

A Review on Use of Chromatography for Analytical Applications

Sunil J. Kulkarni^{*1}, Ajaygiri K. Goswami², Nilesh L. Shinde³

^{*1,3}Datta Meghe College of Engineering, Airoli, Navi Mumbai, Maharashtra, India.

²University Institute of Chemical Technology, North Maharashtra University, Jalgaon, Maharashtra

ABSTRACT

Analysis of the sample is very important in the research and development field. In pharmaceutical and fine chemicals industries the presence of very minute amount of unwanted material can cause very significant effect on quality. In research, the determination of heavy metal, phenol, dye and many other components in the sample of water, raw material or product is key to accuracy of the results and its interpretation. Spectroscopy is handy for detection of components. For very small amount it is not adequate. Chromatography and its various forms are very useful for analysis. The present review summarizes the research and studies on use of chromatography for analysis.

Keywords: Retention Factor, Stationary Phase, Mobile Phase, Solvents.

I. INTRODUCTION

Analysis of the sample is very important aspect of chemical and environmental engineering. The analysis of the wastewater for determination of minute impurities is important from health point of view. The presence of dyes, phenol, organic matter and heavy metals is harmful [1, 2, 3]. It is very important to analyse the water in order to select proper treatment technology. The determination chemical oxygen demand (COD) is normally done by using COD digestion apparatus and potassium dichromate as an oxidizing agent against Mohr's salt [4]. The phenol determination can be done by titration. For more accurate results, spectrophotometric methods are useful. For determination of heavy metals atomic absorption spectrophotometers is useful [5]. The energy dispersed x ray diffraction is also used for determination of various components in solid and liquid samples [6]. The analysis of dyes is generally done by spectrophotometric method [7]. Various chemical analysis methods can be used for glucose and starch [8, 9, 10]. Chromatography is very useful and important analytical technique. It is a method used for separating organic and inorganic compounds. It can be used to find out composition of solids and liquids. It can also be used to find unknown material in the sample. This aspect is important in forensic chemistry. In chromatography two phases, stationary and mobile,

are defined. The retention factor (R_f) is indication of how far compound travels in particular solvent. The chromatography finds wide application in research and development. The present review summarizes the studies and investigations on various aspects of chromatography in the analytical applications.

II. STUDIES AND RESEARCH ON CHROMATOGRAPHY FOR ANALYTICAL APPLICATIONS

Kupiec discussed high-performance liquid chromatography as analytical method [11]. He discussed various aspects of chromatographic separation. He explained retention, resolution and sensitivity. He discussed the mechanisms of chromatography including adsorption, partition, ion-exchange and size an exclusion. He concluded that HPLC is most widely used analytical method in pharmaceutical industries and laboratories. Curry discussed application of chromatography in forensic science [12]. It is difficult for forensic analyst to get high enough purity to obtain such data as % carbon, % hydrogen, % nitrogen, mixed melting points. Usually they do not get enough data required for the analysis. According to him paper chromatography provides a valuable addition to his armoury. Paper chromatography offers separation of similar material on microgram scale.

Even when compound is unknown, the active fraction of the compound can be identified. Sessions carried out review on isotope-ratio detection by gas chromatography [13]. The GC hardware continuously and quantitatively converts all organic matter, including column bleed, to a common molecular form for isotopic measurement. According to him, if problems related to its low elemental abundance can be resolved, and then analysis of organics is feasible. Dhote et.al. carried out research on thin layer chromatography [14]. They used thin layer of stannous silicate study the chromatographic behaviour of 18 metal ions in surfactant mixed solvents. They carried out investigations on effect of presence of alcohol at various concentrations, presence of strong and weak electrolytes, effect of concentration of surfactant, effect of acidity and basicity of aqueous surfactant on mobility of metal cations. In their experiments, mixture of stannous silicate and silica gel was the stationary phase. They observed that mobilities decreased in aqueous anionic surfactant mobile systems as compared to pure water and aqueous cationic surfactant mobile systems. They also observed that changes in pH of mobile phase systems had little effect on the mobility of metal ions. They also observed that R_f value of metal ions decreases as soon as chain length of alcohol increases from ethanol to butanol. Ning et.al. carried out investigation on fractionation of complex protein mixture[15]. They used virtual three-dimensional liquid chromatography based on combined pH and salt steps. They implemented pH and salt steps by turns on a single strong cation exchange column to fully exploit its chromatographic ability. Lehotay investigated application of gas chromatography in food industry[16]. According to them, typical gas chromatography application includes food composition, natural products, food Additives, flavour and aroma components, a variety of transformation products, and contaminants, such as pesticides, fumigants, environmental pollutants, natural toxins, veterinary drugs, and packaging materials. According to the authors, new applications of biotechnology such as food analysis applications, fast-GC/mass spectrometry (MS) will have the most impact in the next decade. Haskin et.al. used gas chromatography for determination of atmospheric gases [17]. They plotted molecular analysis data using peak simple software by SRI systems from torranc. Kashikar used gas chromatography for determination of ethanol in liquid preparations intended for children[18]. According to experts the alcohol should

not be more than 5% [18]. The level of alcohol should be below 5 percent for 6 to 12 years age group and for children above 10 years, it should not contain alcohol above 10 percent. They made an attempt to evaluate quantity as well as quality aspects in terms of contamination from menthol, camphor and propylene glycol. Puranik investigated head space gas chromatography analysis[19]. They analysed residual solvents. An investigation carried out by them presented a simple and validated gas chromatographic method for the simultaneous estimation of residual solvents in drug substances and drug products. Opez-Avila carried out investigation on identification of designer drugs [20]. They used gas chromatography, high-resolution mass spectrometry and a soft-ionization source. They observed that microplasma photoionization(MPPI) derived trifluoroacetic anhydride exhibited both the substituted-phenyl propene radical ions and minimum ions supporting their identification by mass spectroscopy(MS). Sharma et.al. used gas chromatography-headspace for identification of mango and orange flavours in flavoured chyawanprash[21]. Comparison of retention time between the reference standard and test samples was basis for this analysis. According to these studies the chromatogram confirmed the presence of flavours of orange and mango in the sample. Sivakumar and Dhivya carried out an investigation on GC-MS analysis of bioactive compounds on ethyl acetate extract of cordia monoica roxb. Leaves[22]. Their analysis revealed the presence of 20 compounds. They concluded that the bioactive compounds have many applications like antioxidant, anticancer and anti-inflammatory properties.

III. CONCLUSION

The liquid, gas and paper chromatography finds wide application in analysis. Gas chromatography can be used in food industry for analysis of food composition, natural products, food Additives, flavour and aroma components, a variety of transformation products, and contaminants, such as pesticides, fumigants, environmental pollutants, natural toxins, veterinary drugs, and packaging materials. It can also be used for analysis of gases. HPLC is the most widely used method in pharmaceutical industry. Thin layer chromatography has been used successfully for determination metal ions in surfactant mixed solvents. It can be concluded that the chromatography is the most important and widely used

method of analysis. Many more analytical applications can be explored with further research.

IV. REFERENCES

- [1]. Sunil J. Kulkarni, "Removal of phenol from Effluent in Fixed Bed: A Review", *International Journal of Engineering Research and General Science*, Vol. 2, N. 5, pp.35-38, August – September 2014 .
- [2]. Sunil J. Kulkarni, Dr. Jayant P. Kaware, "A Review on Research for Cadmium Removal from Effluent", *International Journal of Engineering Science and Innovative Technology (IJESIT)*, Vol.2, No.4, pp.465-469, July 2013.
- [3]. A. K. Goswami, S.J.Kulkarni, S.K.Dharmadhikari, "Adsorption of Copper (II) ions from Synthetic Waste Water By Teak Leaves", *International Journal of Science, Engineering and Technology Research (IJSETR)*, Vol.2, No. 6, pp.1336-1339, June 2013.
- [4]. Sunil J. Kulkarni, Ajaygiri K. Goswami, "Adsorption Studies for Organic Matter Removal from Wastewater by Using Bagasse Fly ash in Batch and Column Operations", *International Journal of Science and Research*, Vol.2, No. 11, pp.180-183, November 2013.
- [5]. Ullah MR, Haque ME, "Spectrophotometric Determination Of Toxic Elements (Cadmium) In Aqueous Media", *Journal of Chemical Engineering, IEB*, vol. 25, Vo.1, No. 25, pp.1-12, 2010.
- [6]. Sunil J. Kulkarni, Jayant P. Kaware, "Desorption studies for low cost adsorbents", *International Journal of Chemical Studies*, Vol.3, No.2, pp. 38-41, 2015..
- [7]. Jayesh Girap, Vishal Prajapati, Shivprasad Gupta, Sunil Kulkarni, "Chemical Treatment of Dye Wastewater", *International Journal of Research in Sciences*, Vol. 3, No.1, pp. 25-29, January-June, 2015.
- [8]. Veena Ramachandran, Nisha Pujari, Tanmay Matey, Sunil Kulkarni, "Enzymatic Hydrolysis of Cassava using wheat seedlings", *International Journal of Science, Engineering and Technology Research (IJSETR)*, Vol. 3, No. 5, pp. 1216-1219, 2014.
- [9]. Veena Ramachandran, Nisha Pujari, Tanmay Matey, Sunil Kulkarni, " Enzymatic Hydrolysis for Glucose-A Review", *International Journal of Science, Engineering and Technology Research (IJSETR)*, Vol. 2, No.10, pp.1937-1942, 2013.
- [10]. Ukwuru MU and Egbonu SE, "Recent development in cassava-based products research", *Academia Journal of Food Research*, Vol. 1, No.1, pp.001-013, February 2013.
- [11]. Tom Kupiec, "Quality-Control Analytical Methods:High-Performance Liquid Chromatography", *International Journal Of Pharmaceutical Compounding*, Vol. 8 No. 3, p.p.223-227, May/June 2004.
- [12]. A. S. Curry, "The Application Of Paper Chromatography To Forensic Chemistry", *Journal Of Criminal Law And Criminology*, Vol. 44, No.6, p.p.787-796, 1953-1954.
- [13]. Alex L. Sessions, "Isotope-Ratio Detection For Gas Chromatography", *J. Sep. Sci.* , Vol.29, p.p. 1946 – 1961, 2006.
- [14]. S.S.Dhote, L Deshmukh, L Paliwal, "Separation And Identification Of Heavy Metal Ions By Thin Layer Chromatography On Stannous Silicate Layer", *Chemical Sciences Journal*, Vol. 2012: Csj-62, p.p.1-11, 2012.
- [15]. Zhi-Bin Ning, Qing-Run Li, Jie Dai, Rong-Xia Li, Chia-Hui Shieh, And Rong Zeng, "Fractionation Of Complex Protein Mixture By Virtual Three-Dimensional Liquid Chromatography Based On Combined Ph And Salt Steps", *Journal Of Proteome Research*, Vol.7, p.p.4525–4537 ,2008.
- [16]. Steven J. Lehotay, "Application Of Gas Chromatography In Food Analysis", *Trends In Analytical Chemistry*, Vol. 21, Nos. 9,10, pp.686-697, 2002.
- [17]. Chris Haskin, "Determination Of The Concentration Of Atmospheric Gases By Gas Chromatography", *Mcnair Scholars Research Journal*, Vol. 6 , No. 1, pp.37-53, 2013.
- [18]. Kashikar V.S., "Validation Of A Gas Chromatographic Method For Determination Of Ethanol In Liquid Preparations Intended For Children", *International Journal Of Chemistry Research*, Vol 2, No. 2, pp.32-34, 2011.
- [19]. Puranik S.B, Sharath S And Sanjay Pai P.N., "Head Space Gas Chromatography Analysis Of Residualsolvents By Using Ec-5 Column", *International Journal Of Pharmaceutical Chemistry Research*, Vol. 1, No. 1, pp.22-27, 2012.
- [20]. Lopez-Avila V, " Identification Of Designer Drugs Using Gas Chromatography High-Resolution Mass Spectrometry And A Soft-Ionization Source", *Journal Of Forensic Science & Criminology*, Vol. 1, No. 3, pp1-11, 2013.
- [21]. Yamini Sharma, Meena Sharma, Rahul Singh And Chandrakant Katiyar, "Identification Of Mango And Orange Flavours In Flavoured Chyawanprash By Gas Chromatography-Headspace", *Int. J. Of Pharm. & Life Sci. (Ijpls)*, Vol. 3, No. 9, pp.1953-1957, September: 2012.
- [22]. R. Sivakumar, A. Dhivya, "GC-MS Analysis Of Bioactive Compounds On Ethyl Acetate Extract Of Cordia Monoica Roxb. Leaves", *Int. J. Res. Dev. Pharm. L. Sci*, Vol.4, No.1, pp.1328-1333, 2015.