

# Ion Chromatography Market in India

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## Introduction

**Ion Chromatography** as the name suggests is based on reversible ion exchange interactions between solute (e.g. ionic samples such as inorganic salts, Carboxylates, amino groups, cyanides, phenolic groups etc.) and eluents (e.g. NaOH, Na<sub>2</sub>CO<sub>3</sub>, NaHCO<sub>3</sub>, H<sub>2</sub>SO<sub>4</sub>, Methane Sulfonic Acid, etc.). This technique is useful in the analysis of various anions, group I and II elements, organic acids & their salts such as lactate, citrate, tartarate, piruvate & also carbohydrates and amino acids. The technique is also useful in the estimation of amines, inorganic compounds, cyanide etc. as well as for estimations of charged ionic moieties like proteins, peptides, polymers etc.

## Basic Development of IC

Ion chromatography is a special form of liquid chromatography where charged species are separated by selective distributions in a electrolytic mobile phase and a stationary phase with weak ionic sites. Detection in Ion Chromatography is usually performed by a conductivity detector - the greater the concentration of ions the higher the conductivity of the solution. However, because the mobile phase consists of an electrolyte, the conductivity of the mobile phase itself is quite high. This results in a large background current that must be dealt with in order to make sensitive measurements. Ion Chromatographs makes use of a "suppressor" which neutralizes the mobile phase salts thereby lowering the background current.

The IC technique revolves around separation of ionic species from samples based on following modes for separation;

### 1. Ion-Exchange Chromatography (HPIC)

This separation method employs ion-exchange process occurring between the mobile phase and ion-exchange groups bonded to the support material. In ions with high polarisability,

## Market Dynamics in India

- ⇒ IC market in India is small compared to the developed countries.
- ⇒ The demand is increasing at an estimated rate of 20 %.
- ⇒ Environmental monitoring and life sciences are leading in the use of ICs.
- ⇒ 80 to 100 ICs are purchased annually.
- ⇒ The market is shared between Dionex and Metrohm.

additional non-ionic adsorption processes contribute to the separation mechanism. Ion-exchange chromatography is useful for separation of both inorganic and organic anions and cations. Separation of anions is effected against quaternary ammonium (+ve charge) groups attached to stationary support, whereas sulphonate (-ve charge) groups act as exchange sites for separation of cations.

### 2. Ion-Exclusion Chromatography (HPICE)

The separation modality in ion-exclusion is governed by Donnan exclusion, steric exclusion and sorption processes. Ion-exclusion chromatography is particularly useful for the separation of inorganic and organic acids from those acids, which are completely dissociated at the eluent pH.

### 3. Ion-Pair Chromatography (MPIC)

The dominating separation mechanism in ion-pair chromatography is adsorption. In this mode stationary support is low or non polar in nature. Selectivity is solely dependent upon mobile phase and its ingredients. Hence many times this is also called as Mobile Phase Ion Chromatography. Besides organic modifier an ion-pair reagent is added to the eluent depending on chemical nature of analyte.

In 1975, Dr. Hamish Small reported a novel methodology, which changed IC scenario completely. He used a cation

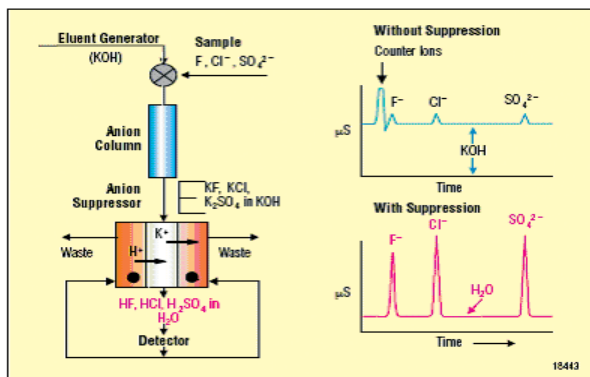
## Dr. V.R. BHATE



Dr. Bhate is Ph.D. in Analytical Chemistry from Mumbai University. He has 25 years of industry experience having worked with esteemed pharmaceutical companies such as Cipla Ltd., Koprana Ltd and Sun Pharma. Since 1995 he has been associated with Dionex Corporation USA, earlier as Director of Indtech Analytical being their distributors and now as one of the Directors in Dionex India Pvt. Ltd. Dr. Bhate also runs Analytical Solutions a Mumbai based Analytical CRO. Dr. Bhate has published more than 25 research papers in reputed national and international journals. He was also associated with WHO projects for Drug Transport Studies in lactating mothers from blood to milk to estimate infant exposure to drugs from mother's treatment.



exchange column in H<sup>+</sup> form after anion separator column during anion estimation. These are termed as Suppressors in IC. This innovation really simplified anion analysis due to three basic reasons,

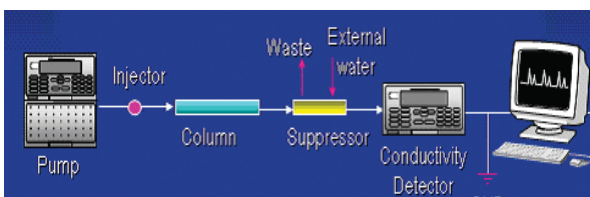


**Advantages of a Continuous Membrane based Suppressor :**

**a)Reduction of background** - Enabled due to removal of positively charged component of eluent and its replacement by H<sup>+</sup> ions. This decreased background conductivity from few hundred uS to virtually 10 uS. The result was a stable baseline.

**b)Removal of sample counter ions by trapping** - Effect was initial disturbance due to counter ions from sample was completely removed increasing accuracy in determination of early eluting peaks like acetate, fluoride etc.

**c)Conversion of analytes to more responsive form** - As cations were replaced by equal amount of H<sup>+</sup> ions, there form during detection was changed from salt to respective acid. Acids are normally 7 to 10 times more conductive than salts. This increased sensitivity of analyte ion detection and decreased lower limits further.



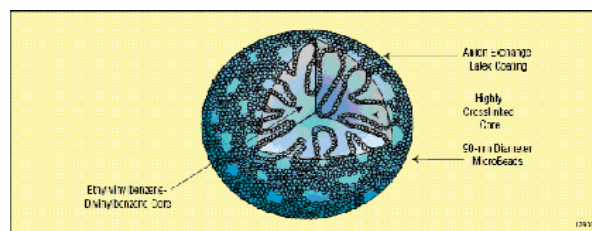
Schematic of a typical IC :

**Columns used in Ion Chromatography:**

Today the columns used in ion chromatography consist of typically inert core made of styrene-divinyl benzene (ST-DVB) cross-linked to about 55% on which functional groups are bonded. The inert core of polymer avoided residual effects of silica like supports as well as it offered very good mechanical strength to the packing. High cross-linked packing were solvent

compatible thereby could be washed with 100% solvents like methanol or acetonitrile to remove non-ionic impurities. Both these properties mean a large number of analysis can be done on a IC column which range from 3000 to 4000 injections.

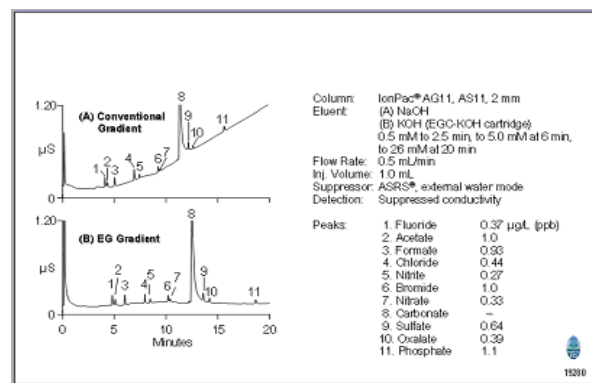
The presence of charged groups is a fundamental property of an ion exchanger. The type of group determines the type and strength of the ion exchanger; their total number and availability determines the capacity. Sulphonic and quaternary amino groups are used to form strong ion exchangers; the other groups form weak ion exchangers. The terms strong and weak refer to the extent of variation of ionization with pH and not the strength of binding. Strong ion exchangers are completely ionized over a wide pH range whereas with weak ion exchangers, the degree of dissociation and thus exchange capacity varies much more markedly with pH.



Structure of a high capacity AS9 HC column

**Latest developments in Ion Chromatography:**

**Reagent-Free IC (RFIC)** is innovative concept that uses clean IC grade water and produces eluents on-line. The eluents are produced electrolytically and eliminate need to hand-prepare eluents. RFIC has redefined the way IC is used. Amongst its many advantages are time and labor savings, elimination of baseline drift in gradient programs, improved detection limits and reproducibility. The pump only delivers deionised water hence the pump wear and tear is also greatly reduced.



Separations with a conventional and RFIC gradient

**Detectors:** The most commonly used detectors used in Ion Chromatography are Conductivity and Electrochemical detectors. Conductivity is used for common anions, cations, organic acids etc. Electrochemical detectors are useful in detection of polarizable compounds like cyanide, iodide and sulphide. Complex carbohydrates and amino acids are also

