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Formulations and Role of Analytical Techniques in Chemical Industries

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Abstract

Analytical methods refer to techniques used for the detection, identification, characterization and quantification of chemical compounds. These methods are commonly used in chemical sciences for research, development and quality control of pharmaceutical products. MALDI-TOF is a mass spectrometer that couples an ionisation source, the matrix-assisted lasers desorption/ionization (MALDI) with a Time of Flight (ToF) analyser is particularly recommended when a limited number of species are present in each sample analyzed. ICP-OES is a trace-level, elemental analysis technique that uses the emission spectra of a sample to identify, and quantify the elements present. Gas Chromatography (GC) provides a quantitative analysis of volatile and semi-volatile organic compounds found in a variety of matrices (gases, liquids and solids) in foods, medical materials, plastics, environmental samples and occupational monitoring samples. NMR (Nuclear Magnetic Resonance) Spectroscopy provides physical, chemical, electronic and structural information from organic compounds in liquid or solid form. Atomic Absorption Spectroscopy provides cost-effective viable solutions for the analysis of trace amounts of metals in the entire range of natural and manmade materials such as Geological samples, Environmental samples, Biological Specimens, Agricultural produce and soils, Pharmaceuticals, Foods and Drinking water.

Keywords: Chemical industries, analytical techniques, chromatography, Chemical compounds.

1. INTRODUCTION

There are different techniques that are used for the detection of chemical compounds as well as their characterization. Some traditional methods and techniques are used but due to high cost and impure production formation leads to falsification in results. It also attributed to the relent of new techniques that are used in these days. Some advanced techniques are used for the synthesis of chemical compounds at commercial and industrial level [1, 2].

There are different techniques that are used for the analysis of chemical elements, compounds such as MALDI-TOF MS, Gas chromatography, ion exchange, HPC. These techniques lead to make significant at attention of process occurring at industrial level for the synthesis of chemical compounds. In analytical chemistry the technique is used for determining the concentration of a particular element (the analytic) in a sample to be analyzed. AAS can be used to determine over 70 different elements in solution, or directly in solid samples via electro thermal vaporization, and is used in pharmacology, biophysics, and archaeology and toxicology research. Chemical analysis and detection has become important for verification of technical data as well as drug discover [3, 4].

Chemical techniques are much important than traditional method for analysis and detection of chemical compounds [5]. The technique affords advantages of speed, sensitivity and precision over the classical gravimetric methods. Introduction of accessories such as graphite furnace, flow injection analysis and improvements in the suppression of matrix interferences have further contributed to improvement in sensitivity and selectivity of analytes in complex matrices [6].

2. Role of Analytical Techniques in Chemical Industries

There are different technique used in chemical industries for analysis, characterization and detection of compounds that synthesized advanced analyzers rather than traditional tools.

2.1 Principles and Role of MALDI-TOF in Chemical Industries

One of the most important technique in analysis and discovery of novel compunds is the MALDI-TOF is a mass spectrometer that couples an ionization source, the matrix-assisted laser desorption/ionization (MALDI) with a Time of Flight (ToF) analyzer[7]. It is helpful for the indication as well as analysis of biological compounds in order to maintain the accuracy of scientific results. This method is particularly recommended when a limited number of species are present in each sample analyzed. It also depends upon the number samples that analyzed to be accurate. It deals the measuring of sample through the irritating of sample via the matrix and lasers that playing major role in production of chemical compounds [8, 9].

Preparation or isolation of samples in MALDI is very important for accurate measuring the samples through series of chemical reactions [10-12]. Different types of samples such as chemical, biological can be tested through MALDI but it depends upon the speed of laser. Investigators have evaluated different sample preparation methods for different groups of microorganisms. Some microbes might be identified directly by MS, called direct cell profiling, while for some others whole cell lysates or crude cell extracts are prepared. Samples of microbes directly mix to the matrix and falling of laser leads to accurate detection of microbial proteins and discovery of antibiotics. It is surprising that the potential applicability of MALDI-TOF MS as a diagnostic tool for testing the organic solvents and their importance has not yet been systematically assessed, in particular because the technique has been successfully employed for identification of novel chemical compounds [13-15].

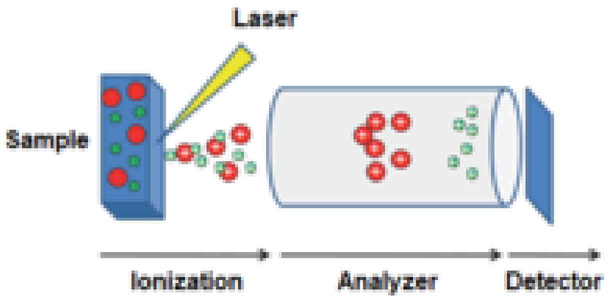

Fig-1: Shows the principle working of MALDI-TOF and its components

2.2. Principles and Role of ICP-OES in Chemical Industries

There is another technique that is used mostly in detection of chemical compounds, environmental samples, water samples, diagnosis [16]. Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES Analysis) is a trace-level, elemental analysis technique that uses the emission spectra of a sample to identify, and quantify the elements present. The principle of this ICP-OES is the generation of plasma by releasing of the argon gas to the samples taken from the soil, biological and environmental. Light is produced once plasma strikes the sample. It is sensitive and hence indents the large number of chemical analysis at a time with accuracy [17-20].

ICP-OES leads to the clear identification of chemical compounds that are synthesized in industries [21]. Sample proration and plasma in ICP-OES are mainly involved and key for detection of chemical compounds in short time. Samples are introduced into the plasma in a process that desolates, ionizes, and excites them. The constituent elements can be identified by their characteristic emission lines, and quantified by the intensity. This technique is used for testing the food samples with concentration of chemical elemental composition, concentrations of heavy metals in drinking and wastewater, soils samples taken from debris in the liquid. This technique has also disadvantages such as severity of torch once damage during detection of compounds leads to serious damage to components of the samples [22].

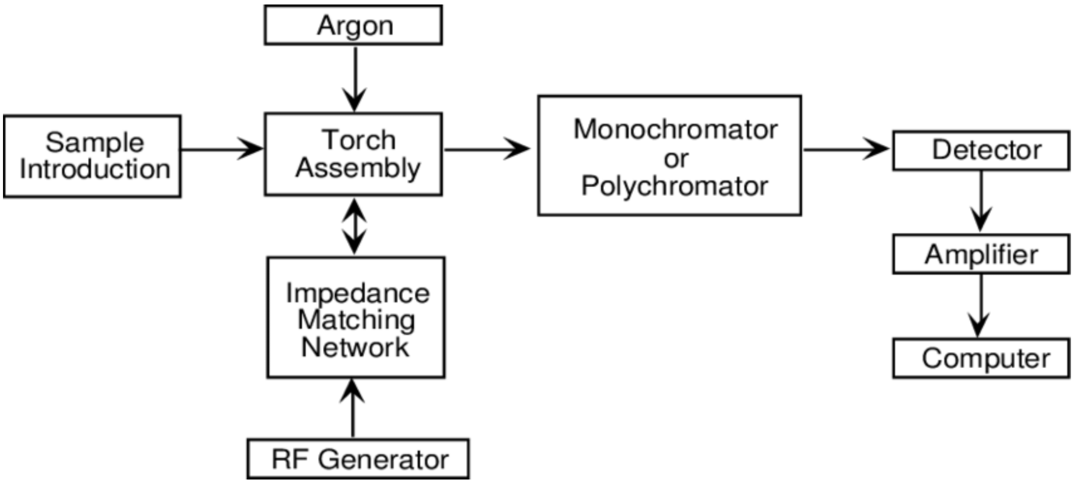

Fig-2: Shows the principle working of ICP-OES and its components

2.3. Principles and Role of NMR in Chemical Industries

There are different chemical compounds that could be detected on the basis of magnetic field through clockwise or anticlockwise. NMR (Nuclear Magnetic Resonance) Spectroscopy provides physical, chemical, electronic and structural information from organic compounds in liquid or solid form. In NMR, samples are usually transferred to the NMR tube that made up of the glass and has resistance against the special impurities. Sample then place under the magnetic field there particular type of atoms jumps by irradiation at the specific frequency. This information provides structural and electronic information which translates into an extremely powerful analytical technique [23, 24].

There is different application of NMR in different chemical industries for the synthesis, detstion of compounds [18]. It also ensures the accuracy of analysis of specific compounds. It is helpful for the determination of molecular weight under the influence of magnetic field. It also determines the movement of biological molecules such as carbohydrates and lipids. It also determine the chemical structures of compounds such as NMR spectra, it is applicable to those compounds where rotation and charge influence on the specific rotation. Hence, NMR is the main technique for the determination of molecular weight rotation when applying the specific magnetic field [25-27].

2.4 Principles and Role of AAS in Chemical Industries

Atomic Absorption spectroscopy is used for the detection of chemical compounds and elements in chemical industries such as for measuring the concentrations of water, concentration of heavy metals in drinking and wastewater. It measures the chemical compounds by using the absorption of optical radiation (light) by free atoms in the gaseous state. There are different bulbs used for the analysis of each heavy metal in water. AAS is time consuming and hence used in some industries but advanced analyzer using the ICP-OES that is the most advanced technique for separation and detection of chemical parameters in specific environmental samples [28].

Atomic Absorption Spectroscopy also used I different studies, research, laboratory investigation but due to extensive materials cost viable solutions for the analysis of trace amounts of metals in the entire range of natural and manmade materials such as Geological samples, Environmental samples, Biological Specimens, Agricultural produce and soils, Pharmaceuticals, Foods and Drinking water. AAS leads to accurate analysis of chemical, biological and medical analysis but some industries at low level cannot afford this costly technique. This technique especially at large level but extensive costing required that leads to innovation and development in analytical techniques [29, 30].

CONCLUSION

There are different analytical techniques that are used for identification, characterization and purification of chemical compounds. These techniques are NMR, HPLC, ICP-OES and atomic absorption. Each technique has its application at the industrial scale but some industries cannot used them due to high cost and mainly run for analysis for manual traditional machines. There review helpful for the advancements in chemical techniques for their measurements both industrial and commercial level.

REFERENCES

1. Welker, M., Fastner, J., Erhard, M., & von Döhren, H. (2002). Applications of MALDI- TOF MS analysis in cyanotoxin research. Environmental

Toxicology: An International Journal, 17(4), 367-374.

2. Khitrov, G. A., & Strouse, G. F. (2003). ZnS nanomaterial characterization by MALDI-TOF mass spectrometry. Journal of the American Chemical Society, 125(34), 10465-10469.
3. Rigueira, L. M., Lana, D. A., Dos Santos, D. M., Pimenta, A. M., Augusti, R., & Costa, L. M. (2016). Identification of metal-binding to proteins in seed samples using RF-HPLC-UV, GFAAS and MALDI-TOF-MS. Food chemistry, 211, 910-915.
4. Remmers, M., Müller, B., Martin, K., Räder, H. J., & Köhler, W. (1999). Poly (p-phenylene) s. Synthesis, Optical Properties, and Quantitative Analysis with HPLC and MALDI− TOF Mass Spectrometry. Macromolecules, 32(4), 1073-1079.
5. Calvano, C. D., Picca, R. A., Bonerba, E., Tantillo, G., Cioffi, N., & Palmisano, F. (2016). MALDI-TOF mass spectrometry analysis of proteins and lipids in Escherichia coli exposed to copper ions and nanoparticles. Journal of Mass Spectrometry, 51(9), 828-840.
6. McNair, H. M., Miller, J. M., & Snow, N. H. (2019). Basic gas chromatography. John Wiley & Sons.
7. Lloyd, D. R., Ward, T. C., & Schreiber, H. P. (1989). Inverse gas chromatography (No. CONF-880604-). Washington, DC (USA); American Chemical Society.
8. Masada, Y. (1976). Analysis of essential oils by gas chromatography and mass spectrometry.
9. Santos, F. J., & Galceran, M. T. (2002). The application of gas chromatography to environmental analysis. TrAC Trends in Analytical Chemistry, 21(9-10), 672-685.
10. Olesik, J. W. (1996). Peer reviewed: Fundamental research in ICP-OES and ICPMS. Analytical Chemistry, 68(15), 469A-474A.
11. Gomez, M. R., Cerutti, S., Sombra, L. L., Silva, M. F., & Martínez, L. D. (2007). Determination of heavy metals for the quality control in argentinian herbal medicines by ETAAS and ICP-OES. Food and Chemical Toxicology, 45(6), 1060-1064.
12. Lara, R., Cerutti, S., Salonia, J. A., Olsina, R. A., & Martinez, L. D. (2005). Trace element determination of Argentine wines using ETAAS and USN-ICP-OES. Food and Chemical Toxicology, 43(2), 293-297.
13. Rezić, I., & Steffan, I. (2007). ICP-OES determination of metals present in textile materials. Microchemical Journal, 85(1), 46-51.
14. Kalinowski, H. O., Berger, S., & Braun, S. (1988). Carbon-13 NMR spectroscopy.
15. Sprangers, R., & Kay, L. E. (2007). Quantitative dynamics and binding studies of the 20S proteasome by NMR. Nature, 445(7128), 618-622.
16. Alderson, T. R., & Kay, L. E. (2020). Unveiling invisible protein states with NMR spectroscopy. Current opinion in structural biology, 60, 39-49.
17. Hope, M. A., Rinkel, B. L., Gunnarsdóttir, A. B., Märker, K., Menkin, S., Paul, S., ... & Grey, C. P. (2020). Selective NMR observation of the SEI–metal interface by dynamic nuclear polarisation from lithium metal. Nature communications, 11(1), 1-8.
18. Schütz, S., & Sprangers, R. (2020). Methyl TROSY spectroscopy: A versatile NMR approach to study challenging biological systems. Progress in nuclear magnetic resonance spectroscopy, 116, 56-84.
19. Wong, L. E., Kim, T. H., Muhandiram, D. R., Forman-Kay, J. D., & Kay, L. E. (2020). NMR experiments for studies of dilute and condensed protein phases: application to the phase-separating protein CAPRIN1. Journal of the American Chemical Society, 142(5), 2471-2489.
20. Troelsen, N. S., Shanina, E., Gonzalez- Romero, D., Danková, D., Jensen, I. S., Śniady, K. J., & Clausen, M. H. (2020). The 3F Library: Fluorinated Fsp3 Rich Fragments for Expeditious 19F NMR Based Screening. Angewandte Chemie International Edition, 59(6), 2204-2210.
21. Chen, L., Zhao, X., Wu, J. E., Liu, Q., Pang, X., & Yang, H. (2020). Metabolic characterisation of eight Escherichia coli strains including" Big Six" and acidic responses of selected strains revealed by NMR spectroscopy. Food microbiology, 88, 103399.
22. Xu, Y., Szell, P. M., Kumar, V., & Bryce, D. L. (2020). Solid-state NMR spectroscopy for the analysis of element-based non-covalent interactions. Coordination Chemistry Reviews, 411, 213237.
23. Tran, T. K., Sailasuta, N., Kreutzer, U., Hurd, R., Chung, Y., Mole, P., & Jue, T. (1999). Comparative analysis of NMR and NIRS measurements of intracellular PO 2 in human skeletal muscle. American Journal of Physiology-Regulatory, Integrative and Comparative Physiology, 276(6), R1682-R1690.
24. Smith Jr, J. C., Butrimovitz, G. P., & Purdy, W. C. (1979). Direct measurement of zinc in plasma by atomic absorption spectroscopy. Clinical Chemistry, 25(8), 1487-1491.
25. Willis, J. B. (1960). The determination of metals in blood serum by atomic absorption spectroscopy—I: calcium. Spectrochimica acta, 16(3), 259-E5.
26. Willis, J. B. (1961). Determination of calcium and magnesium in urine by atomic absorption spectroscopy. Analytical Chemistry, 33(4), 556-559.
27. Maurya, A., Kesharwani, L., & Mishra, M. K. (2018). Analysis of heavy metal in soil through atomic absorption spectroscopy for forensic consideration. Int. J. Res. Appl. Sci. Eng. Technol, 6(6), 1188-1192.

28. Merten, J., & Johnson, B. (2018). Massing laser-induced plasma with atomic absorption spectroscopy. Spectrochimica Acta Part B: Atomic Spectroscopy, 149, 124-131.
29. Merten, J., & Johnson, B. (2018). Laser continuum source atomic absorption spectroscopy: measuring the ground state with nanosecond resolution in laser-induced plasmas. Spectrochimica Acta Part B: Atomic Spectroscopy, 139, 38-43.
30. Rajeshwari, B. M., & Patil, S. J. (2018). Heavy Metals Status in Soils of Ballari District using Atomic Absorption Spectroscopy (AAS). Asian Journal of Research in Chemistry, 11(4), 701-704.

