Supercritical Fluid Chromatography (SFC)

- Principle-Supercritical Fluid Chromatography (SFC) operates on the principle of using a supercritical fluid (SCF) as the mobile phase to separate compounds in a mixture. A supercritical fluid is a substance that has been heated above its critical temperature and pressure, causing it to exhibit properties of both liquids and gases. This unique state allows supercritical fluids to diffuse like gases but dissolve materials like liquids. For SFC, carbon dioxide (CO_2) is typically the supercritical fluid, though others like methane or ethane can also be used depending on the application.

  The separation process in SFC occurs because different compounds in the sample interact with the supercritical fluid and stationary phase to different extents, depending on their chemical properties such as polarity, size, and volatility. The supercritical fluid moves through the column, and compounds are separated based on their affinity for the stationary phase, which leads to different retention times and eventual detection.

- Components
  1. Supercritical Fluid (Mobile Phase)-The key feature of SFC is the use of a supercritical fluid as the mobile phase, which is typically carbon dioxide (CO_2). CO_2 is chosen due to its ability to be easily pressurized and its low toxicity. As a supercritical fluid, CO_2 behaves as a gas and liquid simultaneously, enabling it to dissolve organic compounds similar to a liquid while maintaining the diffusivity of a gas. The density and viscosity of CO_2 can be altered by changing the pressure and temperature, making it a highly versatile solvent for a wide range of compounds.

  2. Syringe Pump-The syringe pump is responsible for introducing the supercritical fluid into the chromatographic system. It controls the flow rate of the mobile phase and ensures it is delivered at the correct pressure to maintain supercritical conditions. Accurate control over the flow rate is essential for reproducible results and efficient separation of components. The pressure can typically range from 1000 psi to 5000 psi, depending on the application.

  3. Chromatographic Column-The column is packed with a stationary phase, often made of silica gel, polymeric material, or other materials depending on the specific type of separation required. The column plays a critical role in determining the separation efficiency by providing a surface for interactions between the analytes and the stationary phase. The length and diameter of the column, as well as the characteristics of the stationary phase, all influence the separation process, including the retention times of analytes.

  4. Detector-The detector is used to identify and quantify the separated compounds as they elute from the column. Common detectors used in SFC include: