

TECHNICAL REPORTS

Setting up a food-processing unit

Part 3: Materials for construction and equipment

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This is the third and final article on the decisions that face small-scale processors when starting a new business or when expanding to larger premises. The article focuses on the materials that are needed to construct food-processing buildings and equipment.

AS A GENERAL STATEMENT, all equipment and internal surfaces of processing rooms and storerooms should be easily cleaned and maintained. The materials that are used to construct equipment and facilities should not interact with foods in any way, either by causing off-flavours if foods come into contact with them, or being corroded by foods.

Food-processing buildings

Walls and roofs

The construction materials determine the extent to which insects, birds, and rodents can enter a building. External walls should be solidly constructed using good quality bricks, poured concrete or concrete blocks that are rendered. Prefabricated, steel-framed buildings are acceptable if the frame is in-filled with concrete or brick. However, low-density cinder blocks used in some domestic buildings should not be used unless they are adequately sealed against moisture penetration. Corrugated metal roofs or walls are difficult to seal against insects, transmit heat, and are subject to corrosion. Wood should not be used because it is difficult to clean and to seal against pests. All types of construction should avoid horizontal external ledges and window sills to discourage birds from roosting or nesting. Where ledges cannot be avoided, they should be sloped at an angle greater than 45°.

In tropical climates, fibre-cement or fired-earth roof tiles offer some insulation against heat transmission from the sun and in cold climates roof insulation reduces heat loss from processing rooms. Roof spaces should be insulated with materials that are non-toxic, odourless, and unattractive to pests. Fibreglass, rock wool, and asbestos should be avoided because they attract insects and rodents and the fibres may become airborne and cause a contamination and/or health hazard. Acceptable materials include expanded polystyrene or polyurethane panels. The joint between the walls and roof should be fully sealed to prevent birds and insects from entering the room.

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Internal floors, walls, and ceilings

All internal walls, floors, and ceilings should be:

- hard, free of cracks and crevices, and smooth (but for safety, floors should not be so smooth that they could cause staff to slip);
- impervious, non-absorbent, resistant to corrosion and cleaning chemicals; and
- durable, wear resistant, and easily maintained.

In some countries there is a legal requirement for specified internal finishes in food processing rooms and processors should consult local authorities or the appropriate government institutions (e.g. ministry of health or bureau of standards) on the types of materials that should be used.

Fire resistant stainless steel sheeting may be used where cookers, ovens, or fryers are positioned close to walls but metal panels are otherwise not used for walls or ceilings due to condensation problems and expansion and contraction of the metal, which makes maintenance of the seals between panels more difficult. Galvanized metal should be avoided because of problems with zinc flaking off and causing product contamination. Wood, plywood, and engineered wood should be avoided for interior walls, floors, and ceilings because it cannot be adequately cleaned or sealed against insects. In countries where legislation on construction materials does not exist, the lowest-cost option is to render walls and floors with good quality, hard, dense concrete that is smooth-finished. Unsealed concrete is highly porous and breaks down to create dust, cracks, and crevices that harbour insects and micro-organisms. Concrete should therefore be treated with a low-odour concrete sealant, but not with floor paints or wax polishes that can wear away and contaminate products. The right angle joint between walls and the floor should be filled with sanitary coving (Figure 1) with a radius of 2.5 cm or more so that it can be easily cleaned. It should be sealed to the wall and the floor.

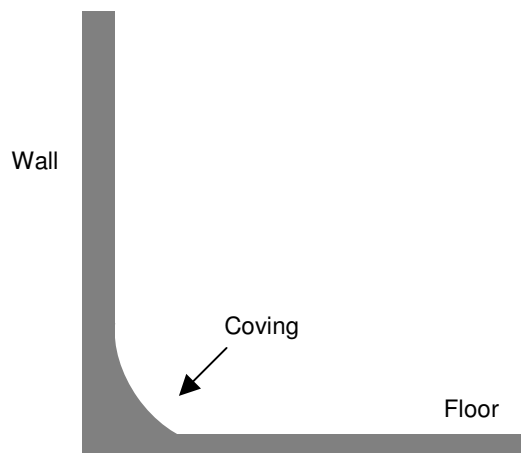


Figure 1 Coving at the wall/floor junction

Quarry tiles or glazed floor tiles provide non-slip floor surfaces that do not absorb grease or oil. Tiles should be securely fitted, with particular attention to the grouting so that it cannot erode and harbour micro-organisms. There are also a number of polymer floor coverings that are specifically designed for use in food processing areas: for example, seamless epoxy MMA (methyl methacrylate) or polyurethane flooring materials are non-slip and non-porous, resistant to scratches and damage from equipment, resistant to acids, oils, hot water, and cleaning chemicals. Different types are made for specific applications (e.g. dairies, bakeries, fruit or meat processing).

Walls may be tiled with glazed white tiles and sealed with waterproof, mould-resistant white grout. Alternatives that are acceptable in many countries include seamless concrete that is smooth-finished with plaster or render and painted with white semi-gloss or gloss paint. Although relatively more expensive, specialized epoxy or fibreglass spray coatings for concrete walls are impervious, cleanable, and durable. Hygienic wall linings are made from PVC (polyvinylchloride), PP (polypropylene), or glass reinforced plastic (GRP) panels (Figure 2). They are bonded onto existing walls and have a hard, smooth, non-porous, mould-resistant surface.

Processing rooms and storerooms should be fitted with panelled or plasterboard ceilings to prevent contamination by dust or insects falling from the roofspace.



Figure 2 Hygienic PVC wall and ceiling panels
 Source: Courtesy of Hygenic (Clad & Clean) Ltd

Interlocking hygienic PVC ceiling tiles or planks have similar advantages to wall linings. They may be fixed into a lightweight aluminium framework that is suspended from an existing ceiling or roof joists.

Dropped (or false) ceilings such as glued and sealed GRP panels have a space above the ceiling for utility services. There should be no gaps or holes around light fittings, utility pipes or cables that pass through the ceiling, which could allow rodents or insects to enter the room.

Cold rooms and walk-in freezers are designed and constructed by specialist manufacturers and use materials that meet the sanitary requirements of food processing facilities. It is important that they are installed with sufficient space (at least 45 cm) between the unit and a wall to allow access for cleaning. If possible, they should be sealed to the ceiling to prevent accumulation of dust on the flat tops, or sufficient clearance should be allowed to provide access for cleaning. The cooling coils and fins of refrigeration units can also collect dust and become a source of contamination, and they should be installed with space for them to be adequately cleaned. Drain pipes from refrigeration equipment should discharge into a separate floor drain and not into a food processing area.

Windows and doors

Windows should ideally be flush with the interior wall and be kept permanently closed. In tropical climates, they may be fitted with insect-proof mesh, which allows them to be left open and provide a flow of air through the room. All doors should be close-fitting in the frames to prevent insects entering and kept closed when not in use. If they are used regularly, doors should be fitted with self-closing devices, or thin metal chains or strips of plastic may be hung vertically from a door lintel. Air 'curtains' are produced by fans located above a doorway, which produce jets of air that reach the floor. The air turbulence helps keep out flying insects and prevents outside air from entering, which reduces the amount of dust and fumes that can enter through the doorway. Non-heated air curtains may be used in hot climates to prevent hot air entering a room, or on doorways to air-conditioned rooms or refrigerated coldrooms to prevent cold air escaping. Heated air curtains are used in colder climates to help heat a room or to prevent cold air entering through the doorway.

Water supplies and drainage

Water is used in food processing for many purposes: washing raw materials, equipment, and processing rooms, blanching, cooling or cooking foods, or directly as an ingredient. In urban areas there is usually a public mains supply, and in some countries supplies are treated and tested to ensure that they meet potable drinking water standards. In others there is no testing by the authorities, or the quality and reliability of treatment may be in doubt. In areas where there is no mains supply, water from boreholes, springs, and wells is generally safer than surface water from rivers or lakes. Construction of underground rainwater storage tanks is expensive and there are usually other lower cost options for securing an adequate water supply.



Figure 3 High-level water tank for treatment by sedimentation

If water contains sand or other particles, it may be clarified by allowing particles to settle out before use. A treatment system uses two high-level covered tanks either in the roof-space of the processing unit or on pillars outside the building (Figure 3). Each tank has a sloping base and a drain valve to flush out any sediment that has accumulated. They are filled alternately, either when mains water is available or by pumping water from a well or borehole. While one tank is being used, any sediment in the other tank settles out. As sedimentation can take several hours, the capacity of each tank should be sufficient for the required production. More rapid sedimentation can be achieved by 'flocculation' with iron hydroxide or aluminium hydroxide, which causes a precipitate to trap most of the suspended matter. This can then be removed using a trickling bed sand filter.

Trickling bed sand filters remove suspended particles and micro-organisms to produce potable water. They consist of a layer of gravel covered by a thick layer of fine sand in a steel, concrete or plastic tank. The top layer develops a film of slime that contains bacteria, which digest organic materials, and also protozoa that digest the bacteria. A gradual build-up of unwanted algae requires the periodic replacement of the top layer of sand to maintain the efficiency of the filter. Pressure filters operate using a similar principle, with water pumped through sand or diatomaceous earth contained in a sealed pressurized steel tank. This produces a higher flow rate of purified water for use in larger-scale processing or in processes that use a lot of water. Water that is not filtered should be chlorinated at ≈ 200 mg of residual chlorine per litre for general purpose water and not greater than 5 mg/l for water that is used for cooking or added directly to the product, to avoid tainting the product with the taste of chlorine. This may be done using calcium hypochlorite (bleaching powder) or sodium hypochlorite solution (bleach).

Water pipes may be made from copper with soldered joints or plastic with push-on connector fittings. Pipework should be routed so that it does not pass through drains or other channels that would risk contaminated water entering through joints. Where pipework is attached to a wall or ceiling, it must be either sealed to the surface or mounted with a minimum of 2–3 cm clearance to allow cleaning behind it.

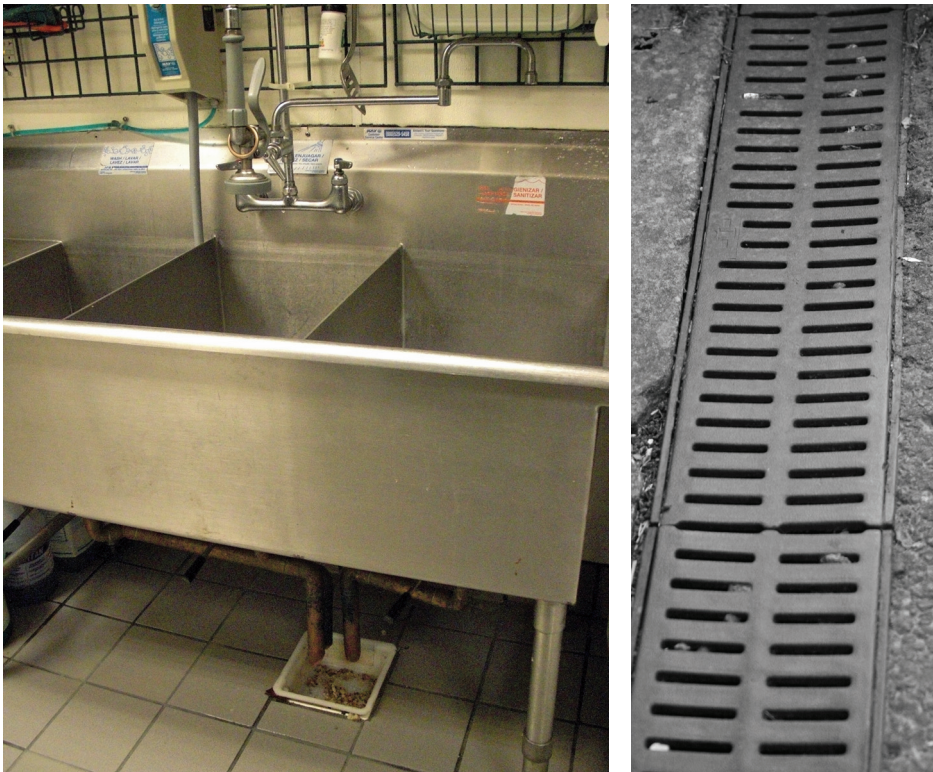


Figure 4 (a) catch basket drain, (b) external trench drain
 Source: courtesy of Drain-Net

Floor drainage uses either ‘catch basket’ drains (Figure 4a) or channel (or trench) drains (Figure 4b). Trench drains are sloped to prevent water collecting in the channel. Both have a steel or plastic grill to prevent pieces of food entering the drain, which is easily removable for cleaning the drain. Where a drain exits the building it should be fitted with a sump and wire grille to prevent rodents and crawling insects entering the building. Processes in which oils and fats are likely to contaminate wastewater should incorporate a grease trap to ensure that these materials are separated from the wastewater before it is allowed into municipal drains.

Power supplies and lighting

The maximum electrical load for a process should be calculated so that the components of electrical installations (wiring, fuses, switches, etc.) have the correct current rating. Electricity is potentially lethal, particularly in wet areas of a processing room, and all electrical circuits should be installed to a high standard by a competent electrician, especially the electrical load from three-phase (440 volt) equipment which should be balanced evenly across the three phases. All plugs should be fitted

with fuses that are appropriate for the power rating of the equipment and the mains supply should have an earth-leakage trip-switch.

Fluorescent lighting tubes use less power than standard (incandescent) light bulbs but they should not be used in areas that have rotating machinery, because they can make machinery appear stationary at certain speeds, causing a hazard to operators. LED (light emitting diode) lighting has low energy consumption compared with incandescent bulbs (a reduction in electricity costs of up to 90 per cent) and long lifespan of typically up to 50,000 hours. All light fittings should be moisture resistant and cleanable and fitted with shatterproof plastic covers. Where possible, lights should be close-fitting or recessed into ceilings to prevent dust accumulating on the fittings and falling into products below.

Equipment

All types of food processing require basic equipment, such as utensils and tables, to handle, weigh, and prepare materials. Separate knives, cutting boards, and other utensils should be used for raw and cooked foods. Containers and utensils that are not heated may be made from food-grade plastic, but not brightly-coloured plastics used for buckets or jerry cans which may contain potentially toxic plasticizers that could contaminate foods. Aluminium or stainless steel tables are preferred because they do not react with foods and are easily cleaned. Wooden tables are more difficult to keep clean and they may contravene health and hygiene regulations in some countries. If wood is used, the table surface should be covered with a sheet of thick plastic, aluminium or a 'melamine' type material, and wooden legs should be painted with white gloss paint to make them more easily cleaned.

All processing equipment that comes into contact with foods should not contaminate the food and should be easy to clean effectively. When buying equipment, processors should check that it conforms to best practice guidelines on hygienic design (e.g. those produced by the European Hygienic Engineering & Design Group (2008) or by the FDA and US Food Safety and Inspection Service (2001). All food contact surfaces should have the same properties as floors, walls, etc. of being impervious, free from cracks and crevices, non-contaminating, non-reactive, corrosion resistant, and durable. In addition they should be easily accessible for cleaning and inspection, or able to be easily disassembled.

Stainless steel is the preferred material for food contact surfaces because it is corrosion resistant, easily cleaned, and durable. It should be polished to a high degree of smoothness or 'finish'. There are different grades of stainless steel, with sanitary standard stainless steel 316 or 300 series stainless steel each used for food processing equipment. Aluminium has poor corrosion resistance and can become pitted and cracked by cleaning and sanitizing chemicals. If it is used in food contact applications, it should be coated with a material such as PTFE (polytetrafluoroethylene). Iron and steel are used in ovens, mills, threshers, and other types of post-harvest equipment; and cast iron is used only for frying and baking surfaces and in some countries the plates in disc mills. Copper is used in some brewing, distilling, and confectionery processing equipment, but iron, copper, brass, and bronze

should not be used in processing equipment for fatty or oily foods because these metals promote rancidity and the development of off-flavours. Plastics and rubbery materials in gaskets and membranes that come into contact with foods should be specified as food-grade. All shafts, bearings, and seals of motorized equipment should be self-lubricating or lubricated by the product. If lubricants are used, they should be food-grade. Bearings on equipment should be sealed so that there is no risk of foods becoming contaminated by lubricants and all components should be accessible and removable for cleaning and disinfection.

Non-product contact surfaces, such as equipment legs, supports, and housings, are commonly constructed using aluminium or painted steel. They should also be cleanable, corrosion resistant, and easily maintained: for example, legs supporting equipment should be sealed to the floor to prevent them harbouring micro-organisms, insects or rodents; there should not be any threaded bolts, screws or rivets above food contact surfaces; tubular steel frameworks should have attachments welded on and not attached using drilled holes and bolts. The interiors of hoppers and tanks should have curved corners, and pipework should have bends with a wide radius and no 'dead ends' that would allow products to accumulate. All joints should be welded with butt-type welds that are continuous and flush to the surface, and also ground to a smooth finish. Tanks should be self-draining and any pipework should slope to a drain if it is not routinely disassembled for cleaning. Openings on tanks should be lipped and covered with an overhanging lid, and the rims of equipment should be constructed so that contaminants cannot collect within them (Figure 5).

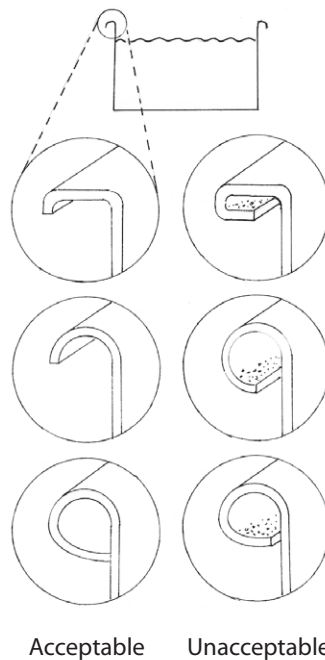


Figure 5 Acceptable and unacceptable designs of rims for tank openings (unacceptable designs allow food to collect under the rim)

Floor-standing equipment should be at least 30 cm from walls and it should be either sealed to the floor or raised at least 15 cm above the floor so that it can be cleaned underneath. Similarly, table-mounted equipment should be sealed to the table or have a space of at least 10 cm underneath for cleaning.

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