and production resumes.

However, what happens on a machine where the smallest misalignment causes a problem? In this situation the drives must be held in alignment while the machine is stopped, to prevent any movement during an operator intervention. There are two ways to achieve this.

The first is to fit brakes to each of the drives. The machine is brought to a controlled stop, the brakes are applied and then power is removed from the drives. The brakes hold the mechanisms in exact alignment while packs are removed and are then released, once the guard doors have been closed and power reconnected to the drives.

The second method of holding servo drives in position is more controversial from a safety point of view, because in this technique the drive is held under power, a method called servo hold or controlled hold. Power is maintained to the drive during a stoppage, but motion is prevented by software. The great advantage of this technique is that the recovery rate after a stop is very fast, because synchronisation is maintained throughout the stoppage.

Some experienced servo driven machine manufacturers feel that servo hold is essential for efficient operation of their machines and argue that if the software controlling the drive is written correctly, safety circuits are duplicated and safety critical components are monitored, this is a perfectly safe method of controlling drives.

However, other manufacturers of both machines and drives argue that servo hold is unnecessary and depends too heavily on the integrity of software and electronic components for safety to be assured. Also, it is difficult to get away from the fact that operators are being asked to work around drives that although stationary are nevertheless connected to a power supply.

But this brings us to another issue. Not all servo drives have separate power supplies for power and logic and so, to retain control information during a machine stop, the power must remain connected to the power supply. In this case power is disconnected from the motors electronically, but not physically using a contactor. This raises the question: Can the electronics be relied upon?

Electrical specialists at the HSE take the view that this is an acceptable method of power disconnection during an operator intervention, provided the control system incorporates a separate motion monitoring function which can disconnect power to the drive if any of the mechanisms are observed to move while the guards are open.

So with all this debate on what is and what is not an acceptable way of disconnecting power to a servo drive, how do you decide what is a satisfactory solution?

In the absence of written guidance or a European standard, many companies are taking the view that there is only one safe bet: systems that provide a physical galvanic disconnection of power to the servo motor, using an electromechanical contactor.

Clauses covering these issues are currently being drafted for the latest group of European standards for packaging machines. The first of these standards, prEN 415-7 *Safety of packaging machines – group and secondary packaging machines*, will be circulated for public comment later this year. Clause 5.1.6 of this standard proposes specific requirements for machines fitted with servo drives and other software controlled drive systems.

140pc increase in accidents with depositors

Recent statistics from the Health and Safety Executive show an alarming increase in the number of accidents taking place with depositors used in the food industry. In the four years 1992-95 there were 18 reported accidents on depositors, but in the years 1997 to 2000 there were 43 reported accidents.

The most frequent cause over both periods has been trapping in the discharge valve during cleaning, or when trying to remove blockages during production. So it seems likely that the main reason for the increase in accidents is an increased use of depositors throughout the food industry, but in particular for ready meals.

The HSE is urging both manufacturers and users of depositors to review cleaning and operator intervention procedures with a view to reducing accidents.

Free guide on ATEX Directive

Specialist vacuum pump manufacturer BOC Edwards has produced an informative technical bulletin to help chemical process operators implement the new Equipment for Use in Potentially Explosive Atmospheres Directive 9419/EC, the so-called ATEX Directive which becomes mandatory from July 2003. A technical paper giving an insight into BOC Edwards' approach to the directive is also available.

The ATEX Directive is the first safety regulation to recognise that mechanical ignition sources are as important as electrical ones, and is a major step forward in eliminating explosion risks in processing equipment.

The BOC Edwards guide includes an 'ATEX Roadmap' to help process operators determine zoning environments, along with key aspects of the directive.

Dry vacuum pumps are a complex mechanical product when considered in the context of explosion safety, but research and development carried out by BOC Edwards in conjunction with notified test houses has ensured that their Drystar range of industrial vacuum pumps meets the new standards.

For a free copy of the ATEX bulletin and technical paper, contact BOC Edwards Customer Care on 08459 212223.

Interlocked guards for belt conveyors

The HSE has published a new free guidance document *Safeguarding flat belt conveyors in the food and drink industries* (Food information sheet 25).

Analysis of accidents in the food and drink industries over a ten-year period has shown that conveyors cause 30 per cent of machinery injuries investigated by HSE, more than any other class of equipment. Around 50 serious injuries are investigated each year.

Traditionally, fixed guards have been provided on conveyors to safeguard dangerous parts, but these can cause cleaning difficulties and sometimes are not replaced properly. As an alternative to fixed guards, the guidance advocates a new approach for conveyors: interlocked guards which can easily be removed to allow cleaning, but which prevent the conveyor running until replaced.

The new guidance has been agreed with the industry through a liaison committee consisting of both food equipment supplier and user trade associations.

Food information sheet 25 is available from HSE Books, PO Box 1999, Sudbury, Suffolk C010 2WA, tel: 01787 881165.

Website: www.hsebooks.co.uk ■