

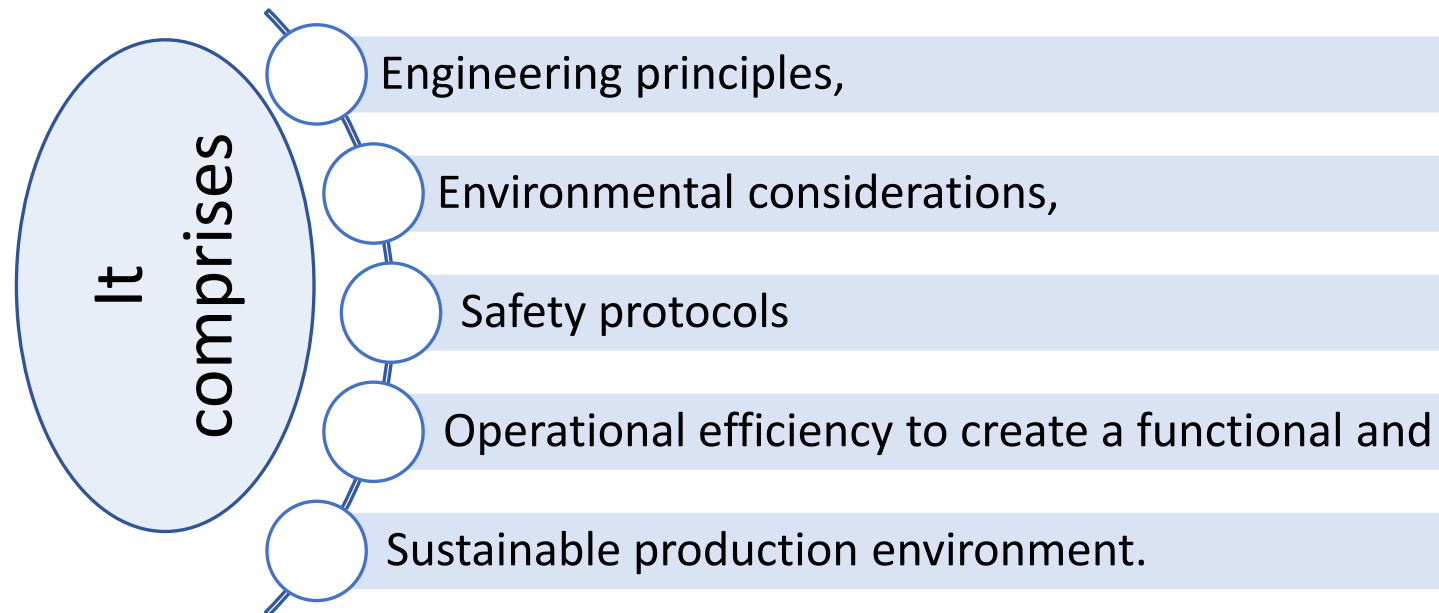
Process Equipment: Basic Standard For Plant Design

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1. Introduction

- Hygienic design is “the designing method keeping components associated with food process machinery designed in such a way that **cleaning can reduce the risk of contaminating** food products with potential hazards”.
- Hygienic design significantly reduces food preparation contamination risks by creating **easy-to-clean, durable, and moisture-free equipment**.



1.1 Benefits of hygienic design

- Minimize the chance of contamination and shield the products from potential hazards.
- Assists in achieving compliance to food safety rules and regulations
- Increase productivity by ensuring industrial facilities and equipment are constructed using sanitary design principles.
- Aids in accelerating extensive cleaning procedures
- Cut down on the amount of time and money companies spend on cleaning their equipment.



1.2 General Consideration for Equipment

Generally following point to be account regarding designing and selecting equipment for the food factories:

- **MOC:** Selected according to their contact with food; metal/plastic/glass.
- **Indirect food additive:** No or to some instant; For material such as glass/plastic.
- **Internal angle:** Rounded at specific angle
- **Manufacturing procedure:** Before designing and selecting any equipment for the industry, general or specific manufacturing procedure of machinery should be known.



1.2 General Consideration for Equipment

- **Opening:** Lipped, opening should be covered to prevent contaminations
- **Cover:** Shoebox design.
- **Top rim:** Resistant to water and dust.
- **Product handling capacity:** Designing and selection should be done considering handling capacity of the products per hour basis.



* GFSI has introduced **GFSI II**, a more robust set of benchmarking requirements for hygienic design for building constructors and equipment manufacturers in 2020.

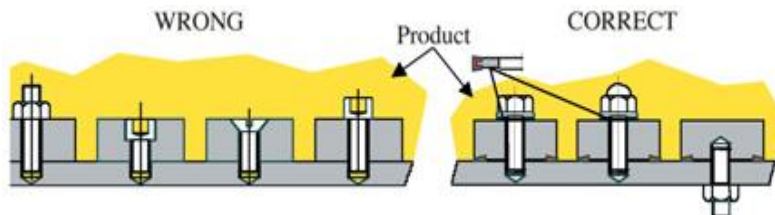
2. Criteria for Hygienic Designing

- The criteria for selection of Hygienic equipment is based on following characteristics:

Characteristics	Specification
Product Contact Material	• Inert to product, detergents and antimicrobial chemicals (sanitizers), & Corrosion-resistant, mechanically stable, smoothly finished and easily cleaned • Make: SS (SS 304, SS 316)
Product Non-Contact Material	• Inert to detergents and antimicrobial chemicals (sanitizers), Corrosion-resistant, mechanically stable, smoothly finished and easily cleaned • Make: Mild Steel
Surface roughness	• Smooth enough to be easily cleanable • Max. roughness of $R_a = 0.8 \mu\text{m}$ (Acc. to EHEDG; European Hygienic Engineering and Design Group and American 3-A Sanitary organization)

2. Criteria for Hygienic Designing

Characteristics	Specification
Dead areas	Difficult to clean, should be avoided
Screw threads	Should be avoided. If not, crevices created should be sealed, at min.
Corners	Sharp corners should be avoided
Drain-ability	Designed to be self-drainable
Shaft passages and seals	Double seals with microbiocidal barrier liquids



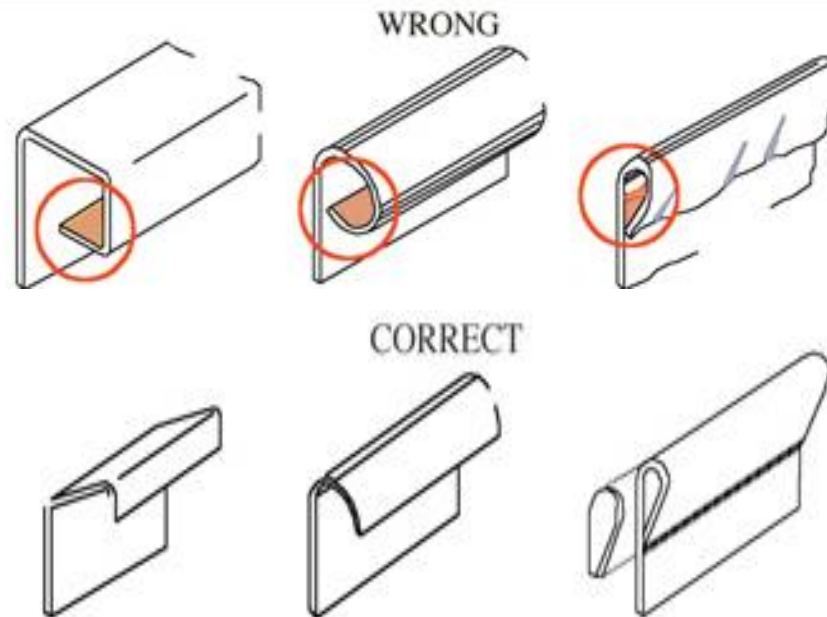
Threads



Internal angle of corners

2. Criteria for Hygienic Designing

Characteristics	Specification
Top rim	• Avoid ledges, where product can lodge • Open-top rim, rounded and sloped for draining
Drain-ability	• Designed to be self-drainable



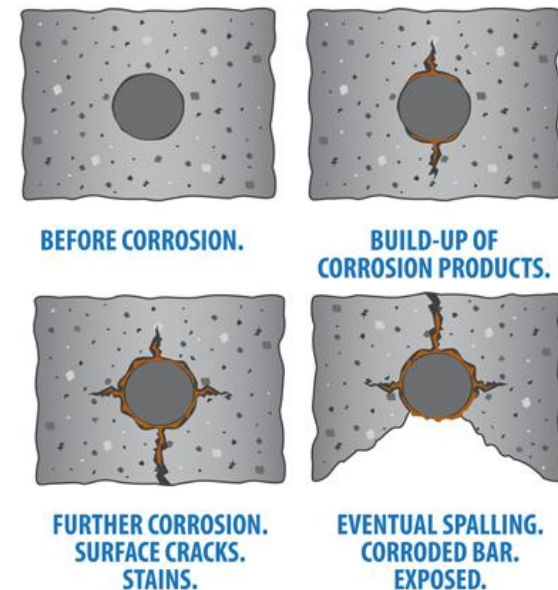
Top rim

3. Basic Standards for Equipment

(a) Contact surfaces

i. Standards for surface

- **Type:** Smooth and resistive
- **Make:** Non-porous, non-absorbent material, Non-leaching/ non-reactive to food constituent, non-toxic, odourless
- **Corrosion:** Less or no corrosive
- **Surface faults:** Without single cracks (crevice) or pores on surface
- **Durability:** Extremely high
- **Service requirements:** Cleanable, require less or no maintenance



Effect of Corrosion

3. Basic Standards for Equipment (Cont.)

ii. Standards for Surface Texture

- Surface of equipment should have characteristics such as
 - Smoothness,
 - Crack free,
 - Meeting sanitary standards.
- To create finished internal surface, methods such as
 - Polishing,
 - Lacquering,
 - Texturizing etc

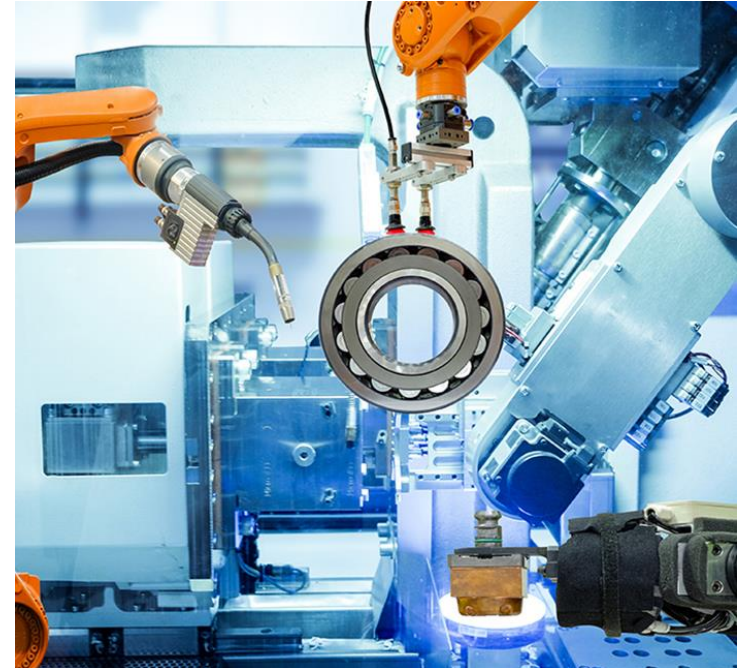
Done as per American 3-a Sanitary Organization.



3. Basic Standards for Equipment (Cont.)

iii. Standards for Machine Construction

- Equipment to be
 - Free of sharp corner,
 - Cracks/ crevices
 - Easy assembly, & disassembly for cleaning
 - Self-drain using draining port.
- Piping to be at proper self-slope for efficient draining



3. Basic Standards for Equipment (Cont.)

(b) For non-contact surfaces

- Most of the specification is same as for food contact surfaces such as Smoothly finished and easily cleaned, drainable and entirely sealed and not penetrable having some differences
 - **Make:** Fabricated with material having properties such as less corrosive and excellent malleable, mechanically stable, and maintenance free such as, MS (Mild steel) is generally specified.
 - **Ledges** or areas where dust can collect should be avoided.
 - **Tops:** Equipment, shields, covers, or boxes should have their tops inclined at least 45 degrees.
 - **Threads** used on leveling components should be of the enclosed type.

4. Standards for Pipe & Pipe Rack

Pipes used for material handling, Drainage and CIP, following consideration is assumed:

#	Purpose	Type of pipe	Flow rate (m/s)	Dimension (mm)
1	Process flow	Make: SS 304 (stainless steel) Joints: • For high pressure handling – seamless, • For med. pressure handling – SS for food contact pipes	< 1.2	25.4, 38.1, 50.8, 63.5, or even 76.2
2	CIP for process line	CIP done using same piping used for product processing	> 1.5 to 2.1	25.4, 38.1, 50.8, 63.5, or even 76.2

5. Equipment Location & safety aspect

Equipment	Location	Safety aspect
Silos	1. Grouped, offsite to the plant 2. Lower elevations,	Surrounded by a dike wall to maintain integrity, maintain temp. & reduces contamination risk
Tanks	Possibly grouped with avg. dia of 1/2 between tanks, onsite- 2 m to the building wall	• Jacketed to control temp. change. • Provision for Containment loss
Dryers	2.5 m away from building walls	As can be source of contaminants.
Furnaces and fired heaters	15 m away from process zone	Extremely hot air or direct flame can be hazardous to personnel or even processing unit.
Evaporator	Barometric leg type (with height at least 10 mm)	Hazard of explosion or implosion due to extreme pressures, Burns and scorches (due to hot water and leaking steam)

5. Equipment Location & safety aspect

Equipment	Location	Safety aspect
Process reactors	- Access area 40 m², for each 30 cm³ reactor volume - Either side of the pipe rack,	As close as possible to the heater (minimizes cost of high heating piping)
Heat exchanger	Horizontal: Placed on grade, Vertical: Accessible to mobile crane or monorail with hoist	High risk of fire, exploding (to a hazardous material explosion) during working or maintenance.
Pumps	Close to suction source, axis perpendicular to other equipment	Premature failure, risk of fire due to leakage or excess heat.
Air compressor	- At clean and dry place - Sufficiently away from the HAC of equipment	Risk of contamination, release of flying particles.
Packaging machine	At clean & dry place with 2-2.5 m distance in between, near to warehouse room	Highly risk zone, potential area of contaminations, change of leakage in-case of failure.

6. References

- [Equipment Layout - Thepiping.com](http://Thepiping.com)
- [Plant Layout Design Rules | Piping Layout Rules \(PDF\) – What Is Piping](#)
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