



What is Inherently Safer Design (ISD) ?

Inherent safety is a concept, an approach to safety that focuses on eliminating or reducing the hazards associated with a set of conditions. **Inherently Safer Design avoids/removes hazards at source instead of controlling them, particularly by eliminating or reducing the hazard by changing the process or material amount or materials which are non-hazardous or less hazardous and the number of hazardous operations in the plant and this elimination or reduction is permanent and inseparable.**

It is Safety “Built in” not “Added On”.

“Inherent safer Design” concept was introduced by Trevor Kletz. The term inherently safer implies that the process is safer because of its very nature and not because equipment has been added to make it safer. Inherently safer and friendly features should be introduced **during design stage.** **Inherently safer designs considers chemistry as well as engineering issues** such as siting, transportation and detail equipment design.

Inherently safer and user-friendly designs are parts of a total package of improvements that the process industry needs: **a move toward plants that are simpler, cheaper, and safer and that use less energy, need less maintenance, and produce less waste and pollution.** Inherently safer plants are usually cheaper than conventional ones because they do not need so much additional protective equipment.

Our traditional Safety approach is preventive or mitigative type and not for elimination or significantly reduce process hazards.

Prevent : Alarms, Safety Interlocks, Procedures, Training
Mitigate : Sprinkler systems, Water curtains, Emergency response systems & procedures

- There are two sources of Chemical process hazards :
1. Hazards that are characteristic of the materials and chemistry used (Intrinsic).
 2. Hazards that are characteristic of the process variables, or the way the chemistry works within process (Condition of use).

Following 5 strategies are used for Inherently Safer designs.

1. INTENSIFICATION OR MINIMIZATION
It means use smaller quantities of hazardous substances.

Friendly plants contain low inventories of hazardous materials—so little that it does not matter if the entire inventory leaks out. At Bhopal, India, in 1984, the material that leaked, killing over 2000 people, was an intermediate that was convenient, but not essential, to store. Inventories can often be reduced in almost all unit operations as well as during storage. Intensification implementation makes plant smaller, simpler and cost effective.

2. SUBSTITUTION
It means replace a material with a less hazardous substance.

If intensification is not possible, then an alternative is substitution: using a safer material in place of a hazardous one. Like use of water in place of solvents in paints.

3. ATTENUATION OR MODERATION
It means carrying out a hazardous reaction under less hazardous conditions or storing or transporting a hazardous material in a less hazardous form. Like

- Liquefied chlorine and ammonia can be stored as refrigerated liquids at atmospheric pressure instead of storage under pressure at ambient temperature.
- Dyestuffs that form explosive dusts can be handled as slurries.
- Dust explosive pharma intermediates kept under slurry form instead of complete drying for next processing.

4. LIMITATION OF EFFECTS

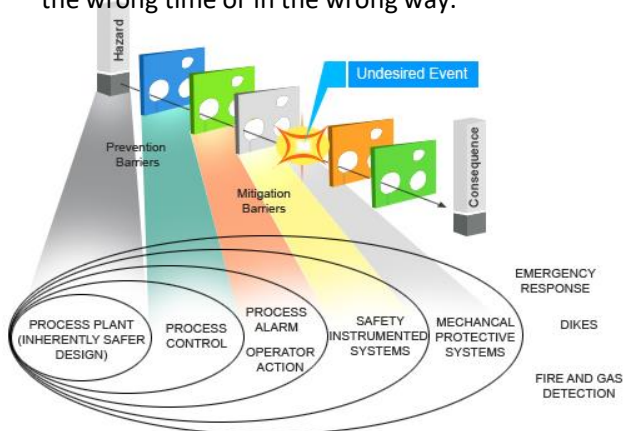
It means limiting the effects of failures (of equipment, control systems, or people) by equipment design or change in reaction conditions rather than by adding protective equipment that may fail or be neglected or may introduce other problems. Like

- Different Vessels for Different Stages
- Changing the Order of Operations
- Changing Temperature, Concentration, or Other Parameters
- Limiting the Level of the Energy Available

5. SIMPLICITY

It means simpler plants are safer than more complex ones because they contain less equipment that can leak and provide fewer opportunities for human error.

If what you don't have can't leak, equipment you don't install cannot develop faults or be operated at the wrong time or in the wrong way.



EXAMPLES OF ISD :

1. Water-based paints, adhesives replacing solvent-based products.
3. The modification of a bromine raw-material-handling facility by replacing an existing bulk storage tank with cylinders.
4. Aqueous ammonia / HCl instead of anhydrous ammonia / HCl. Dilute nitric acid / Sulfuric acid in place of Concentric Nitric Acid / Oleum.
5. Use of hot water as heating media instead of steam for low temperature requirements.
6. Use of Loop reactors in place of batch stirred tank reactors in chlorination, ethoxylation, hydrogenation, and polymerization.
7. Instead of using solvent to apply coatings to paper, board, optical glass, or other substrates, the coatings can be applied as dry powders and then fixed by exposure to ultraviolet or electron beam radiation.
8. Carbon dioxide can be used instead of mineral acid for controlling the pH of drinking water.
9. Develop chemistry which is not exothermic or mildly exothermic.
10. Fixed pipes or articulated arms, if flexibility is necessary, are friendlier than hoses.
11. Spiral-wound gaskets are friendlier than fiber gaskets because, if the bolts work loose or are not tightened correctly, the leak rate is lower.
12. Metal is friendlier than glass or plastic.
13. Ductile materials are usually safer than brittle ones.
14. Do not install larger pipes and valves (especially control valves) than necessary.
15. Use of orifice for the limiting component addition.
16. Stronger Equipment can replace Relief Systems.
17. Alternative energy sources: centrifugal fluids, ultrasound, solar energy, microwave, electric fields, plasma technology

Intensify

The best way of preventing large leaks of hazardous material is not to have so much hazardous material – Lower Inventory!



Substitute

If we cannot reduce the inventory of hazardous material, may we can use a safer material instead – Use Safer Material!



Attenuate

If we cannot do both above, may we can use the hazardous material under less hazardous conditions – Safer Conditions!



Simplify

Very complicated plant makes them expensive & provides so many opportunities for error – Make It Simple!



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