

Northern Technical University

Technical College - Kirkuk

Fuel and Energy Technologies Eng. Dept.

Forth Year Students



Reactors Design



Lecture one

The Basics of Reaction Kinetics



Chemical Thermodynamics

- ▶ Chemical **kinetics** is the study of chemical reaction rates and reaction mechanisms.
- ▶ It is the study of chemical kinetics with the reactors in which the reactions occur. Chemical kinetics and reactor design are at the heart of producing almost all industrial chemicals.



Chemical Thermodynamics

- ▶ Reactor design uses information, knowledge, and experience from a variety of areas-thermodynamics, chemical kinetics, fluid mechanics, heat transfer, mass transfer, and economics.
- ▶ Chemical reaction engineering is the synthesis of all these factors with the aim of properly designing a chemical reactor.



Classification of Reactions

- ▶ A reaction is **homogeneous** if it takes place in **one phase** alone.
- ▶ A reaction is **heterogeneous** if it requires the presence of **at least two phases** to proceed at the rate that it does.
- ▶ **catalytic** is materials that are neither reactants nor products.
- ▶ These foreign materials(catalysts), need not be present in large amounts.
- ▶ Catalysts act somehow as go-betweens, either hindering or accelerating the reaction process while being modified relatively slowly if at all.

Table 1.1 Classification of Chemical Reactions Useful in Reactor Design

	Noncatalytic	Catalytic
Homogeneous	Most gas-phase reactions	Most liquid-phase reactions
	Fast reactions such as burning of a flame	Reactions in colloidal systems Enzyme and microbial reactions
Heterogeneous	Burning of coal	Ammonia synthesis
	Roasting of ores	Oxidation of ammonia to produce nitric acid
	Attack of solids by acids	Cracking of crude oil
	Gas-liquid absorption with reaction	Oxidation of SO_2 to SO_3
	Reduction of iron ore to iron and steel	



Variables Affecting the Rate of Reaction

- ▶ Many variables may affect the rate of a chemical reaction. In homogeneous systems the temperature, pressure, and composition are obvious variables.
- ▶ In heterogeneous systems more than one phase is involved; hence, the problem becomes more complex.



Variables Affecting the Rate of Reaction

- ▶ Material may have to move from phase to phase during reaction; hence, the rate of mass transfer can become important. In addition, the rate of heat transfer may also become a factor. These heat and mass transfer effects become increasingly important the faster the rate of reaction, and in very fast reactions, such as burning flames, they become rate controlling. Thus, heat and mass transfer may play important roles in determining the rates of heterogeneous reactions.