Chapter 13
Eco-Friendly Solvents:
A Promising Approach to Green Synthesis

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ABSTRACT

Solvents influence cost, safety, and health concerns in addition to defining a significant portion of the environmental performance of chemical industrial processes. The concept of "green" solvents reflects the intention to reduce the negative effects that solvent use in chemical production has on our surroundings. This chapter provides a thorough framework for evaluating the environmental impact of solvents, covering significant health and safety concerns in addition to key facets of the solvents' environmental performance in chemical manufacturing. The methodology integrates the evaluation of substance-specific risks with the measurement of emissions and resource consumption during a solvent's whole life cycle. This chapter also discusses the requirements for green solvents, what constitutes an ideal green solvent, and the various kinds of green solvents, including supercritical carbon dioxide, water, fluorous solvents, glycerol as a solvent, ionic liquids, deep eutectic liquids, and switchable solvents.

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INTRODUCTION

Green chemistry has focused tremendously regarding priority given to solvents (Breeden *et al.*, 2012; Clark *et al.*, 2015; Pena-Pereira *et al.*, 2015; Pollet *et al.*, 2014). This is explained by the enormous amount of solvent that is usually utilized in a formulation or in a reaction, particularly during the purification stage (Abou-Shehada *et al.*, 2016; Constable *et al.*, 2007). As revolutionary as catalysts, solvents establish essential characteristics for chemical processing and reactions. A solvent is more than simply a tool and a place to react; it can also be the secret to a successful chemical process. In many significant chemical processes, particularly the production of fine chemicals, chemical solvents make up about 80% of the total volume of chemicals required. Surprisingly, these solvents are frequently volatile organic petroleum resource compounds that pose numerous risks to the surroundings and public health. Due to these two reasons, a lot of scholars are searching for new, eco-friendly solvents that can substitute the conventional ones. A significant portion of the environmental and financial performance of a process is determined by the use of huge volumes of volatile and combustible organic solvents in different reaction systems and separation phases found in many industrial processes.

The usage of "safer solvents and auxiliaries" is specifically mentioned by Anastas and Warner (Anastas and Warner, 2000) in their book 12 Principles of Green Chemistry. The principles of Green Chemistry have significantly transformed the approaches of organic chemists over the past thirty years (Gałuszka *et al.*, 2013). Similarly, solvents have become more significant for chemical process engineers designing under the circularity framework of the "10R frame work," (Morseletto and recycling, 2020) which stands for ten principles beginning with the letter "R," including recycling, reuse, repair, rethinking, remanufacturing, and so forth. The concentration at which reactants may be processed—solubility—is determined by the solvent, which ultimately determines productivity and economic advantage. Additionally, they can steer the activation potential-energy curves by promoting the stability of excited states.

METHODOLOGIES FOR EVALUATION

"What is a green solvent?" is the fundamental query Fischer and colleagues at ETH Zurich, often known as the Swiss Federal Institute of Technology, put in the title of their 2007 paper (Capello, Fischer, *et al.*, 2007). Methodology for evaluating solvents' environmental impact that addresses both health and safety concerns as well as the main environmental performance characteristics of solvents used in chemical manufacturing. The above model applies two environmental evaluation techniques with varying purviews.

- EHS assessment method
- Life-cycle assessment (LCA) method

EHS Assessment Method

The EHS assessment method the first approach is a screening technique designed to find possible chemical dangers. The EHS approach mainly depends on the availability of information about the toxicity, safety, environmental factors, and physical and chemical characteristics of the substances to be evaluated (Koller *et al.*, 2000). In a previous sophisticated software program, the EHS tool used as a communication channel between database systems and the tool to automatically gather these data