Chapter 7: Factors Affecting Reaction Rates

Aditi Banjare*

Shaildevi Mahavidyala Anda, Durg, Affiliated to Hemchand Yadav Vishwavidyalaya, Durg (CG)

Abstract

This chapter discusses the many factors that affect the rate of chemical reactions with a critical insight into the laboratory and industrial fields. Some of the important factors that were discussed are temperature, pressure, concentration of reactants, catalysts, and solvent effects, which have a significant influence on reaction kinetics and the formation of products. The chapter describes the impact of temperature on molecular collisions and activation energy, pressure on gas reactions, and the concentration on reaction frequency. The mechanism of catalysts in reducing the activation energy and increasing the reaction rate without undergoing consumption is explained, the interaction of solvents with the reaction medium polarity, and the reaction mechanism. The industrial applications are also presented by illustrative examples of the chemical manufacturing industry, polymer manufacturing industry, pharmaceuticals and catalytic-based industries and the significance of optimization of the reaction conditions to make it efficient, safe and economically viable. The chapter is a combination of theory and practice that can enable students to know how to regulate the rate of reactions, enhance yields, decrease energy use, and create safer chemical reactions. Process engineers, industrial chemists, and researchers should be aware of such factors so that they can come up with effective, scalable, and sustainable chemical operations.

Keywords: Reaction rate, Temperature effect, Pressure effect, Catalysts, Solvent effects, Industrial applications, Reaction optimization.

[ ] ***Corresponding author**

Ms. Aditi Banjare

E-mail address: aditi.banjare@gmail.com

7.1. Reaction Rates

The rate of a chemical reaction is a measure of how quickly reactants are converted into products over time. It is defined as the change in concentration of a reactant or product per unit time. Mathematically, for a reactant A and product P:

$$\text{Rate} = -\frac{\Delta[A]}{\Delta t} = \frac{\Delta[P]}{\Delta t}$$

The negative sign is an indication of the decline in the concentration of the reactants with time. The rate of reactions is crucial in reaction mechanisms and the design of reactors as well as optimization of industrial processes. The rates depend on a number of factors. The concentration of reactants influences the frequency of molecular collisions as generally the higher the concentration, the higher the rate. Another important consideration is temperature; as temperature rises so does kinetic energy, and since the more slamming, energetic collisions take place. Gas reactions are affected by pressure and the greater the pressure, the more the reaction is concentrated. The rate of a heterogeneous reaction depends on the surface area of the solid reactants used whereas catalysts offer a different mechanism that has a lower activation energy thus speeding up the reaction but does not get used. Reaction rates give an understanding of the manner and reasons behind reactions and also allow chemists to predict how a reaction proceeds, optimize reaction conditions, scale up laboratory reactions, and ensure product quality and safety. All basic research and industrial practice in chemical kinetics require an understanding of the principles of reaction rates, which encompasses a gap between theory and practice. Rates of reactions can be determined experimentally by observing the change of concentration by spectrophotometry, gas volumetry, titration and conductivity measurements. With the aid of