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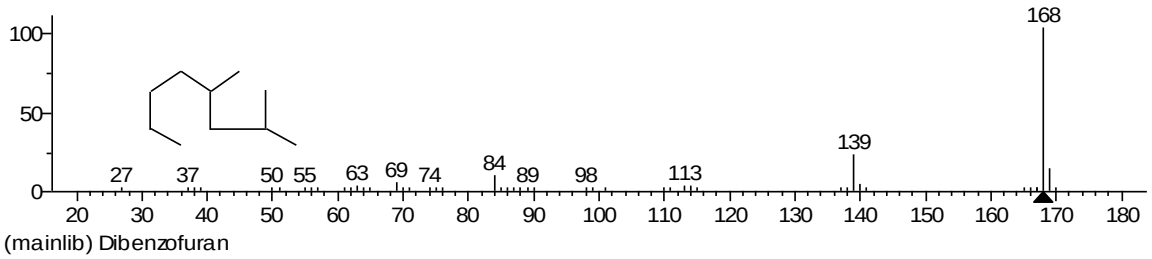
Introduction

Gas Chromatography–Mass Spectrometry (GC-MS) is a hyphenated analytical technique that combines the separation properties of gas-liquid chromatography with the detection feature of mass spectrometry to identify di erent substances within a test sample (Figure 1). GC is used to separate the volatile and thermally stable substitutes in a sample whereas GC-MS fragments the analyte to be identi ed on the basis of its mass. e further addition of mass spectrometer in it leads to GC-MS/MS. Superior performance is achieved by single and triple quadrupole modes [1-3].

Figure 1: A typical GC-MS with head space of Shimadzu Company



analyzed the atmosphere of Venus with GC-MS. e Huygens probe of the Cassini-Huygens mission landed one GC-MS on Saturn's largest moon, Titan. e material in the comet 67P/Churyumov-Gerasimenko will be analyzed by the Rosetta mission with a chiral GC-MS in 2014.

Signi cantly enhanced molecular ions, major isomer and structurally signi cant mass spectral peaks, extended range of low volatility hydrocarbons that are amenable for analysis and unique isotope ratio information make GC-MS valuable for organic geochemical applications [15,16].

Medicine and Pharmaceutical Applications

Dozens of congenital metabolic diseases called as inborn error of metabolism are now detectable in newborn by screening tests using gas chromatography–mass spectrometry. GC-MS can determine compounds in urine even in minor concentration. ese compounds are normally not present but appear in individuals su ering from metabolic disorders. is is easy, e ective and e cient way to diagnose the problem like in case of genetic metabolic disorders by a urine test at birth. In combination with isotopic labeling of metabolite, the GC-MS is used for determining metabolic activity. Most applications are based on the use of ^{13}C labeling and the measurement of ^{13}C-^{12}C ratios with an isotope ratio mass spectrometer (IRMS); an MS with a detector designed to measure a few select ions and return values as ratios. It is useful to detect oils in creams, ointments, lotion etc.

GC-MS is widely used in pharmaceutical industries for analytical research and development, quality control, quality assurance, production, pilot plants departments for active pharmaceutical ingredients (API), bulk drugs and formulations. It is used for process and method development, identi cation of impurities in API. It is an integral part of research associated with medicinal chemistry (synthesis and characterization of compounds), pharmaceutical analysis (stability testing, impurity pro ling), pharmacognosy, pharmaceutical process control (Figure 7), pharmaceutical biotechnology etc. [17,18].

Petrochemical and hydrocarbons analysis

Signi cantly enhanced molecular ions that are always observed, isomer and structurally signi cant mass spectral peaks and extended range of low volatilite hydrocarbons that are amenable for analysis including waxes up to $C_{74}H_{150}$ makes the GC-MS a most valuable technique. Broad range of petrochemicals, fuels and hydrocarbon mixtures, including gasoline, kerosene, naphthenic acids, diesel fuel (Figures 8A and 8B), various oil types, transformer oil, biodiesel, wax and broad range of geochemical samples can be analyzed by GC-MS [19].

Clinical toxicology

Enhanced molecular ions, extended range of compounds amenable for analysis, superior sensitivity for compounds and faster analysis are the main attractive features of the clinical toxicology. e toxin and venoms are identi ed by GC-MS. It is extensively used in clinical toxicology [20].

Academic research

As a unique and powerful technology the GC-MS provides a rare opportunity to perform the analysis of new compounds for characterization and identi cation of synthesized or derivatized compound. It is widely used in pure and applied sciences like Chemistry, Polymers, Nanotechnology and Biotechnology etc. It yields useful information that w 0 -1.nced molecular ions, 8o43nformation that w 0

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