9. PLANT LOCATION AND LAYOUT

Plant location and site selection:

The location of the plant can have a crucial effect on the profitability of a project and the scope for future expansion.Many factors must be considered when selecting a suitable site.The factors to be considered are:

1. Location with respect to the marketing area
2. Raw material supply.
3. Transport facilities.
4. Availability of labour.
5. Availability of utilities: water,fuel,power.
6. Availability of suitable land.
7. Environmental impact, and effluent disposal.
8. Local community considerations.
9. Climate.
10. Political and strategic considerations.

Marketing Area:

For materials that are produced in bulk quantities such as cement,mineral acids and fertilizers where the cost of the poduct per tonne is relatively low and the cost of transport a significant fraction of the sales price, the plant should be located close to the primary market.This consideration will be less important for low volume production, high-priced products,such as pharmaceuticals.

Raw Materials:

The availability and price of suitable raw materials will often detrmine the ite location.Plant producing bulk chemicals are best located close to the source of the major raw material: where this is also close to the marketing area.

Transport:

The transport of materials & products to & from the plant will be an overriding condideration in site selection.

If practicable, site should be selected that is close ti at least two major forms of transport:road, rail,waterway(canal or river) or a sea port. Road transport is being increasingly used, and is suitable for long-distance transport of bulk chemicals.

Air transport is convenient & efficient for the movement of personnel &essential equipment & supplies & the proximity of the site airport should be considered.

Availibility of labour:

Labour will be needed for construction of the plant & its operation. Skilled construction workers will usually be brought in from outside the site area, but there should be an adequate pool of unskilled labour available locally ; & labour suitable for training to operate the plant. Skilled tradesmen will be needed for plant maintainance . Local trade union customs & restrictive practices will have to be considered when assessing the availability & suitability of the local labour for recruitment & training.

Utilities(Services)

Chemical processes invaribly require large quantities of water for cooling & general process use , & the plant must be located near a source of water of suitable quantity. Process water may be drawn from a river, from wells, or purchased from a local authority.

At some sites the cooling water required can be taken from a river or lake , or from the sea; at other locations cooling tower will be needed.

Electrical power will be needed at all sites. Electrochemical processes that require large quantities of power; for example,aluminium smelters need to be located close to a cheap source of power.

A competitive priced fuel must be available on site for steam & power generation.

Environment impact,& disposal:

All industrial proceses produce waste products & full consideration must be given to the difficulties & cost of their disposal. The disposal of toxic & harmful effluents will be coverd by local regulations & the appropriate authorities must be consulted during the initial site survey to determine the standards that must be met.

An environmental impact assessment should be made for each new project or major modification or addition to an existing process.

Local community considerations:

The propoded plant must fit in with & be acceptable to the local community.Full consideration must be given to the safe location of the plant so that it does not impose a significant additional risk to the community.

On a new site, the local community must be able to provide adequate facilities for the plant personnel : school,banks,housing & recreational & cultural facilities.

Land(site selection)

Sufficient suitable land must be available for the proposed plant & for future expansion. The land should ideally be flat, well draind & have suitable load bearing characteristics.A full site evaluation should be made to determine the need of piling or other special formations.

Climate:

Adverse climate conditions at a site will increase cost. Abnormally low temperatures will require the provisition of additional insulation & special heating for equipment & pipe runs. Tronger structures will be needed at locations subject to high winds(cyclone-hurricane areas) or earthquakes.

Political & Stratergic Considerations:

Capital grants tax concesssions & other inducements are often given by the government to direct renew investments to preffered locations, such as areas of high unemployment. The availability of such grants can be the overriding consideration in site selection.

SiteLayout:

The process units & ancillary buildings should be laid out to give the most economical flow of materials & personnel around the site.
Hazardous processes must be located at a safe distance from other buildings. Consideration must also be given to the future expansion of the site.The ancilliary buildings & services required on a site, in addition to the main processing units will include.

1. Storages for raw materials & products: tank farms & warehouses.
2. Maintainance workshops.
3. Stores for maintainance & operating supplies.
4. Laboratories for process control
5. Fire stations & other emergency services.
6. Utilities : steam boilers, compressed air,power generation,refrigeration,transformer stations.
7. Effluent disposal plant .
8. Offices for general administration.
9. Canteens & other amenity buildings, such as medical centers.
10. Car parks

When roughing out the preminary site layout, the process units will normally be sited first & arranged to give a smooth flow of materials through the various processing steps, from raw material to final product storage. Process units are normally spaced at least 30m apart; greater spacing may be needed for hazardous processes.

The location of the principal ancillary buildings should then be decided.They shoiul be arranged so as to minimise the time spent by personnel in travelling between buildings.Administration offices & laboratories, in which a relatively large number of people will be working, should be located well away from potentially hazardous processes.Control rooms will normally be located be located adjacent to the processing units, but with potentially hazardous processes may have to be sited at a safer distance.

The sitting of the main process units will determine the layout of the plant roads,pipe alleys & drains. Access roads will be needed to each building for construction ,& for operation & maintainance.

Utility buildings should be sited ti give the most economical run of pipes to & from the process units.

Cooling towers should be sited so that under the prevailing wind the plume of condensate spray drifts away from the plant ara & adjacent properties.

The main storage area should be placed between the loading & unloading facilities & the process units they serve.Storage tanks containing hazardous materials should be sited at least 70m from the site boundary.

Plant Layout:

The economic construction & efficient operation of a proces unit will depend on how well he plant & equipment specified on the process flow-sheet is laid out.

The principal factors to be considered are:

1. Economic consideration : construction & operating cost
2. The process requirements

3. Convenience of operation
4. Convenience of maintainanace
5. Safety
6. Future expantion
7. Modular construction

Costs:

The cost of construction can be minimised by adopting a layout tht gives the shortest run of connecting pipe between equipment & the least amount of structural steel work.However this will not necessarily be the best arrangement for operation & maintainance.

Process Requirements:

An example of the need to take into account process considerations is the need to clevate the base of columns to provide the necessary net positive suction head to a pump or the operating head for a thermosyphon reboiler.

Operator:

Equipment that needs to have frequent operator attention should be located convenient to the control room. Valves,sample points, and instruments should be located at convienient positions and heights.Sufficient working space and head room must be provided to allow easy access to equipments.

Maintainance:

Heat exchangers need to be cited so that the tube bundles can be easily withdrawn for cleaning and tube replacement. Vessels that require frequent replacement of catalyst or packing should be located on the outside of buildings. Equipment that requires dismantling for maintainnace, such as compressors and large pumps, should be placed under cover.

Safety:

Blast walls maybe needed to isolate potentially hazardous equipment, and confine the effects of an explosion. At least two escape routes for operators must be provided from each level in the process buildings.

Plant Expansion:

Equipments should be located so that it can be conveniently tied in with any future expansion of the process. Space should be left on pipe alleys for future needs, and services pipes over-sized to allow for future requirements.

Modular Constructions:

In resent years there has been a move to assemble sections of plant at the plant manufacturers site. These modules will include the equipment, structural steel, piping and instrumentation. The modules are then transported to the plant site, by road or sea. The advantage of modular construction are :

(1) Improved quality control
(2) Reduced construction cost

(3) Less need for skilled labour on site.
(4) Less need for a skilled personal on overseas sites.

Some of the disadvantages are:
(1) Higher design costs.
(2) More structural steel work.
(3) More flanged connections.
(4) Possible problems with assembly on site.

Utilities:

The word utilities is not generally used for the ancillary services needed in the operation of any production process. These services will normally be supplied from a central site facility, and will include:
(1) Electricity.
(2) Steam for process heating.
(3) Cooling water.
(4) Water for general use.
(5) Demineralised water.
(6) Compressed air.
(7) Inert gas supplies.
(8) Refrigeration.
(9) Effluent disposal facilities.

Electricity:

The power required for electrochemical processes, motor drives, lighting, and general use maybe generated on site, but will more usually be purchased from the local supply company. The voltage at which the supply is taken or generated will depend on the demand. For a large site the supply will be taken at a very high voltage, typically 11,000 or 33,000 V. Transformers will be used to step down the supply voltage to the voltages used on the site. In the United Kingdom a three phase 415V system is used for general industrial purposes, and 240V single phase for lighting and other low power requirements. If a number of large motors is used, a supply at an intermediate high voltage will also be provided, typically 6000 or 11,000V.

Steam:

The steam for heating is usually generated in water tube boilers using the most economical fuel level available. The process temperatures required can usually be obtained with low temperature steam typically 2.5 bar and steam distributed at a relatively low pressure, typically around 8 bar (100 psig). Higher steam pressures, or proprietary heat transfer fluids, such as dowtherm will be needed for high process temperatures.

Combined Heat and Power (Co-generation):

The energy costs on a large site can be reduced if the electrical power required is generated on the site and the exhaust steam from the turbines used for process heating. The overall thermal efficiency of such systems can be in the range 70-80 %, compared with the 30-40 % obtained from a conventional power station, where the heat in the

exhaust steam is wasted in the condenser. Whether a combined heat and power system scheme is worth considering for a particular site will depend on the size of the site, the cost of fuel, the balance between the power and heating demands, and particularly on the availability of and cost of, stand by supplies and the price paid for any surplus power electricity generated.

Cooling Water:

Natural and forced draft cooling towers are generally used to provide the cooling water required in a site; unless water can be drawn from a convinient river or lake in sufficient quantity.

Water for General Use:

The water required for general purposes on a site will usually be taken from the local mains supply, unless a cheaper source of suitable quantity water is available from a river, lake or well.

Demineralised Water:

Demineralised water from which all the minerals have been removed by ion exchange, is used where pure water is needed for process use, and as boiler feed water. Mixed and multiple bed ion exchange units are used, one resin converting the cations to hydrogen and the other removing the acid radicals. Water with less than one ppm of dissolved solids can be produced.

Refrigeration:

It will be needed for processes that require temperatures below those that can be economically obtained with cooling water. For temperatures down to around $10^{o}C$ chilled water can be used. For lower temperatures, down to $-30^{o}C$, salt brines are used to distribute the "refrigeration" round the site from a central refrigeration machine.

Compressed Air:

It will be needed for general use, and for the pneumatic controllers that are usually used for chemical process plant control.

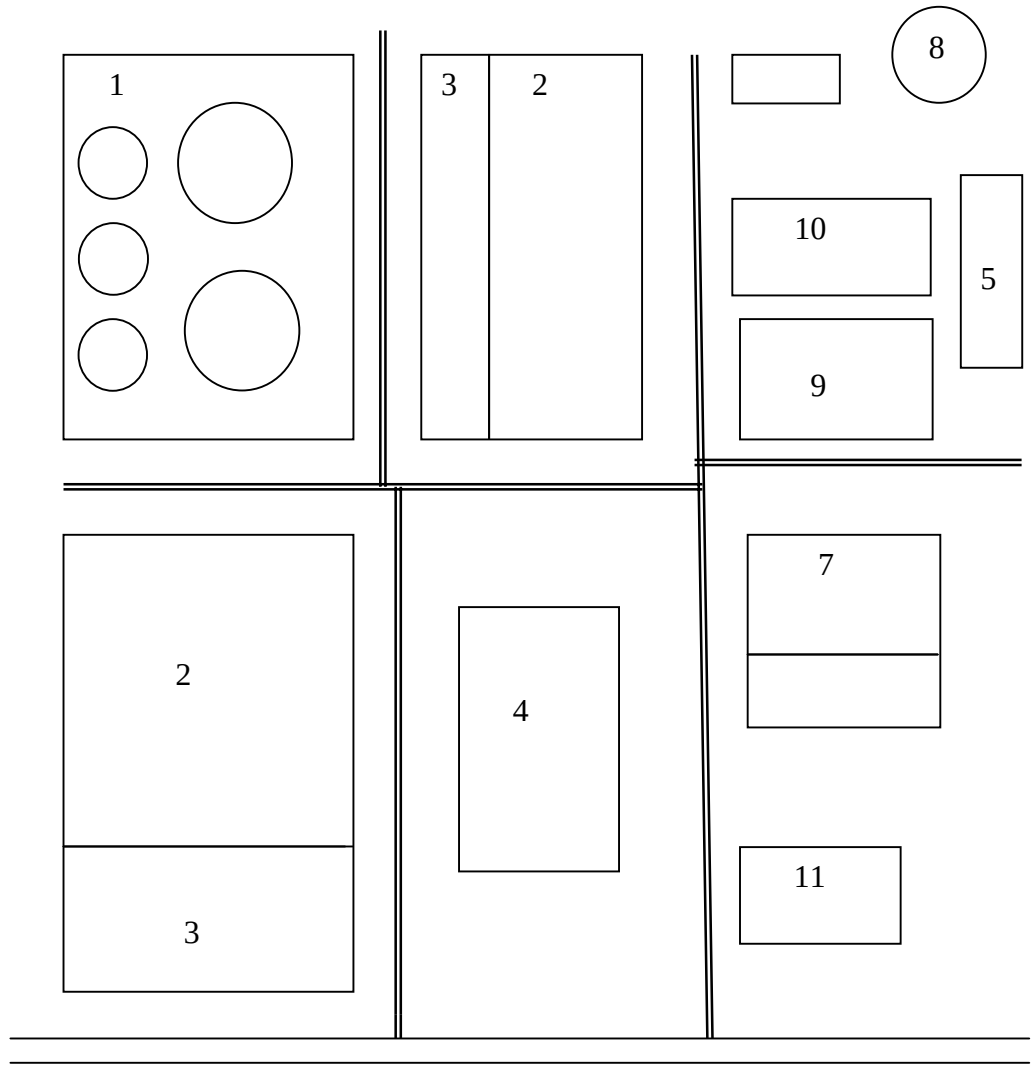
Inert Gases:

Where large quantities of inert gas are required for the inert blanketing of tanks and for purging is usually supplied from a central facility. Nitrogen is normally used and is manufactured on site in an air liquefaction plant, or purchased as liquid in tankers.

Effluent Disposal:

Facilities will be required at all sites for the disposal of waste materials without creating a public nuisance.

SITE LAYOUT



1. TANK FARM
2; PLANT AREA
3. EXPANSION
4.PLANT UTILITIES
5. STORES
6. FIRE STATION
7. CANTEEN
8. EMERGENCY WATER
9. LABORATORY
10. WORK SHOP
11. OFFICE