3.5 Chain Reactions

Many reactions proceed through series of self repeating steps involving formation of active species called free radicals, as intermediates. These species either regenerate themselves or produce other active species that can carry on the reaction and are responsible for the formation of products. Such reactions are called chain reactions.

The chain reaction, in general, involves following three steps:

(*a*) *Initiation step:* In this step the intermediate or free radicals which are responsible to carry on the reaction, are formed from the ordinary molecules. For example in the reaction of H_2 and Br_2, at the first stage, the molecules of bromine are dissociated into atoms

$$Br_2 \rightarrow Br + Br \text{ (chain initiation)} \qquad \text{(i)}$$

(*b*) *Propagation step:* The initiation step is followed by reactions leading to the formation of the product with simultaneous generation of one or more reactive species. Such steps are called *propagation steps*

$$Br + H_2 \rightarrow HBr + H \qquad \text{(ii)}$$

$$H + Br_2 \rightarrow HBr + Br \qquad \text{(iii)}$$

Br atom which leads to the formation of HBr in steps (ii) and (iii) is also required to continue the cycle. These self-propagating steps are likely to continue through repeated generation of chains of H and Br atoms. Thus, for any initial Br atom, the formation of a large number of HBr would result.

(*c*) *Termination step:* The removal of the active species from the participation in the propagation steps results in breaking of the chain and stopping of the reaction. This step is called *termination step*. For example, when two Br atoms come together to unite into a Br_2 molecule, the chain is broken and stopped

$$Br + Br \rightarrow Br_2 \quad \text{(termination step)} \qquad \text{(iv)}$$

In any controlled chain reaction steps (*a*) to (c) are essentially present. However, in some chain reactions, a step, which may inhibit the process, may also be involved. This step is called *inhibition step*. For example, in Br_2 and H_2 reaction, a collision between H atom and HBr inhibit the process and inhibitation step is also present

$$H + HBr \rightarrow H_2 + Br \quad \text{(inhibitation step)} \qquad \text{(v)}$$