Hygiene with fluid power

Lubrication and the risk of direct or indirect contamination from compressed air are among issues that affect hygienic design of fluid power systems on packaging and processing machinery. By Martin Keay.

Hygienic design: *Regulations demand attention to components, even if not in contact with food*

Hygiene in manufacturing processes has always been an important issue in the food, pharmaceutical and toiletries industries, but it is only in recent years that machine manufacturers have been required by law to ensure that machines are hygienically designed. This new requirement poses some interesting problems for machine makers and also for the manufacturers of fluid power components.

The legal requirement to design equipment to be hygienic appears in essential requirement 2.1 of the Machinery Directive (98/37/EC) which has been made into UK law as the Supply of Machinery (Safety) Regulations 1992. The text of this requirement suggests that it only applies to "agri-foodstuffs", a piece of Euro-English, which means food or animal food.

However, the EU Commission has made it clear in its commentary on the Machinery Directive and in the proposed third amendment to the Machinery Directive, that "agri-foodstuffs" includes all products ingested by people and animals, that is cosmetics, toiletries, proprietary medicines and pharmaceuticals, as well as food and animal food.

The overall objective set out for the machine manufacturer to achieve is that machinery "must be so designed and constructed as to avoid any risk of infection, sickness or contagion", but the regulations then go on to identify key hygienic design issues.

The first of these issues is that surfaces which are likely to come into contact with the food or product must be made from suitable materials and be smooth so that they do not harbour micro-organisms and can be cleaned easily. On the face of it this would not appear to be a problem for fluid power components.

Few if any machines are designed with pneumatic or hydraulic cylinders in places where they will come into direct regular contact with the product. However, if food splashes up on to a pneumatic cylinder or piping, festers a while and then falls back into the food, the food will be contaminated. Consequently European standards define all these parts of a machine as being "food areas" which must be made from food quality materials.

Food product quality ultimately depends on all the materials deployed within the production process, and laws in many countries regulate the composition of materials that can be used for the construction of food processing systems and equipment. They must be mechanically stable, have a smooth surface and resistant to breakage, fractures, splintering, abrasion and corrosion.

Zinc, lead, cadmium, antimony, plastics (that contain phenol, formaldehyde or plasticisers), wood, copper, brass and bronze may not be

used in food production. Typically, types of stainless steel, such as ASIS-304, AISI-316 and AISI-316L are sufficiently corrosion resistant and are frequently used for this reason. Alternatively, plastics that offer significant weight or cost advantages can be used, so long as they are sufficiently resistant to chemical influences.

The materials most often used for pneumatic components in food areas are austenitic stainless steel, aluminium and plastics. The optimum choice comes down to a great extent upon the corrosive characteristics of the product, the operating temperature and the cleaning agents to be employed.

Design considerations

All of the aspects of the hygienic design of machines are discussed in BS EN 167-2 *Food processing machinery – basic concepts – hygienic design* and its international equivalent BS ISO 14159. Both of these standards have been substantially influenced by the hygienic design department at the Campden and Chorleywood Food Research Association and describe the essential engineering elements that should be deployed in systems design.

High quality surface characteristics for components that come into contact with food products are absolutely essential to prevent microbic contamination. This is assured by adopting the use of a mean peak-to-valley height of 0.8 microns or less for surface finishes in accordance with ISO 468 in the food area.

But what about other areas of the machine? In addition to the food area on a machine BS EN 1672-2 and other food processing machine standards define two other areas, the "splash area" and the "non-food" area.

The "splash area" is any part of the machine which can be splashed with foodstuffs but is in such a position that the foodstuff cannot be reintroduced to the food flow from this area. This inevitably includes many more fluid power components.

Surprisingly components in the splash area must be planned and designed using the same criteria as the food area, even though foodstuffs cannot be returned to the food flow. This is because contamination in the splash areas can quite easily be passed to the food areas during cleaning.

Components with a peak-to-valley height of 3.2 microns or less are often used in the splash area. Beyond this, components with smooth surfaces deliver improved corrosion resistance. In contrast, rough surfaces, fractures and cracks must be avoided.

Fasteners such as screws, bolts and rivets are cause for hygienic concern. Where they are unavoidable in the food or splash areas for technical reasons, they must be easy to clean and disinfect. Open threads are extremely difficult to clean and promote infection. Minute gaps that cannot be cleaned occur between engaged, internal and external metal threads. So, if threads cannot be avoided, they should be sealed with suitable acorn nuts and seals.

Very small radii and corners in food and splash areas also present a basic hygiene risk. As the flow rates of cleaning and disinfecting agents are greatly reduced by such features, the desired cleanliness cannot be guaranteed. So the minimum radius required is 3mm.

But what about non food areas, like enclosures for solenoid valves or trunking containing pneumatic pipes? The assumption with non food areas is that food cannot enter them, although experience suggests that food and liquids can find their way into the most unlikely places and, if allowed to accumulate, can become a source of contamination. The requirements for non-food areas therefore are that there should be no enclosed spaces that cannot be cleaned and inspected for cleanliness and that it should be possible to drain any liquids that may accumulate in non-food areas.

Lubricants and hygiene

Another important aspect of hygienic design is to avoid contaminating food with lubricants. The best way of achieving this is to ensure that gearboxes, bearings and shafts are in non food areas, but sometimes this is simply not practicable and so food grade lubricants must be used.

The world's strictest regulations concerning the use of lubricants and additives in food processing come from the USA. Lubricating oils and greases must comply with FDA regulations, section 178.3570 of which defines the substances that are permitted to be present in lubrication greases and oils that come into contact with foodstuffs or their constituents. As such, the approvals issued by the US Department of Agriculture (USDA) are recognised as standards the world over.

Contamination from compressed air

It is often assumed that compressed air is sterile and completely hygienic. However, special care is required when working with compressed air, especially when it comes into either direct or indirect contact with foodstuffs, because it is not inherently clean. On the contrary, particles are present almost everywhere in the form of dust. Water is also present in air, occurring naturally as atmospheric humidity, and which is released in large volumes when compressed air cools down.

In some packaging machines compressed air is discharged directly on to packaging materials or containers that will later come in to contact with the food product and so indirectly contaminate the product.

In other machines, compressed air is used directly to assist the flow of food products, for mixing ingredients, or at the filling machine. If the air is not clean and sterile in this situation the food will be contaminated.

Vented to atmosphere

However, the most common form of indirect contamination in food factories occurs when lubricated compressed air is vented into the atmosphere, carrying with it microscopic particles of moisture and lubricating oil. These particles will move around in the air in the factory and will inevitably find their way on to any uncovered food.

Oddly enough, there is no specific compressed air quality standard for the food processing industry! However advice from pneumatic components specialist Festo, for example, advocates the use of a fine filter (1 micron) upstream from a micro-filter (0.01 micron), followed by an active carbon filter.

Festo claims that a micro-filter removes 99.999 per cent of all oil present in the air and reduces solids contamination to a particle size of 0.01 microns or less. This achieves Quality Class 1. The downstream carbon filter further reduces oil content to less than 0.003 mg/m^3, and ensures a completely neutral taste.

Depending on the exact application and the sensitivity of the food product being processed, the automation system designer needs to determine whether additional sterile filtration is required. A sterile filter ensures the retention of bacteria, eliminating the impairment of food and results in a reduction in perishability.

In fact, Festo has produced a booklet *Manual for the Food Processing and Packaging Industry – Theory & Practice* to help users understand the hygienic design issues involved with fluid power systems. It can be obtained from Festo direct (tel: 01252 775000) or via *Machinery Update* by entering **402** on the reader service card in this issue. ■