2. Hygienic design of Surfaces

There are different types of surfaces used in a food factory (EN 1672):

1. Food contact surfaces: surfaces in direct or indirect contact with food, including areas from which deposits may return to the main product flow.

2. Splash areas.

3. Non food areas.

For closed systems, food contact surfaces are most important. However, for open processes indirect surfaces can also cause recontamination of food products (below):

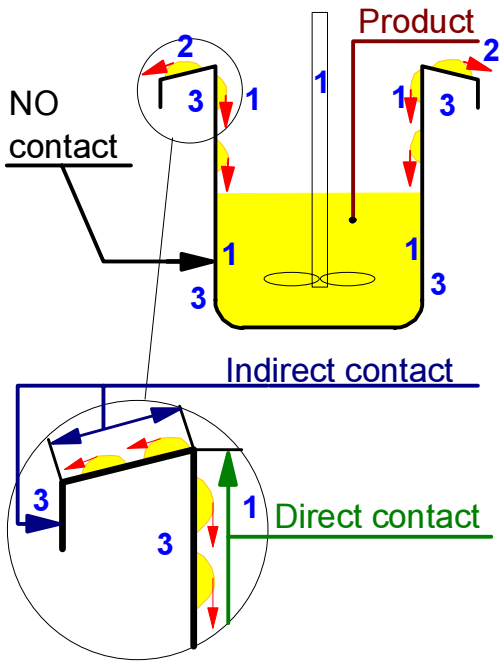
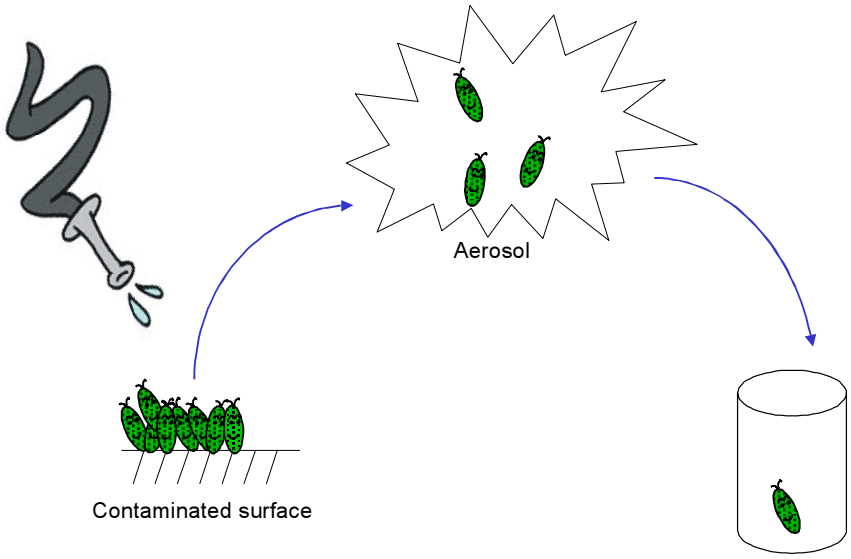


Figure 2.1 Definitions of contact surfaces



2.1. Product contact surfaces

Surfaces must be smooth and easily cleanable. Contact with screw threads and crevices should be avoided because product and micro-organisms may accumulate in these non-cleanable places:

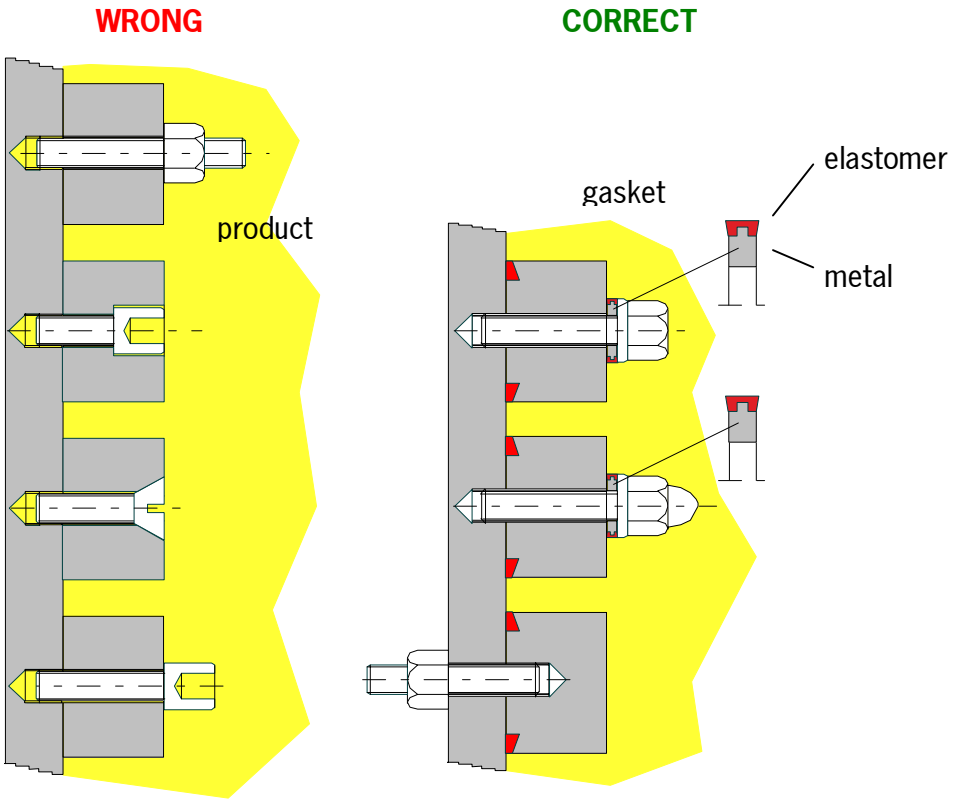


Figure 2.2 Hygienic and non-hygienic contact surface construction details

2.1.1. Surface Roughness

The roughness (or smoothness) of a surface is usually expressed in µm as Ra-value. A surface roughness of smaller than 0.8 µm is recommended by EHEDG (see documents 8 and 10).

Even when a surface looks smooth to the eye, the microscope may reveal that there are holes where bacteria can hide and accumulate (right):

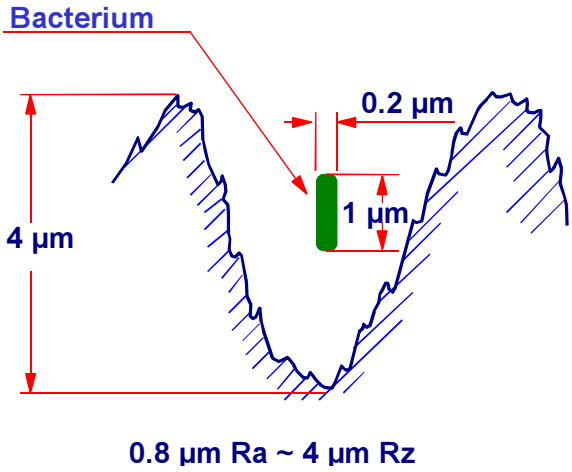


Figure 2.3 Surface roughness of a material, compared to bacterial dimensions.

2.1.2. Welding

When surfaces are to be connected through welding, this must be done hygienically. For this purpose, materials should match and the welding temperature should be correct to prevent corrosion and formation of cracks and crevices (Figure 2.4):

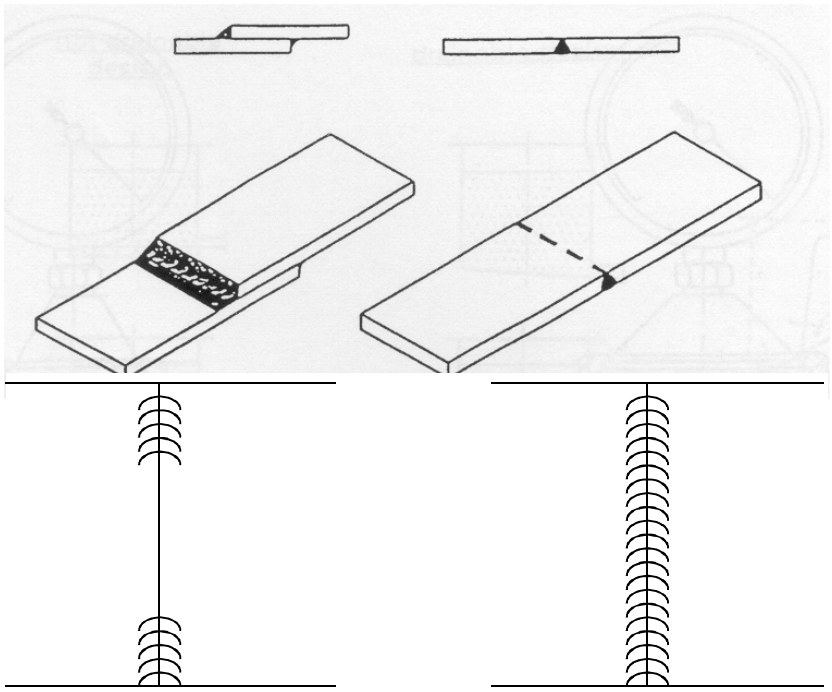


Figure 2.4 Less preferred (left) and preferred (right) ways of welding.

The weld metal should exactly fill the joint:

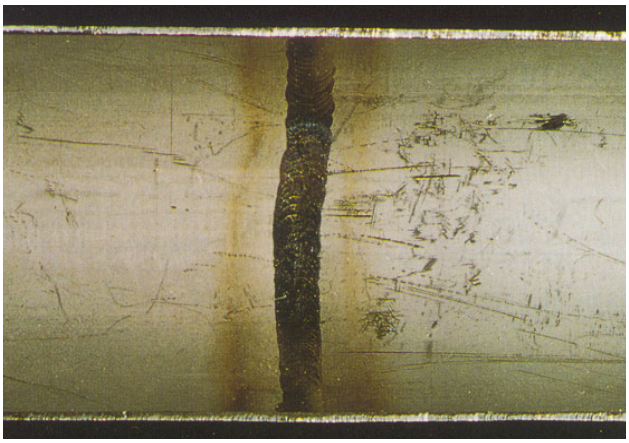


Figure 2.5 Correct welding of tubes

Under-penetration leaves a crevice at the joint and excessive over-penetration also causes unevenness of the surface and thus build up of micro-organisms.

When welds are completed from one side only (for example in pipelines), the reverse surface must be protected with an inert gas. EHEDG recommends Tungsten Inert Gas (TIG) welding as most appropriate welding process. Using this technique welds of 3-4 µm Ra can be achieved.

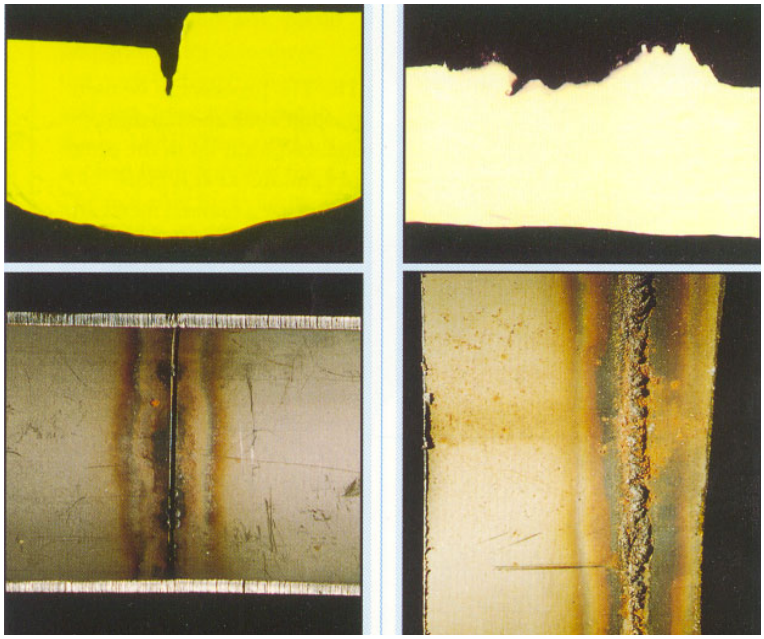


Figure 2.6 Examples of bad welding. Left: misalignment and lack of penetration. Right: Lack of gas shielding.

For more information on TIG welding or on hygienic welding see document 9 EHEDG.

2.1.3. Corrosion

Surface materials used must be resistant to the product and withstand cleaning procedures. Stainless steel is the most widely used material in the food industry. In spite of the good corrosion resistance of this material, chloride ions can cause corrosion:

Food products usually contain chloride and have a pH between 3 and 5, a combination that can cause corrosion.

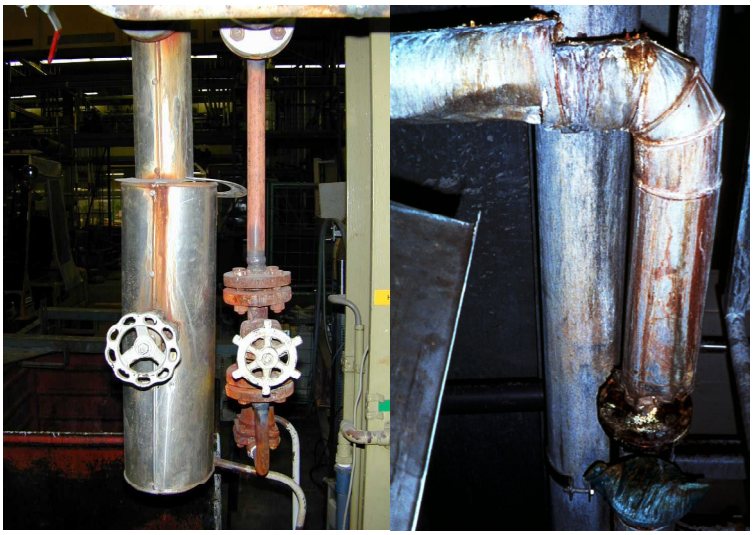


Figure 2.7 Pipelines with corrosion.

Corrosion causes an increase in surface roughness, enhancing attachment of bacteria. Furthermore, corrosion can result in pitting and development of leaks in the equipment (Lelieveld, 2000). Coating the surface with chromium oxide prevents corrosion. Once this layer is damaged it can be repaired with oxidising acids such as HNO_3. This treatment is called: passivation (see doc. 18 EHEDG).

Accumulation of chloride on stainless steel surfaces should be prevented to avoid corrosion.

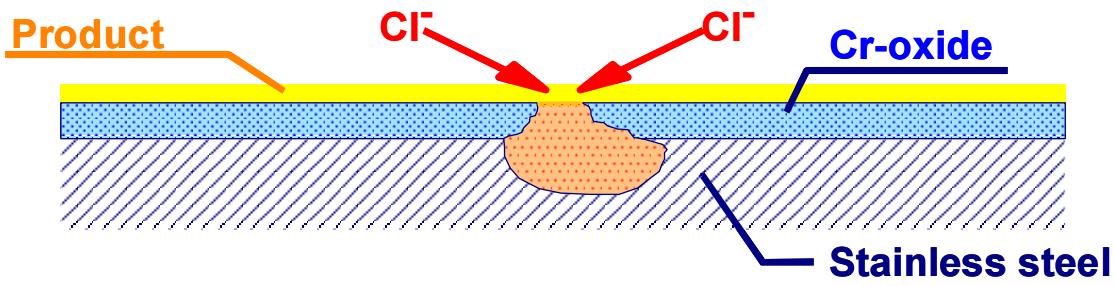


Figure 2.8 Cl^--induced corrosion of stainless steel.

Therefore, insulation of materials should be done such that the insulation cannot be wetted by ingress of water from outside (doc 8, EHEDG). This is best done by welding to prevent the occurrence of crevices:

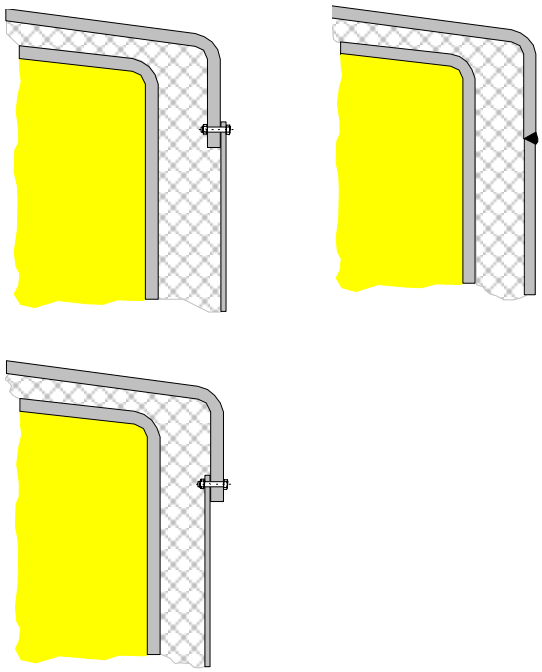


Figure 2.9 Wrong (left) and correct (right) construction of insulation.

2.2. Indirect contact surfaces

2.2.1. Floors/walls

Floors and walls should be designed such that no accumulation and growth of micro-organisms can take place.

Round edges:

Edges should be round instead of sharp to prevent accumulation of dirt and micro-organisms. The radius of the angle should be at least 3 mm.

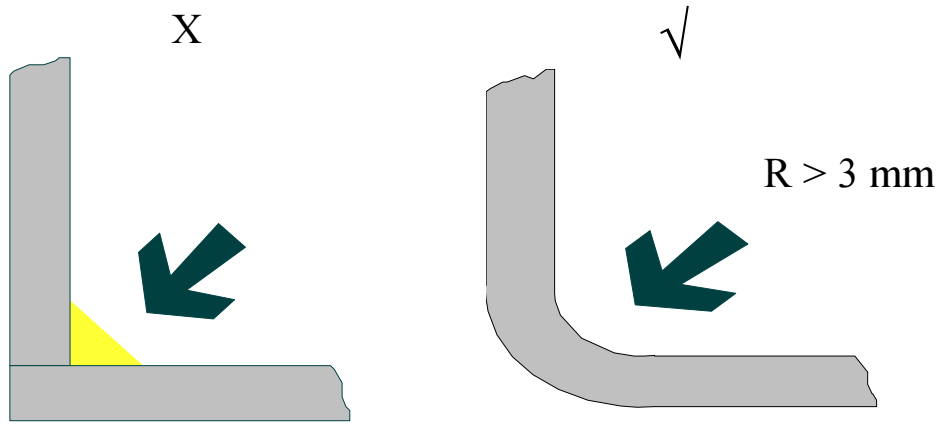


Figure 2.10 Wrong (left) and correct (right) way of construction of edges, see EN 1672.

Example of sharp and round edges:

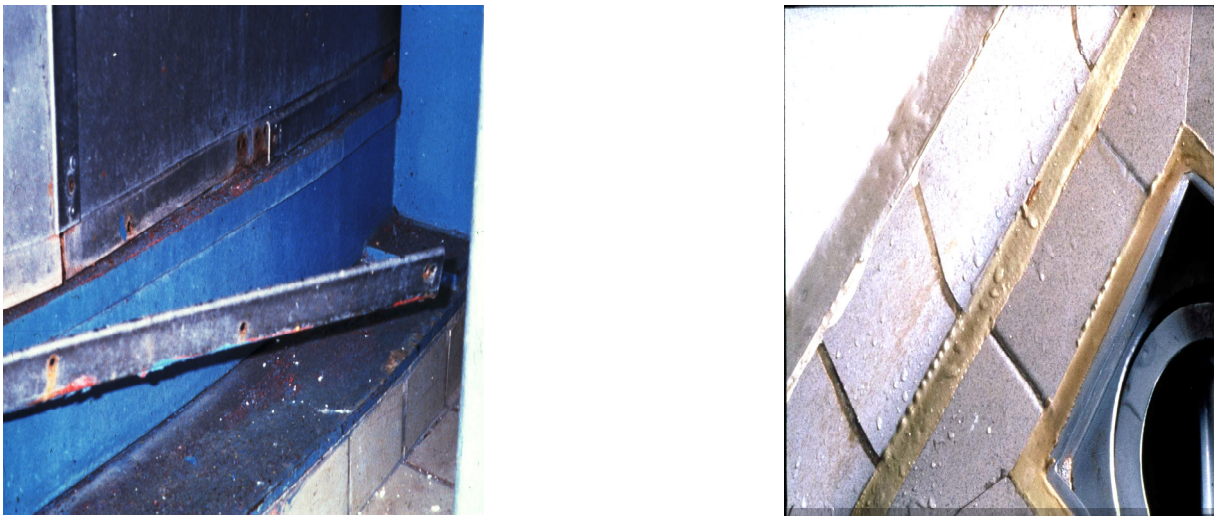


Figure 2.11 Sharp (left) and round (right) edges. Design of drain and floor material in right image is correct. Beware: seals must be maintained to prevent cracks and crevices.

Floors must be smooth, not be slippery and strong enough to withstand heavy duties like the movement of forklift trucks. The material used for he floor should be able to withstand all possible treatments: cold and hot temperatures, cleaning agents, greases etc. In wet areas floors should slope around 2% towards drains or gutters (Lelieveld, 2000).

Figure 2.12 Water and residuals of NaOH on floor which can cause a damaged floor.

Below a number of examples of badly designed floors:

Figure 2.13 Sharp corners and build up of material on edges.

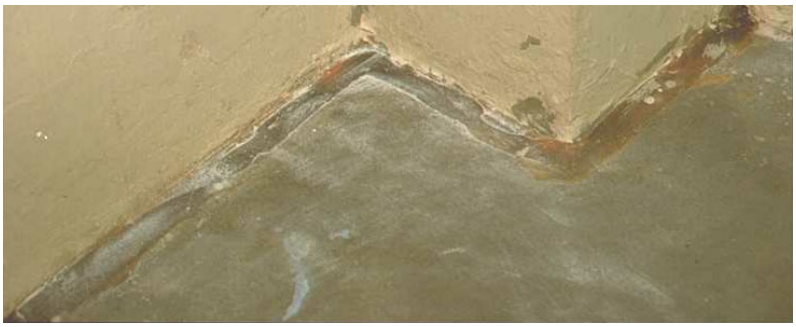


Figure 2.14 Sharp corners, different material for floor and wall causing damages and build up of product residuals.

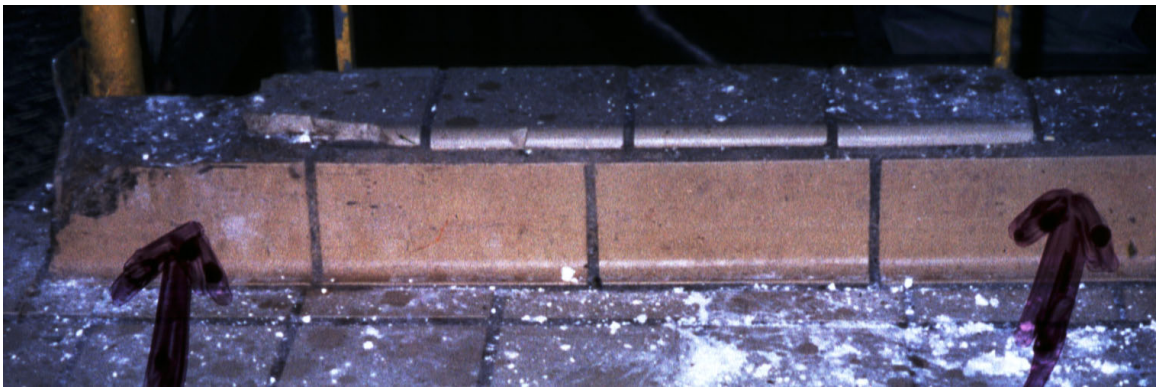


Figure 2.15 Damaged floor.

Materials used for walls and floors should be able to resist the effect of product residues, cleaning agents and mechanical wear:

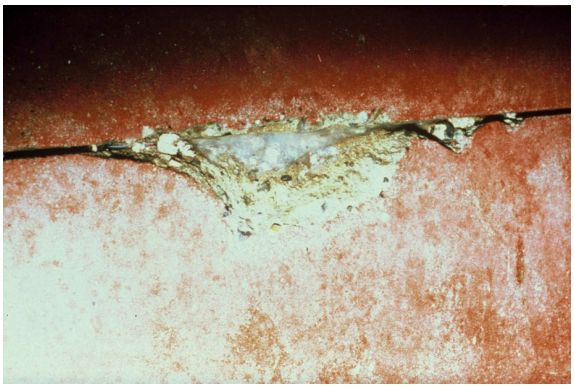


Figure 2.16 Crack in floor material allowing accumulation of product residuals and micro-organisms.

Figure 2.17 Damaged concrete allowing accumulation of product residues and microorganisms.

Good design of ceiling::

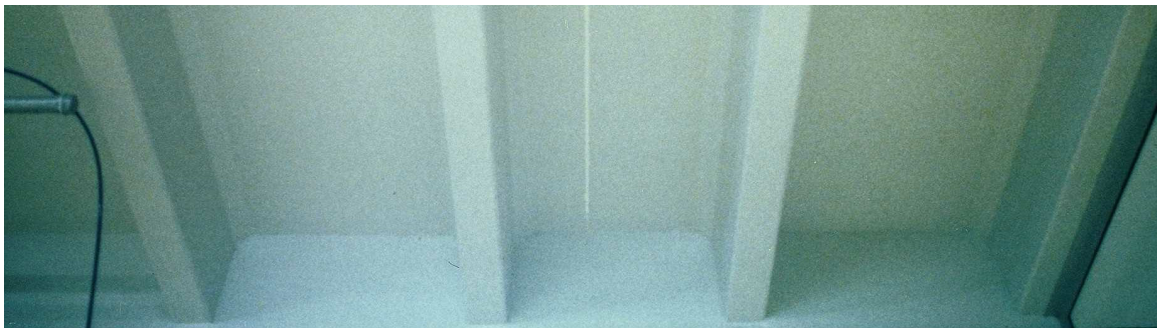


Figure 2.18 Smooth resin material on ceiling.

2.3. Doors

Doors must be smooth and fit tightly to reduce crevices between the door and the frame. Preferably, doors are self-closing to prevent entrance of pests and insects. Materials used for fabrication of doors should be rodent-resistant such as stainless steel. Doors and windows should

be inspected and cleaned regularly to prevent accumulation of dirt and micro-organisms (Lelieveld, 2000).

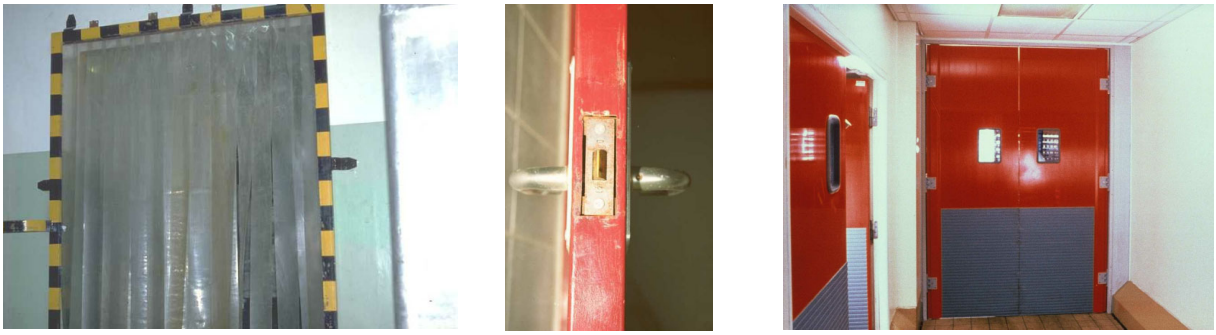


Figure 2.19 Left: using slabs is better than using no separation between areas. However, slabs do facilitate entrance of rodents and insects. Middle: doors with hollow bodies: cracks and crevices near the lock enhancing accumulation of dirt and micro-organisms. Right: good design of doors. Good fit: no overlapping places and easily cleanable.

2.4. Drains

For drainage of floors hygienic drains should be used that are flush with the floor and easily cleanable (Lelieveld, 2000). Floors should be slightly sloped to prevent puddle formation. Gutters should be prevented. If gutters are unavoidable they should be hygienically designed and easily accessible for cleaning.

Figure 2.20 Hygienic gutters.

Hygienic gutters (above). Equipment should be placed next to the gutter (right) instead of on top of the gutter to allow easy cleaning.

Figure 2.21 Pipes and equipment placed in and above gutter and drains. Difficult to open and clean.