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Commentary

Note on High Performance Liquid Chromatography (HPLC)

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DESCRIPTION

The most extensively used analytical technology for pharmaceutical analysis is High-Performance Liquid Chromatography (HPLC). Indeed, it is the most important technique used in the quality control of bulk drugs and pharmaceutical formulations (e.g., API analysis, impurity characterization, degradation product determination to test product stability, and enantiomeric purity determination), as well as the determination of drugs and metabolites in biological samples. The Reversed-Phase (RP) mode, which uses a hydrophobic stationary phase and a polar mobile phase, is used in the majority of HPLC procedures established in pharmaceutical laboratories. The Ultraviolet (UV)/Visible detector is the most often utilized detection mode in quality control. As a result, mobile phase compatibility with this detection is a factor that is frequently considered during the formulation of pharmaceutical analysis. Water (with additions to alter pH and ionic strength) and organic solvent, such as acetonitrile (ACN) or methanol, makes the mobile phase of RP-HPLC (MeOH). Because of this mix of qualities beneficial for RP-HPLC applications, these two organic solvents are by far the most organic solvents utilized in RP-HPLC.

Despite their remarkable properties, ACN and MeOH have certain concerns about their environmental effect and health safety. ACN is combustible, volatile, and poisonous. Despite the fact that MeOH is less toxic and more easily biodegradable than ACN, it is nevertheless classified as a hazardous solvent due to its intrinsic toxicity and the high waste disposal requirements. The quantity of waste created by RP-HPLC tests, however, cannot be disregarded. In reality, a continuous liquid chromatograph with a standard LC column (15-25 cm length, 4.6 mm i.d., packed with 5 m particles) and a mobile phase flow rate of 1 mL/min produces around 1.5 L of effluent per day, or about 500 L of effluent per year.

Despite the fact that this amount of waste is insignificant in comparison to the waste generated by large industrial manufacturing companies, some large pharmaceutical companies use hundreds of liquid chromatographs in their research and development and quality control laboratories, resulting in thousands of litres of toxic waste being produced every day. Furthermore, HPLC is being used more often as a result of technical advancements that allow for high-throughput analysis, which increases the quantity of waste produced at the same time. These ACN and MeOH-containing HPLC waste streams must be disposed of as chemical waste, which is expensive and adds to the laboratory's environmental waste disposal load.

Some ways are often used to produce quality liquid chromatography procedures based on the 12 principles of green chemistry. They emphasize reducing solvent consumption by reducing column length, internal diameter, and/or column particle size; replacing toxic and hazardous solvents like ACN and MeOH with less toxic and environmentally friendly alternatives; and emphasizing recycling in larger-scale preparative separation technologies. At all stages of the analysis, from sample collection and preparation through separation and final determination, chromatographic procedures have the potential to be more environmentally friendly. Because certain strategies for improving quality of chromatographic methods is more effective than others, evaluation tools to measure the quality of analytical methods are required. The NEMI labeling and analytical Eco-scale approaches are two of the most well-known technologies that have previously been created. If hazardous or corrosive chemicals are utilized, or if the method creates considerable volumes of waste, NEMI labeling produces an easy-to-read pictogram. The analytical Eco-scale is a more quantitative technique based on deducting penalty points from a total of 100 depending on reagent quantity and danger, energy consumption and occupational risks.

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