


Chapter 2


Catalysis and Sonochemistry

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ABSTRACT

Sonochemistry or ultrasound promoted chemistry is one of the emerging subjects of chemistry and materials sciences. The utility of sonochemistry has created a huge impact in academic and industrial sectors. Increasing efficiency is the major point focussed by all the industrialists and ultrasound chemistry has proved its value and is in high use from recent years. Catalysis is the process where catalysts are employed for the acceleration of the reaction. On the other hand, sonochemistry has extended its arm in contributing in efficient synthesis of various organic compounds using the principles of green techniques. Furthermore, biocatalytic reactions are also dependent on fundamentals of sonochemistry, making use of enzyme catalysts and making organic synthesis more effective and interesting. Many of the heterocycles used for the therapeutic applications employ sonochemistry for different cross-coupling reactions and result in enhanced productivity. Thus, sonochemistry and catalysis play an important role in industrial processes and drag attention due to their extensive properties

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INTRODUCTION

Ultrasound technique has been widely used nowadays due to their remarkable properties and execution of reactions with several merits. Thus, their principle is a must-learn aspect for every organic chemist who is in the verge of excelling in the field of synthetic organic chemistry. (Al-bogami, 2015; El-bendary et al., 2021; N. N. Gharat & Rathod, 2020; Nikpassand et al., 2020; Veisi et al., 2021) With the frequency range of 20 kHz to 5 MHz, ultrasound functions as an intensified tool for the removal of biologically active molecules aiding for the formation of medicines. (Draye et al., 2020; Majhi, 2021; Mohammadi Ziarani et al., 2020) Especially, in the liquid medium, the role of ultrasonics is pivotal as it is dealt with increasing the chemical reactivity through the formation and collapse of the bubbles (cavitation). (Ashokkumar, 2011) The mechanism of ultrasound in the liquid reactions is very clear with alternate compression and rarefaction resulting in the formation of cavities. (Yasui, 2010) Ultimately, the energy gets dissipated as the cavities grow to a maximum size and burst out. Eventually, mass transfer energy rates are significantly improved due to the turbulence associated with the creation and bursting out of the cavity bubbles. (Rosales Pérez & Esquivel Escalante, 2024) Ultrasound irradiation is employed to accelerate the reaction and for its acceleration several external factors affect the reaction rate which are discussed in the sections below.

Catalysis is the phenomenon of accelerating a chemical reaction with the aid of a chemical substance that plays a key role without being consumed during the reaction. This substance or agent is known as catalyst. There are numerous catalysts available today specific for many organic reactions. Catalysis is of two kinds based on the phases, namely, homogenous and heterogenous, respectively. When there are components dispersed in one phase is known as homogenous catalysis and that with two different phases is known as heterogenous catalysis. (Dev et al., 2018; García Mancheño & Waser, 2023; Guan et al., 2023; Z. Li et al., 2021; Rosales Pérez & Esquivel Escalante, 2024)

In this current chapter, we discuss the external factors responsible for the acceleration of the reaction using sonochemistry principles. By making use of these factors, we herein reflect several organic reactions where ultrasound irradiation is applied for the successful catalytic processes.

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