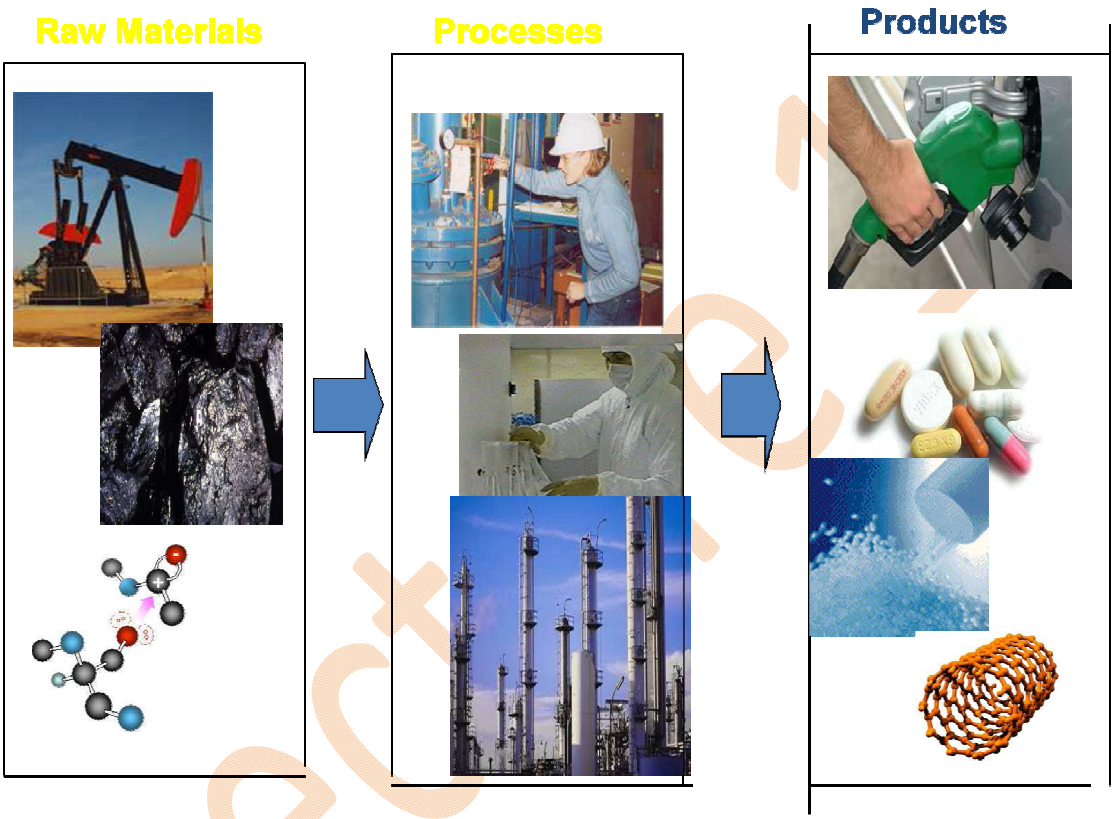
What is chemical engineering?

Chemical Engineering is a group of industrial processes in which row materials are changed or separated into useful products



What are "Unit Operations"?

Every industrial chemical process is based on Unit Operations (physical treatment) and Unit Process (chemical treatment) to produce economically a desired product from specific raw materials. The raw materials are treated through physical steps to make it suitable for chemical reaction. So, knowledge of unit operations like 'Mixing and agitation of liquid' and' heat flow' is very much necessary. The subject Unit Operations is based on fundamental laws, physicochemical principles. Unit Operations gives idea about science related to specific physical operation;

different equipments-its design, material of construction and operation; and calculation of various physical parameters (mass flow, heat flow, mass balance, power and force etc.). Examples of Unit Operations are listed in Table 1.

Table 1: List of some unit operations

Heat flow, Fluid flow	Mixing
Drying	Absorption
Evaporation	Adsorption
Distillation	Condensation
Crystallization	Vaporization
Leaching	Separation
Extraction	Sedimentation
Filtration	Crushing

Following are some examples of physical processes :

1) Sugar Manufacture:

Sugar cane crushing → sugar extraction → thickening of syrup →evaporation of water → sugar crystallization → filtration →drying →screening →packing

2) Salt Manufacture:

Brine transportation → evaporation → crystallization →drying → screening → conveying → packaging.

3) Pharmaceutical Manufacture:

Formulation of chemicals, mixing, granulation → drying of granules→ screening → pressing tablet → packaging

The equipment used in the chemical processes industries can be divided into two classes:.

1. Proprietary equipment, such as pumps, compressors, filters, centrifuges and dryers, is designed and manufactured by specialist firms.

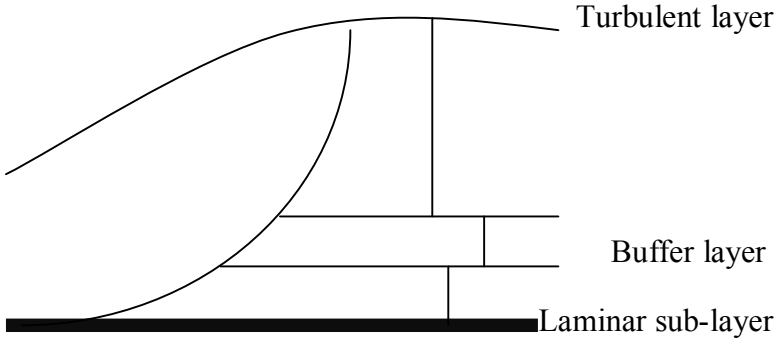
2. Non-proprietary equipment is designed as special , one-off , items for particular processes; for example, reactors, distillation columns and heat exchangers .

Momentum , Heat and Mass Transfer

In most of the unit operations encountered in chemical and petroleum industries , or more of the processes of momentum , heat and mass transfer involved .

In some cases , momentum , heat and mass transfer all occur simultaneously as , for example :

In a water – cooling tower where transfer of sensible heat evaporation both take place from the surface of the water droplets . When a fluid flows under turbulent conditions over a surface , the flow can conveniently be divided into three regions,



1- At the surface , the laminar sub – layer , in which the only motion at right angles to the surface is due to molecular diffusion .
2- Next , the buffer layer , in which molecular diffusion and eddy motion are of comparable magnitude .
3- Finally , over the greater part of the fluid the turbulent region in which eddy motion is large compared with molecular diffusion .

In addition to momentum , both heat and mass can be transferred either by molecular diffusion alone or by molecular diffusion combined with eddy diffusion . Because the effects of eddy diffusion are generally far greater than those of the molecular diffusion , the main resistance to transfer will lie in the region where only molecular diffusion is occurring .

Transfer by molecular Diffusion momentum transfer .

Momentum Transfer

When the flow characteristics of the fluid are Newtonian , the shear stress (R_y) in a fluid is proportional to the velocity gradient and to the viscosity .

$$R_y = -\mu \frac{dU_x}{dy}$$

$$R_y = -\frac{\mu}{\rho} \frac{d(\rho U_x)}{dy}$$

Where:

U_x : is the velocity of the fluid parallel to the surface at distance (y) from it .

R_y : is the shear stress within the fluid , [is a measure of the rate of transfer of momentum per unit area at right angles at the surface .

The negative sign indicates that momentum is transferred from fast to the slow moving fluid and the shear stress acts in such a direction as to oppose the motion of the fluid .