

# Metrohm Inline Sample Preparation



Making your ion chromatography more efficient

## Metrohm Inline Sample Preparation for precise and accurate analysis

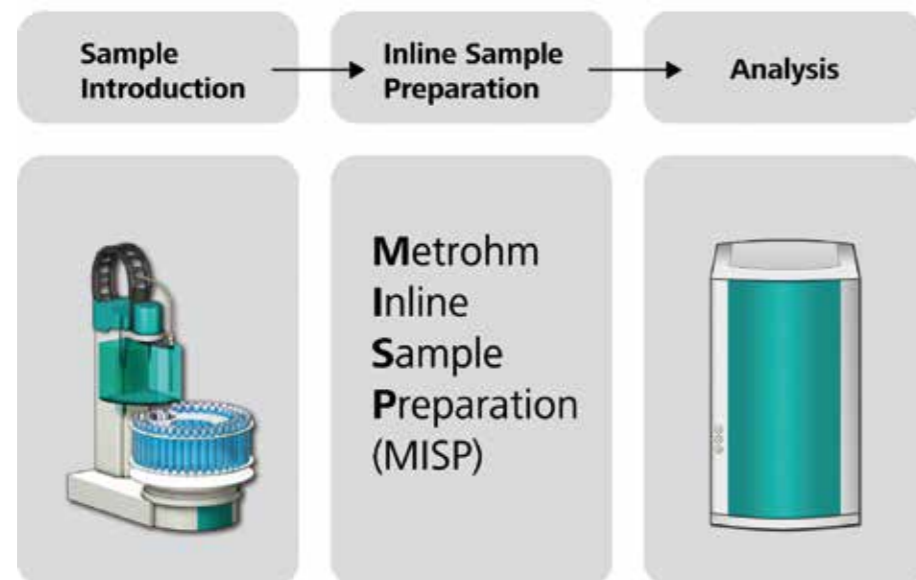
Crystal clear, clinically pure, no bacteria and no particles: this would be an ideal sample for ion chromatography. The real world is often different. Apart from the ions to be determined, the samples contain matrix components which may be aggressive or lead to precipitation in the system. They can sometimes make analysis difficult, if not impossible. Samples with a high load of matrix components can damage the separation column or lead to blockages in the system. That is why suitable sample preparation is essential for reliable and accurate analysis.

In the past, all sample preparation steps had to be carried out manually. That is history. With the unique Metrohm Inline Sample Preparation (MISP) techniques, some of which have been patented, it is now possible to automate these processes in full and make each individual step traceable. The high precision and accuracy of Liquid Handling are based on the outstanding properties of the patented 800 Dosino. The use of Dosino technology

ensures that up to 0.2 µL liquid can be measured out and transferred exactly, quickly and precisely. The advantages are clear. You will benefit from significant time and cost savings while at the same time increasing the reliability of your analyses.

### Methods of Metrohm Inline Sample Preparation

- Inline Ultrafiltration
- Inline Dialysis
- Inline Dilution
- Intelligent Partial Loop Injection Technique
- Intelligent Pick-up Injection Technique
- Inline Extraction
- Inline Matrix Elimination
- Inline Calibration
- Inline Preconcentration
- Inline Neutralization
- Inline Cation Removal



**Metrohm Inline Sample Preparation (MISP):** These techniques are the key to fully automated sample analysis by ion chromatography. The samples are delivered into the system with an autosampler, subjected to one of the Metrohm Inline Sample Preparation techniques, and are then injected directly into an IC system.

## Highlights

- Unique, partially patented and fully automated sample preparation
- Inline transfer of a solid, liquid or gaseous sample through to injection
- Improves precision and accuracy of the analysis results
- Minimizes processing time
- Reduces manual steps
- Guarantees traceability for each sample preparation step
- Minimizes the risk of contamination
- Opens up new application areas
- Enables ultratrace analysis
- Self-optimizing analyses based on logical decisions of the system
- Professional Liquid Handling thanks to Dosino technology



## Metrohm Inline Ultrafiltration

In modern ion chromatography it is highly recommended to filter all samples prior to injection, in order to avoid particle deposits in the injection valve, in capillary tubes or on separation columns. Such deposits in turn reduces the chromatographic performance and the lifetime of the columns.

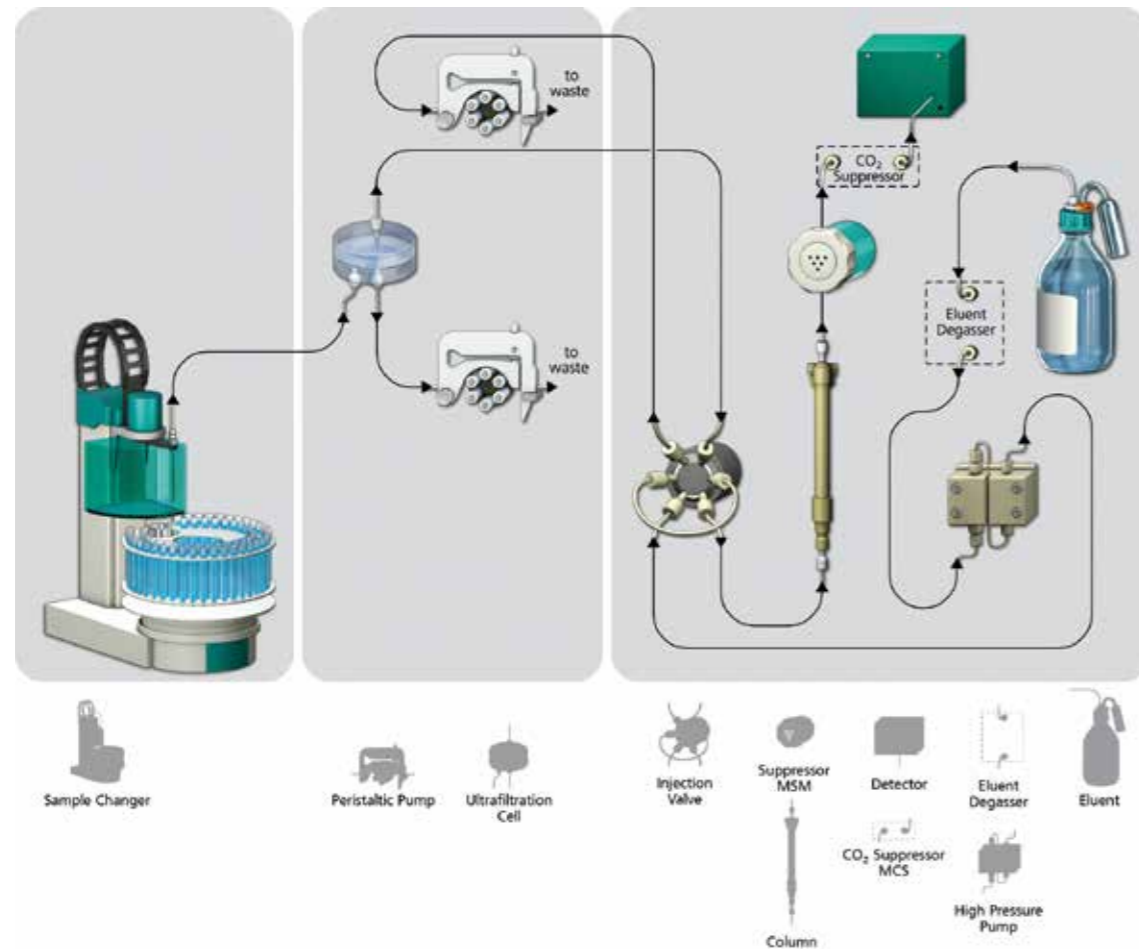
With Inline Ultrafiltration, Metrohm offers a fast and economical alternative to manual filtration. Inline Ultrafiltration combines sample injection directly with filtration. Because of this unique functional feature, filters with a pore size of 0.2  $\mu\text{m}$  can be used for 100 or more samples. This is ideal sample preparation for routine analysis.

### Inline Ultrafiltration at a glance

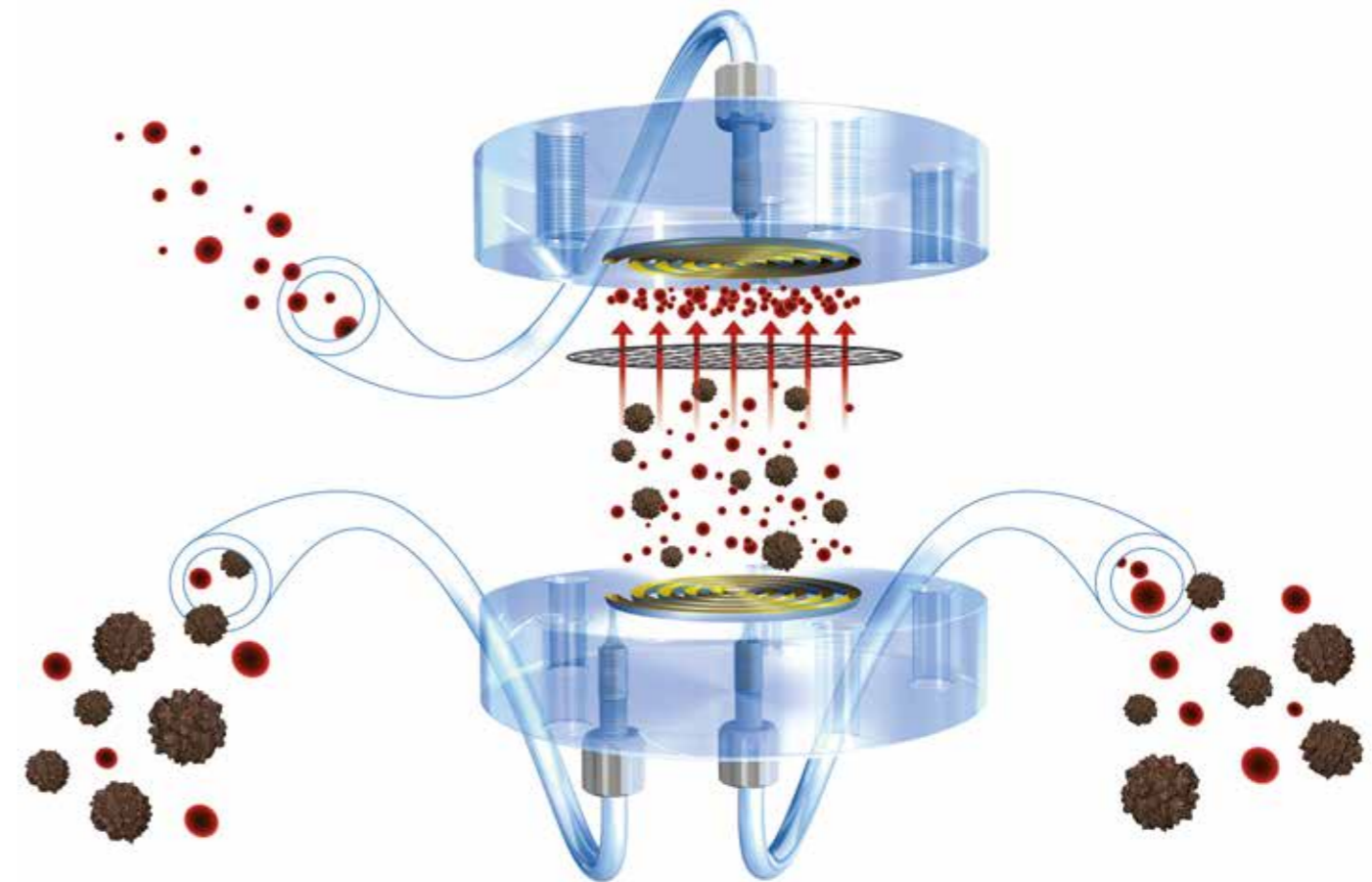
- Fully automated sample filtration (0.2  $\mu\text{m}$ ) during sample injection
- Only 3.5 mL of sample needed
- Lifetime of the column is extended
- Saving of a manual step and resulting reduced risk of contamination
- Lower maintenance
- More than 100 samples with a single filter, due to negligible carryover from sample to sample (<0.1%)
- Cost-saving solution for routine analysis
- Can be combined with Inline Dilution and intelligent Partial Loop Injection Technique

### Applications with Inline Ultrafiltration

- Analysis of anions, cations, carbohydrates, and polar substances in the ng/L to g/L range
- Samples slightly or moderately contaminated with particles, algae or bacteria
- Drinking water and surface water
- Process water and waste water
- Extracts
- Digestion solutions
- Diluted fruit and vegetable juices



**Inline Ultrafiltration** is made possible through the combination of a dual-channel peristaltic pump and an ultrafiltration cell. The sample can be delivered either manually or automatically by a sample changer.



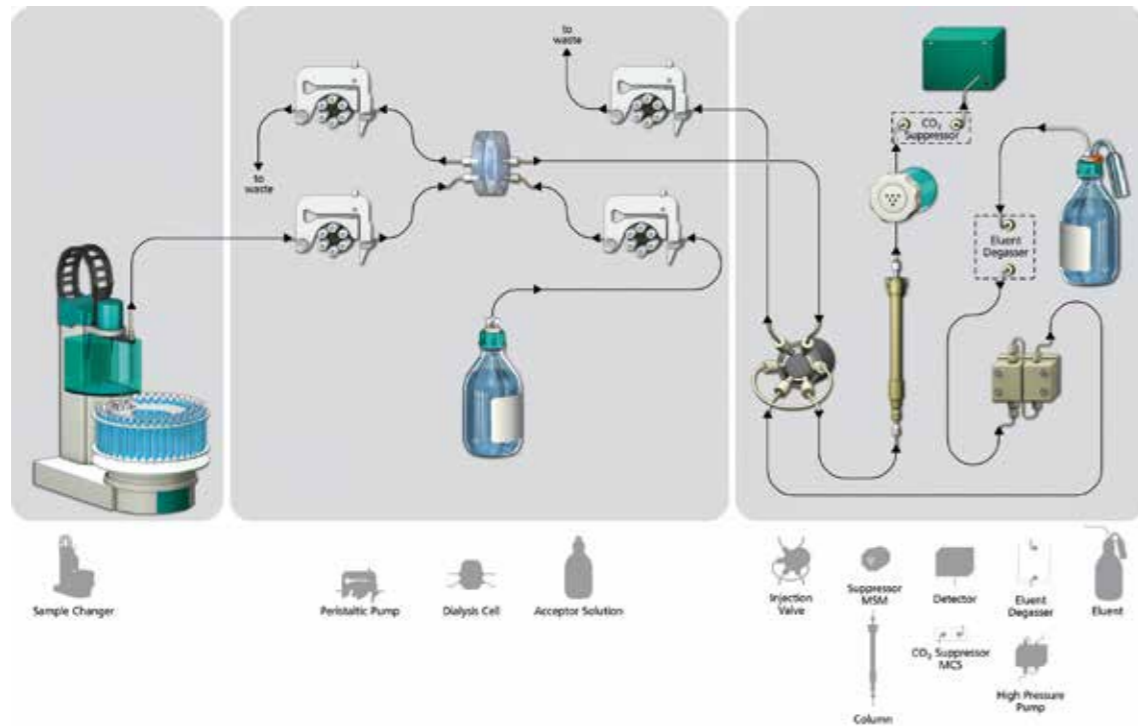
**The two parts of the ultrafiltration cell are separated by a filter membrane.** On one side, the sample is carried through the cell at a high flow rate. On the other side, some of the sample is drawn off through the membrane and transported to the injection valve. The formation of filter cake is prevented by continuous flushing of particles out of the cell at a high flow rate.

# Metrohm Inline Dialysis

Inline Dialysis is the answer to complex sample matrices. This technique separates not only particles from their analytes, but also colloids, oil components, and large molecules. Protein-containing samples can be injected directly after Inline Dialysis. This saves time-consuming manual steps such as the precipitation of proteins with Carrez reagent.

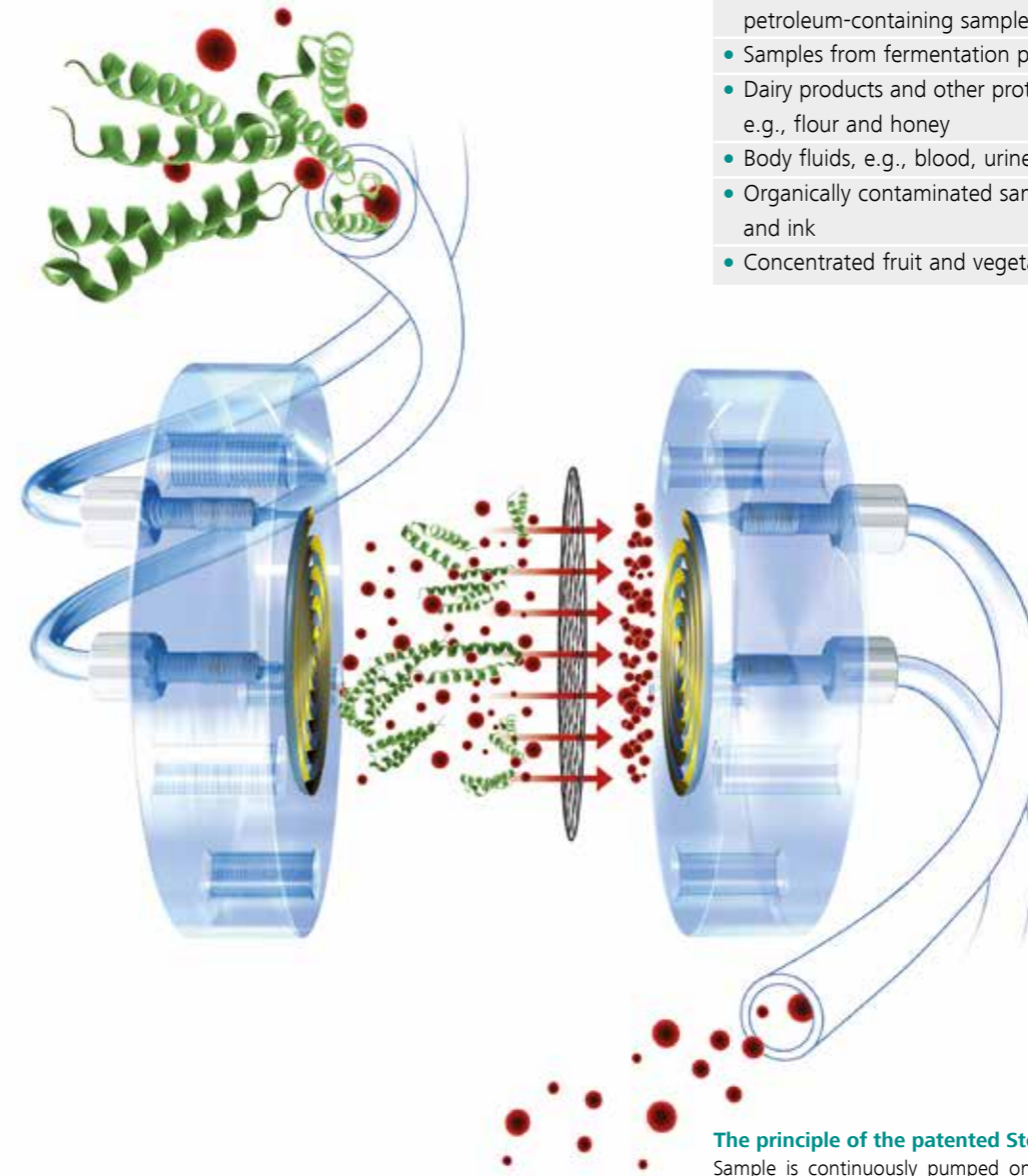
To separate the analytes from the matrix, a cellulose acetate or nylon membrane (pore size 0.2 µm) is used. If your samples are heavily contaminated with particles and filtration is not feasible because the filters would get blocked, Inline Dialysis is the solution.

- Inline Dialysis at a glance**
- Time- and cost-saving Inline Sample Preparation for analysis of complex samples
  - Patented «Stopped-Flow Dialysis»
  - Fully automatic dialysis of samples during sample injection
  - Increased column lifetime due to elimination of large molecules, oily sample components, proteins, and particles
  - No time-consuming manual working steps
  - Low-maintenance requirement (replacement of dialysis membrane every 40–400 samples)
  - Minimal carryover from sample to sample (<0.2%)
  - Nearly complete dialysis rates
  - Possibility of combination with Inline Dilution and Inline Extraction



**Setup for Inline Dialysis:** In the traditional setup, two dual-channel peristaltic pumps are combined with the dialysis cell. Inline Dialysis can also be carried out manually or with a sample changer.

- Applications with Inline Dialysis**
- Analysis of anions, cations, carbohydrates, and polar substances in the ng/L to g/L range
  - Samples heavily contaminated with particles, algae or bacteria
  - Emulsions and dispersions
  - Process water, washing water, and waste water
  - Oil-containing samples such as cutting oils and petroleum-containing samples
  - Samples from fermentation processes
  - Dairy products and other protein-containing samples, e.g., flour and honey
  - Body fluids, e.g., blood, urine, and sweat
  - Organically contaminated samples such as tobacco and ink
  - Concentrated fruit and vegetable juices



**The principle of the patented Stopped-Flow Dialysis:** Sample is continuously pumped on the sample side (the left side of the membrane). After a rinsing phase, the acceptor stream to the right of the membrane is stopped. Because of the concentration gradient, the ions pass through the membrane until an equilibrium is achieved and thus the concentration in the acceptor solution matches the concentration of the original sample. Afterwards, the acceptor solution is injected directly into the IC.

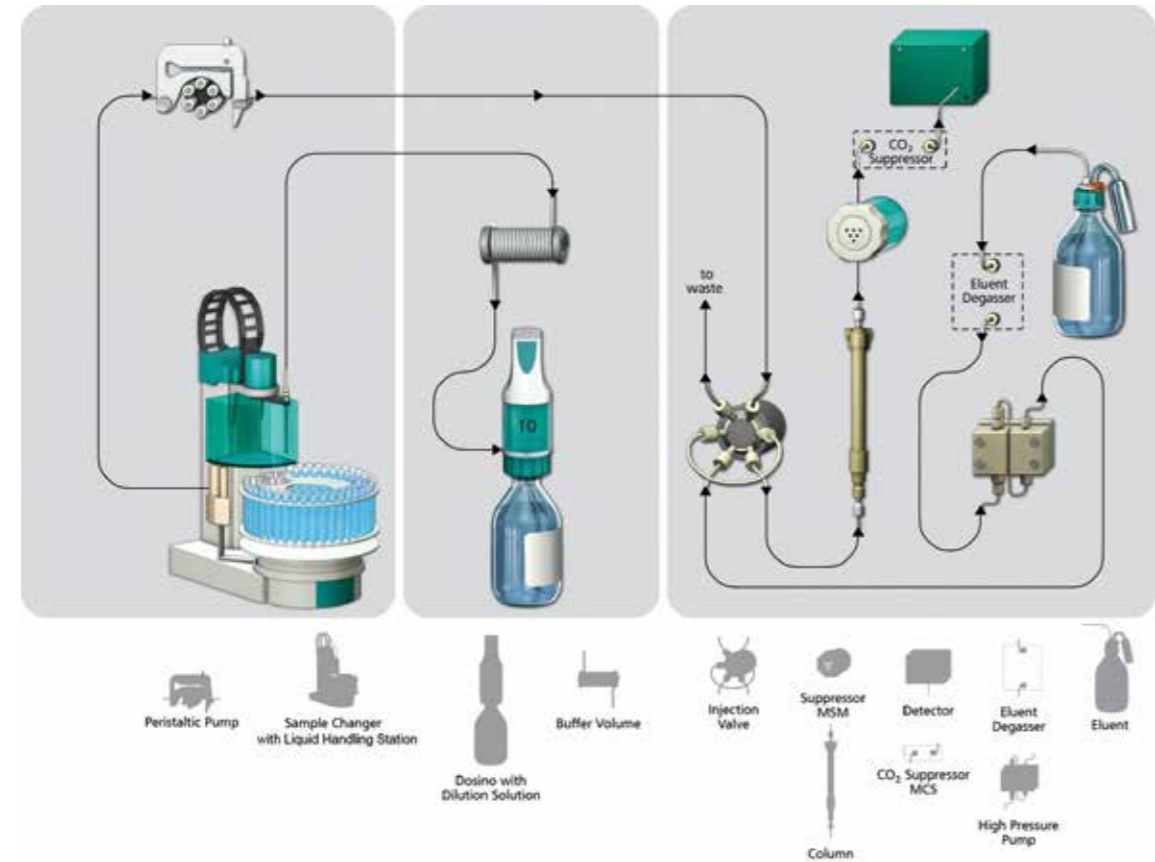
# Metrohm Logical Inline Dilution

One of the oldest sample preparation techniques is the dilution of samples. Nowadays, this step too can be carried out inline using an automated system. A further development is Logical Inline Dilution (Metrohm Inline Dilution Technique «MIDT»). For this, the sample just needs to be placed on the autosampler and the analysis is started. The system automatically calculates the optimum dilution factor and analyzes the sample. Thus your results are always reliable, because they are always within the calibration range.

Of course, not only samples, but also standards can be diluted. Consequently, Metrohm offers the possibility of automatic calibration, i.e., a single multi-ion standard is all that is needed. The system dilutes this standard with different dilution factors and thus carries out multi-point calibration.

### Logical Inline Dilution at a glance

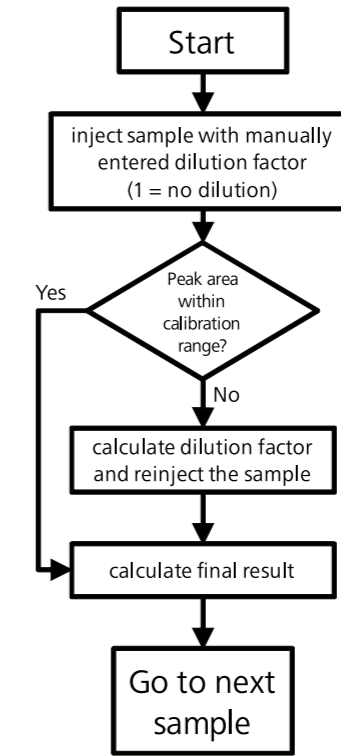
- Time- and cost-saving Inline Sample Preparation for routine analysis
- Unique dilution system based on logical decisions of the system
- Fully automatic sample dilution during sample injection
- Accurate and reliable results, irrespective of the initial concentration of the sample
- Very low-maintenance technology
- Automatic calibration; preparation of a single multi-ion standard is enough
- High flexibility: a single method for all dilution factors
- Sample concentrations in the range 1:10,000 can be analyzed reliably with a single automated calibration
- Unlimited dilution factors through multi-stage dilutions
- Possibility of combination with Inline Ultrafiltration and Inline Dialysis



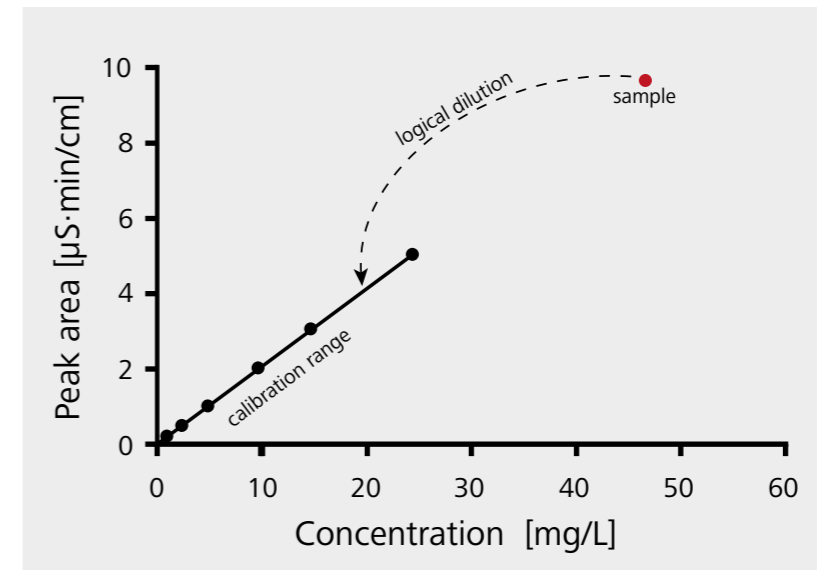
**Setup for Inline Dilution:** Dilution takes place in a dilution vessel in the Liquid Handling Station, so all positions on the sample rack are available for samples. The concentrated sample, as well as the diluting agent, are measured out exactly and added by means of an 800 Dosino. After mixing, the diluted sample is transferred by a peristaltic pump to the injection valve of the ion chromatograph. Afterward, the needle in the rinsing unit of the Liquid Handling Station is cleaned. This minimizes the carryover risk. Undiluted samples can also be analyzed with the same setup.

### Applications with Logical Inline Dilution

- Analysis of anions, cations, carbohydrates, and polar substances in the mg/L to g/L range
- Samples with high ion concentration
- Samples from all branches of industry



Determination of the optimum dilution factor



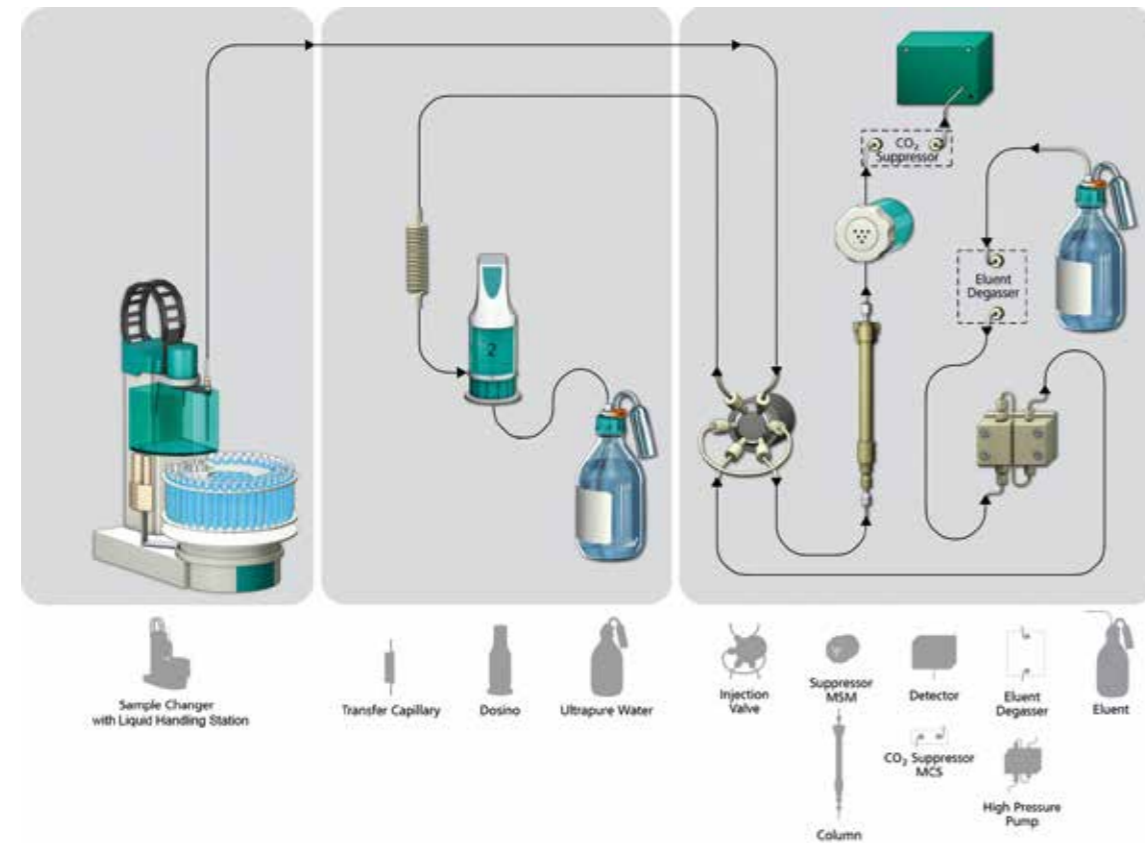
If the sample is outside the calibration range, it is diluted with the optimum dilution factor and analyzed. Thus your results are always within the calibration range.

# Metrohm intelligent Partial Loop Injection Technique

Unlike with Logical Inline Dilution, the dilution factor is not varied when using «MiPT» – Metrohm intelligent Partial Loop Injection Technique. With this technique, the injection volume of an undiluted sample is adjusted between 2 and 200 µL. The method is «intelligent» because it automatically calculates the optimum injection volume. As a result, here too it is possible to cover a very wide range of sample concentrations. Furthermore, this technique is almost free of any carryover (<0.001%), enabling sequential analysis in the mg/L and µg/L range.

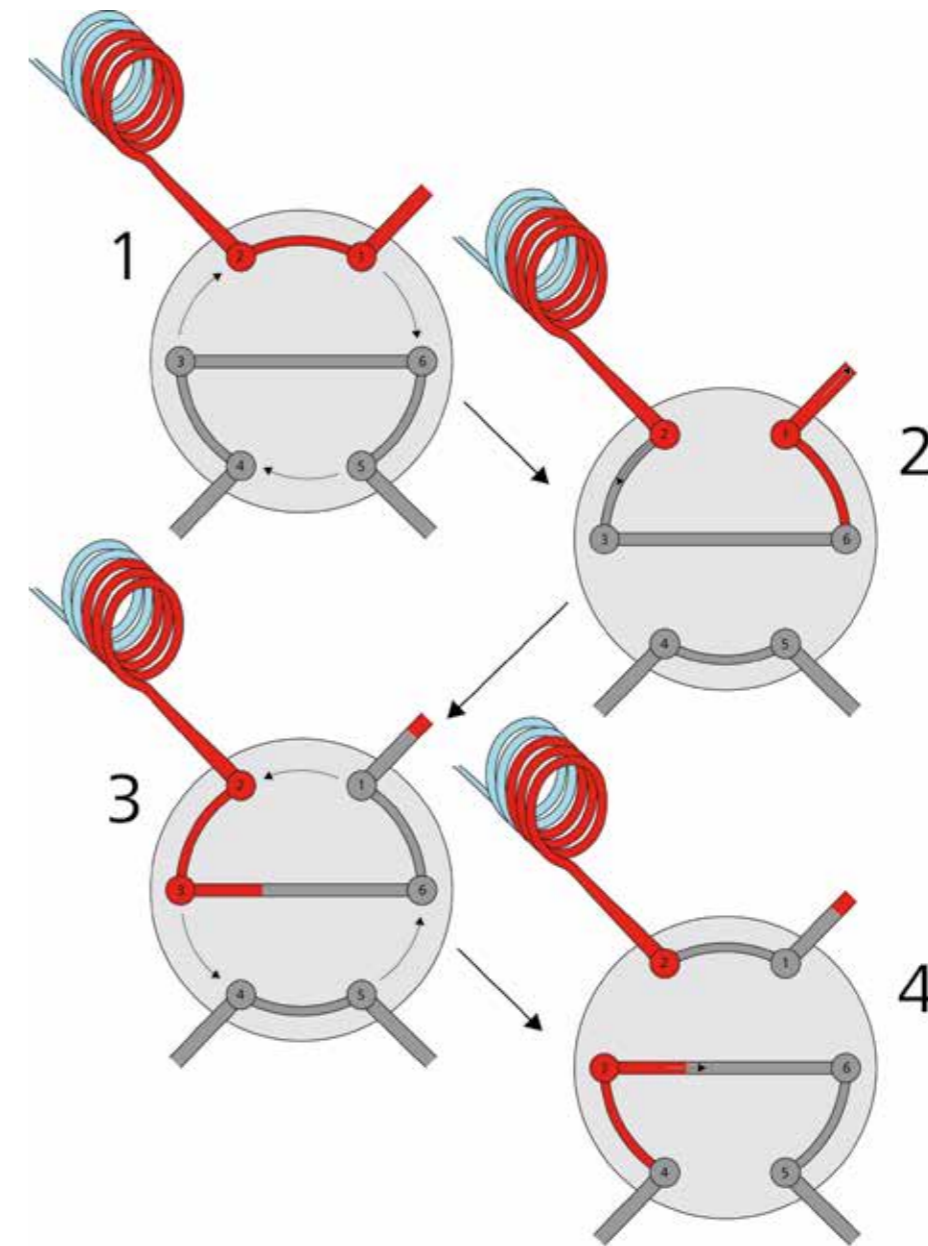
MiPT is characterized by outstanding linearity over the entire volume range. For this reason, this technique can also be used for automatic calibrations using a single multi-ion standard.

- Intelligent Partial Loop Injection Technique at a glance**
- Time- and cost-saving intelligent injection technique for routine applications and method development
  - High-performance analysis system adjusting the injection volume to the concentration of the sample
  - Accurate and reliable results, because the results are always within the calibration range
  - Faster and more precise than manual dilution
  - Practically maintenance-free technology
  - Automatic calibration; preparation of just one single multi-ion standard
  - Optimum flexibility – one method for injection volumes between 2 and 200 µL
  - Smallest carryover from sample to sample of all sample preparation techniques: <0.001%
  - Sample concentrations in the range 1:10,000 can be analyzed reliably with automatic calibration
  - Can be combined with Inline Ultrafiltration



**Setup of the intelligent Partial Loop Injection Technique:** Here too an 800 Dosino measures the sample with high accuracy. It can dose exactly 0.2 µL. Intelligent Partial Loop Injection Technique can be carried out both with and without an autosampler and is also suitable for combined anion-cation systems.

- Applications with intelligent Partial Loop Injection Technique**
- Analysis of anions, cations, carbohydrates and polar substances in the µg/L to mg/L range
  - For universal application to all types of samples in the typical IC concentration range: trace analysis to waste water analysis



**Flowchart of an intelligent Partial Loop Injection:** (1) conditioning of the sample path and aspiration of the sample, (2) injection valve switches to «Inject», (3) accurate dosing of the injection volume into the sample loop, (4) injection of the volume supplied.

## Metrohm intelligent Pick-up Injection Technique

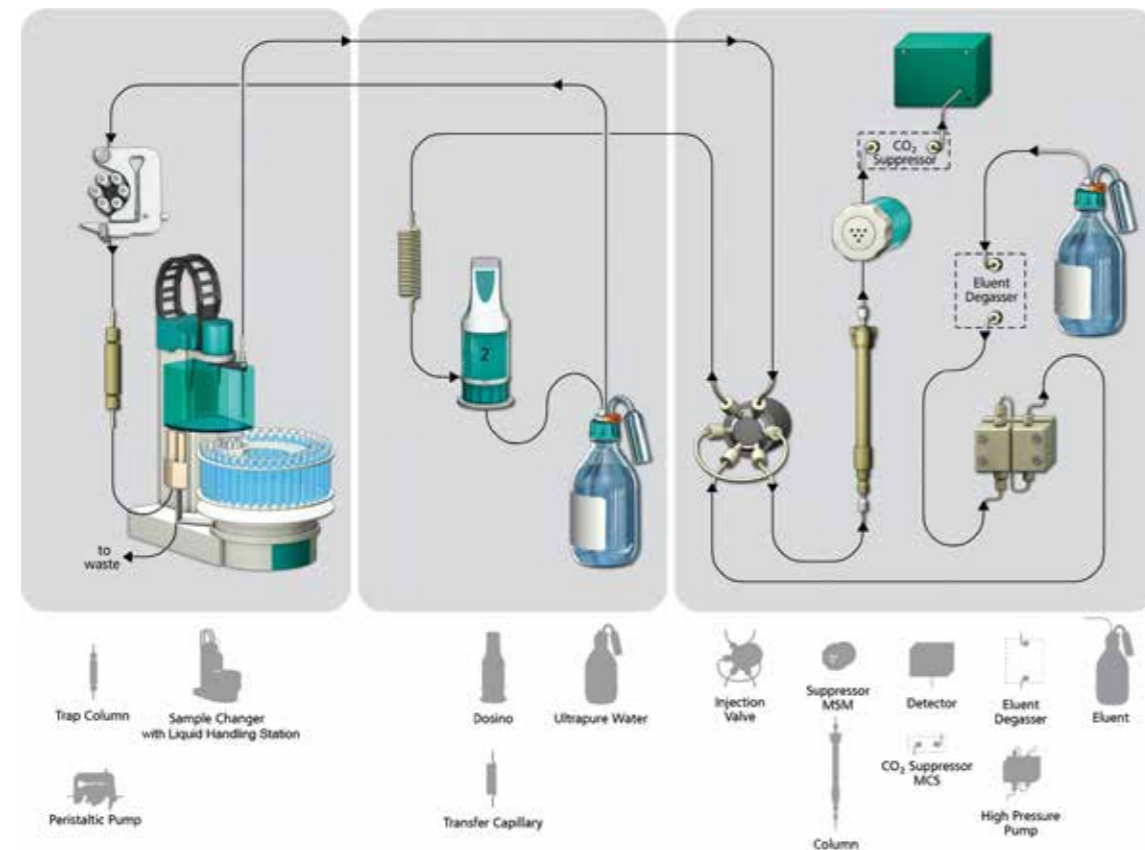
Metrohm intelligent Pick-up Technique «MiPuT» is the ideal sample injection technique for small sample quantities of just a few  $\mu\text{L}$ . This technique requires only as much sample volume as the amount needed for injection into the ion chromatograph. Users can choose volumes ranging from 4  $\mu\text{L}$  to 60  $\mu\text{L}$ . The benefit of this technique is that samples from a broad range of concentrations can be delivered without the need for any manual dilution. The optimal injection volume is calculated automatically.

A system using Pick-up Injection Technique can be calibrated automatically just like systems using Logical Inline Dilution and intelligent Partial Loop Injection Technique. All that is needed for an automatic calibration is a multi-ion standard. The system injects the multi-ion standard with various injection volumes, creating a multi-point calibration. This simplifies and accelerates calibration.

A coated-steel needle with a very low dead volume was developed for the Pick-up Injection Technique. The coating prevents any contamination by metal traces. The robust design ensures that even sealed reaction vessels, such as those made by Eppendorf, can be pierced. Suitable reaction vessels are available for a range of volumes from 1.5 to 2.5 mL.

### Intelligent Pick-up Injection Technique at a glance

- Time- and cost-saving intelligent injection technique for small sample volumes
- No sample loss
- Dependable, precise results for small sample volumes
- Practically maintenance-free technology
- Automatic calibration; preparation of a single multi-ion standard is sufficient
- Very low carryover from sample to sample: <0.001%
- For combined anion and cation analysis



**Setup of the intelligent Pick-up Injection Technique:** The 800 Dosino has the key function in this sample preparation technique. With the 800 Dosino, sample volumes of 4  $\mu\text{L}$  to 60  $\mu\text{L}$  can be aspirated with the highest precision. For the transfer of the sample into the sample loop, the 800 Dosino aspirates ultrapure water from the Liquid Handling Station. This ensures the accurate transfer of the measured sample volume into the sample loop.



### Applications with intelligent Pick-up Injection Technique

- Analysis of anions, cations, carbohydrates, and polar substances in the  $\mu\text{g/L}$  to  $\text{mg/L}$  range
- Small sample volumes
- Samples from any industry

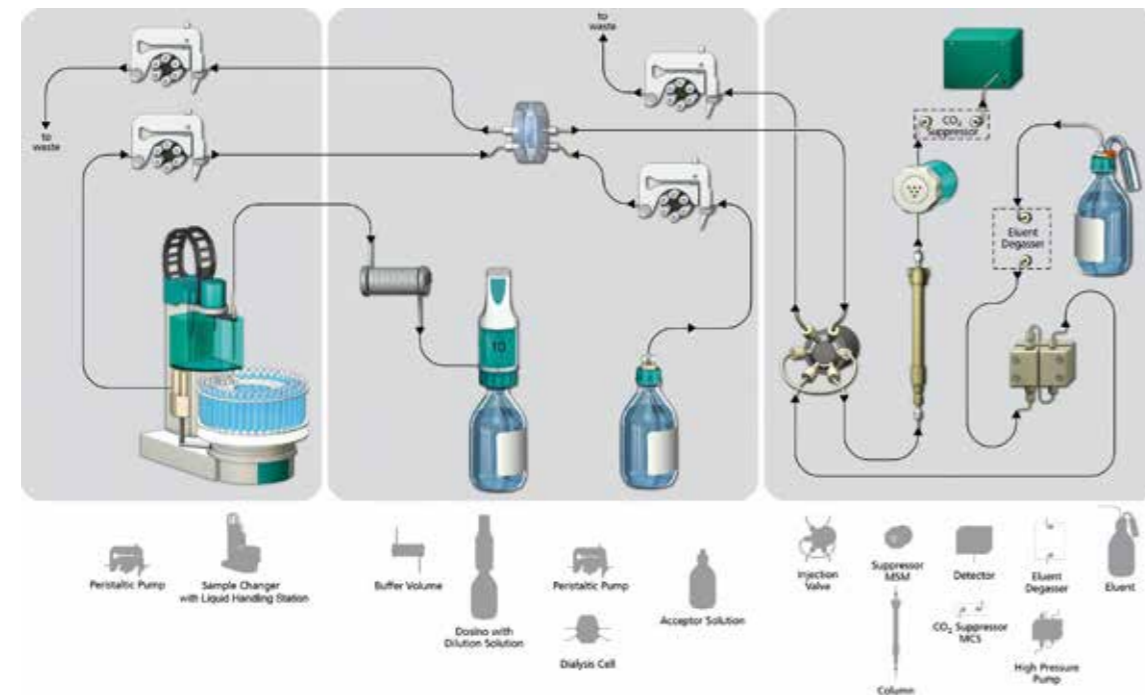


## Metrohm Inline Extraction

Extractions make it possible to transfer components from one medium into another. In ion chromatography, water is used as the basis of the mobile phase. Inline Extraction is used to transfer water soluble components from a non-polar organic phase into an aqueous phase. The aqueous phase can then be injected directly after Inline Dialysis and is analyzed subsequently. Thus whole sample series can be processed fully automatically.

### Inline Extraction at a glance

- Time- and cost-saving Inline Sample Preparation for analysis of organic samples
- Unique inline technique for fully automated extraction of samples during sample injection
- Facilitates ion chromatographic analysis of the water-soluble components of non-polar, organic samples
- No time-consuming manual working steps
- Low maintenance
- Minimal carryover from sample to sample (<0.2%)
- Inline Extraction includes patented Stopped-Flow Dialysis



**Setup and operation of Inline Extraction:** A precisely measured sample is transferred to the dilution unit of the Liquid Handling Station. There the extraction medium is added and stirred for a certain time. During a waiting time that follows, two phases form. The aqueous phase now contains all the extractable, water-soluble ingredients of the sample. Any organic droplets remaining are removed from this phase during subsequent Inline Dialysis. Now the sample can be injected and analyzed.



### Applications with Inline Extraction

- Analysis of water-soluble anions, cations, and carbohydrates in the  $\mu\text{g/L}$  to  $\text{mg/L}$  range
- Quality control of biodiesel
- Determination of impurities in edible oils





## Metrohm Inline Matrix Elimination

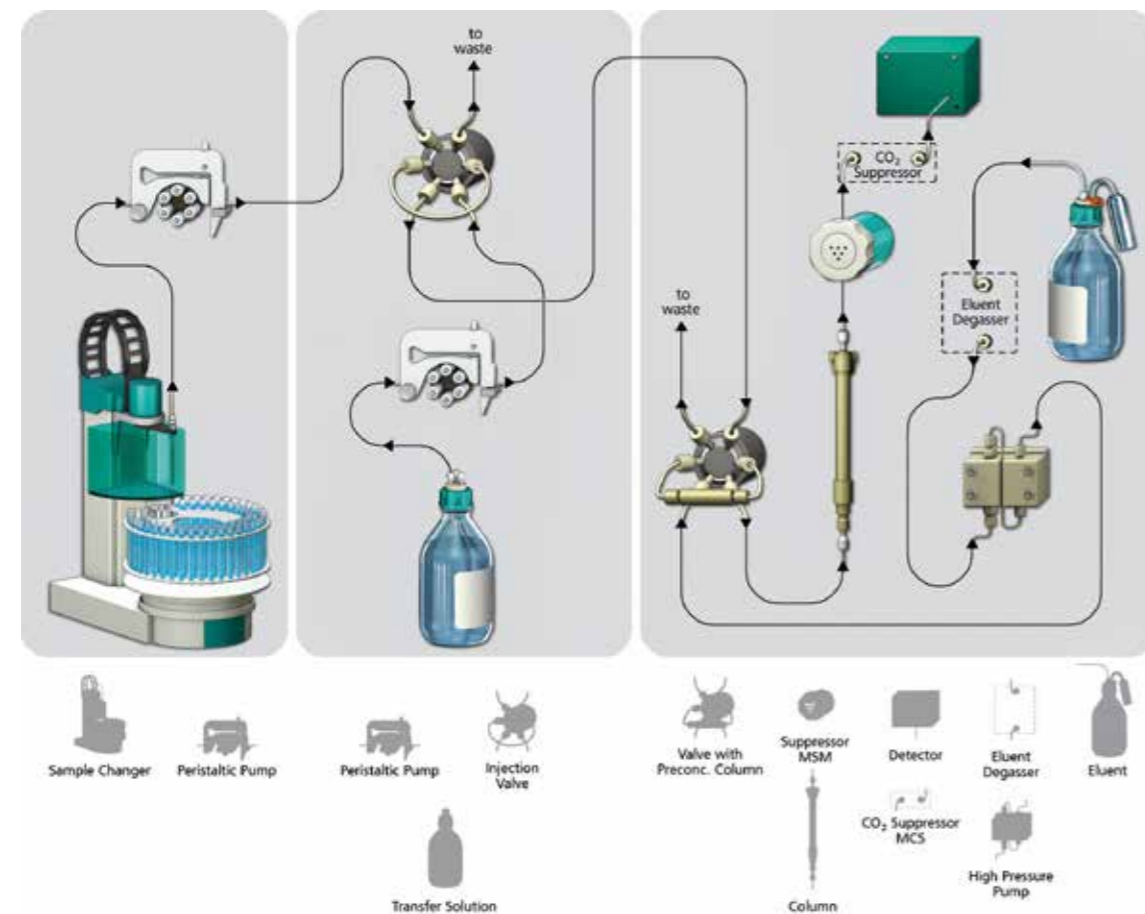
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The determination of anions or cations in polar organic solvents or other aggressive matrices is an analytical challenge. Such samples can damage the column or affect the chromatograms in such a way that evaluation is impossible. This challenge can be met with Inline Matrix Elimination.

Inline Matrix Elimination is a technique that is able to separate ionic analytes from the uncharged matrix without sample preparation cartridges (SPE cartridges). In addition, the counterions of the analytes and of the matrix are removed. In contrast to Inline Dialysis, small matrix molecules (e.g. isopropanol, hydrogen peroxide, and undissociated boric acid) can also be eliminated with Inline Matrix Elimination.

### Inline Matrix Elimination at a glance

- Universal sample preparation to remove an uncharged or oppositely charged matrix during sample injection
- Increased column lifetime
- Opens up the possibility of applications that are impossible with direct injection
- Alternative to time-consuming and expensive manual sample preparation with SPE cartridges
- Ultratrace analysis in combination with Inline Calibration
- No risk of contamination due to blank-free liquid handling
- Low maintenance
- Can be combined with Inline Preconcentration and Inline Neutralization



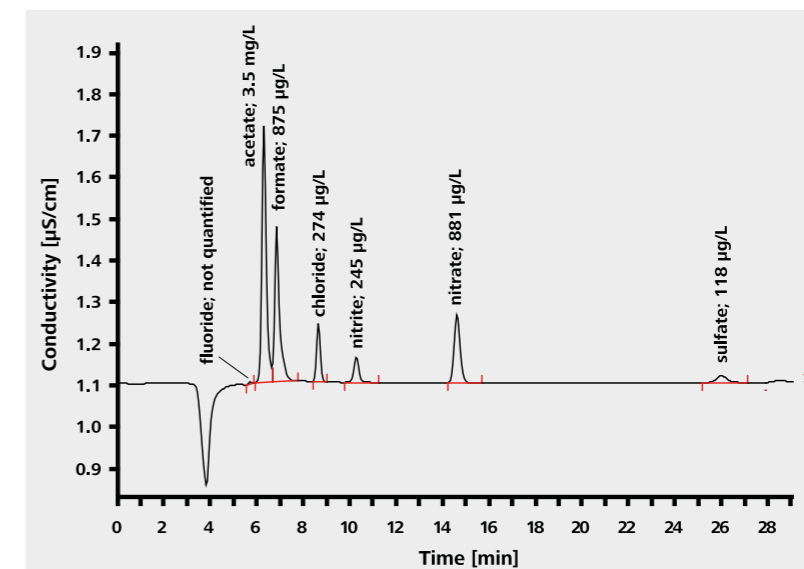
**Setup of Inline Matrix Elimination** as used in the analysis of fuel mixtures. The sample is measured by way of a sample loop, which is placed on an additional valve, and then washed by means of a transfer solution onto a preconcentration column. The transfer solution can be ultrapure water or a diluted solvent. It washes any uncharged and organic matrix components from the preconcentration column. In addition, all counterions in the sample are removed.



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### Applications with Inline Matrix Elimination

- Analysis of anions or cations in the ng/L to g/L range
- Trace analysis in polar solvents such as isopropanol, ethanol, THF
- Trace and ultratrace analysis in extracting agents
- Quality control in fuels, fuel mixtures, and biofuels
- Analysis of the ionic components in hydrogen peroxide
- Quality assurance of ultrapure chemicals
- Ultratrace analysis in samples from nuclear power plants and conventional power plants



**Matrix elimination in a fuel-ethanol mixture** (E85: 85% ethanol, 15% gasoline); column: Metrosep A Supp 7 - 250/4.0; eluent: 3.6 mmol/L  $\text{Na}_2\text{CO}_3$  + 7.5% acetone; 0.8 mL/min; sample volume: 10  $\mu\text{L}$ ; transfer solution: 7.5% acetone.

## Metrohm Inline Preconcentration

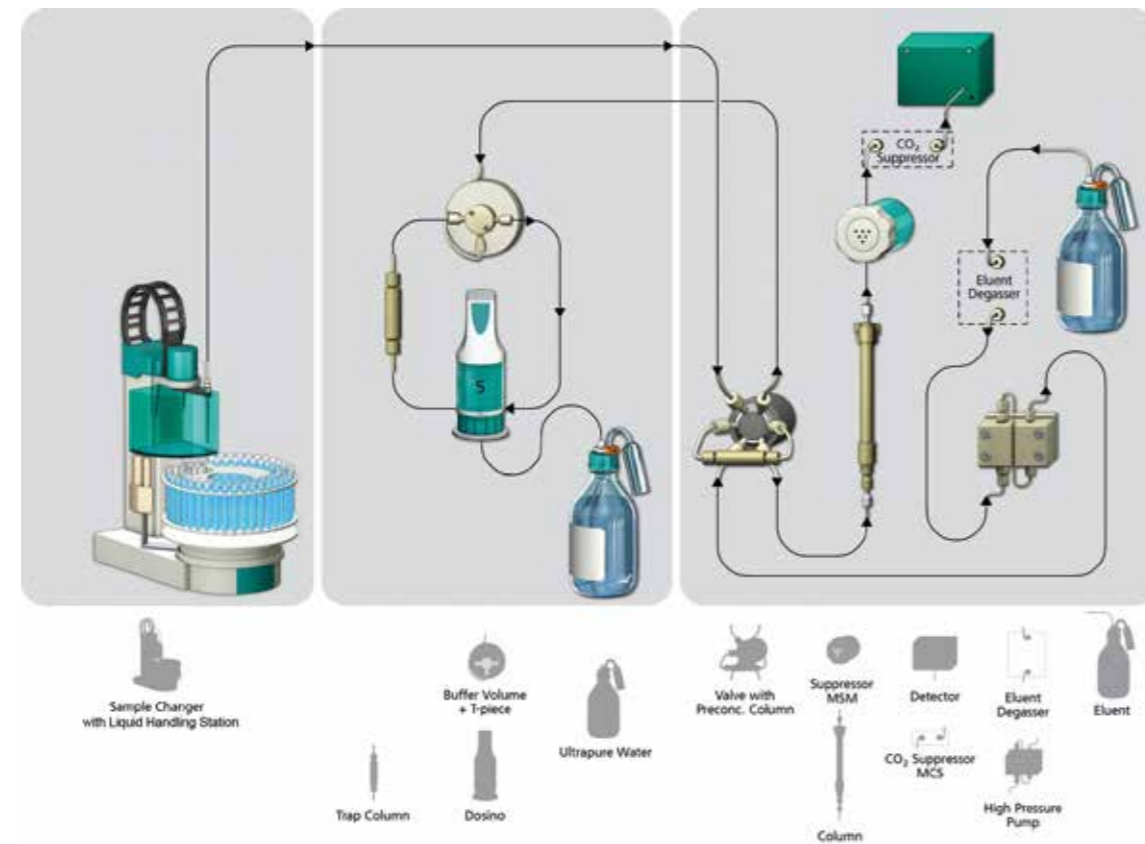
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For each analytical method, there are limits regarding the smallest detectable concentration. In ion chromatography, depending on the system used, these limits are between 0.1 µg/L and 100 µg/L. Inline Preconcentration increases measuring sensitivity considerably and opens up concentration ranges in the ng/L range.

For Inline Preconcentration, a preconcentration column is used instead of a sample loop. This column features functional properties very similar to those of separation columns, except that the material has a considerably higher capacity and consists of comparatively large particles, which ensure a much lower backpressure. If a defined volume of sample is passed over the preconcentration

column, the relevant ions are retained. Through injection the accumulated ions are eluted with the eluent onto the separation column.

The crucial step is exact measurement of the volume. Here you benefit from the outstanding accuracy of the 800 Dosino. The 800 Dosino makes preconcentration of variable volumes possible (Metrohm intelligent Preconcentration Technique «MiPCT»). Inline Preconcentration is linear over a broad range. This means that the method is enormously flexible and automatic calibration is possible. All you need to do is to create a single multi-ion standard. The system then carries out a multi-point calibration.



**Inline Preconcentration for trace analysis:** The sample is drawn through the injection valve (inject position) into a buffer volume. Then the valve is switched to the fill position and the exact volume fed onto the preconcentration column. After injection, the ions elute from the preconcentration column and are analyzed.

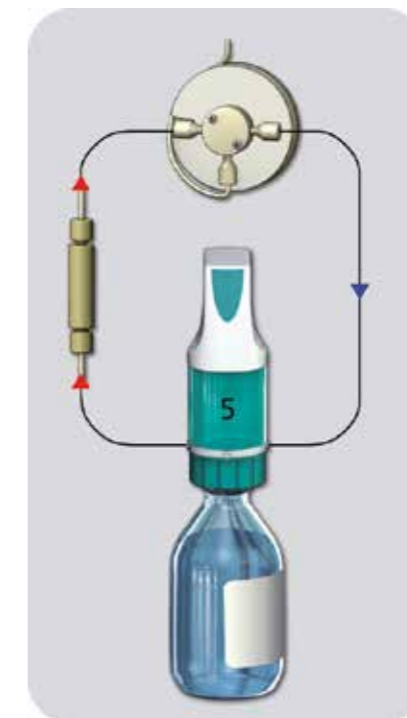
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### Inline Preconcentration at a glance

- Highly flexible sample preparation technique for trace and ultratrace analysis
- Enables detection limits in the ng/L range
- Variable preconcentration volumes. The system automatically optimizes the preconcentration volume
- Always reliable results, because they are always within the calibration range
- Very precise and exact analyses down to the ultratrace range
- Practically maintenance-free technology
- Automatic calibration; the preparation of a single multi-ion standard is sufficient
- A single analytical method for variable preconcentration volumes between 0.2 and 20 mL
- Minimal risk of contamination due to blank-free liquid handling
- Combination with Inline Calibration possible, the ideal calibration method for the ng/L range
- High capacity preconcentration columns enable the use of this technique, even in samples with high ionic contamination
- Can be combined with Inline Matrix Elimination and Inline Neutralization

### Applications with Inline Preconcentration

- Analysis of anions or cations in the ng/L to µg/L range
- Numerous applications from ultrapure water analysis to drinking water analysis
- Quality control of cooling water in conventional power plants
- Analyses of various samples from nuclear power plants
- Process control and monitoring of rinsing solutions in the semiconductor industry



**Professional Liquid Handling** based on the accuracy and precision of the patented 800 Dosino. The transfer water is dosed by the trap column (red arrows). Thus, the transfer solution is free of any contamination. Solutions are aspirated along the path marked with the blue arrow. Sample is only drawn along as far as the buffer volume. Because of the lower backpressure, this can be done very quickly.

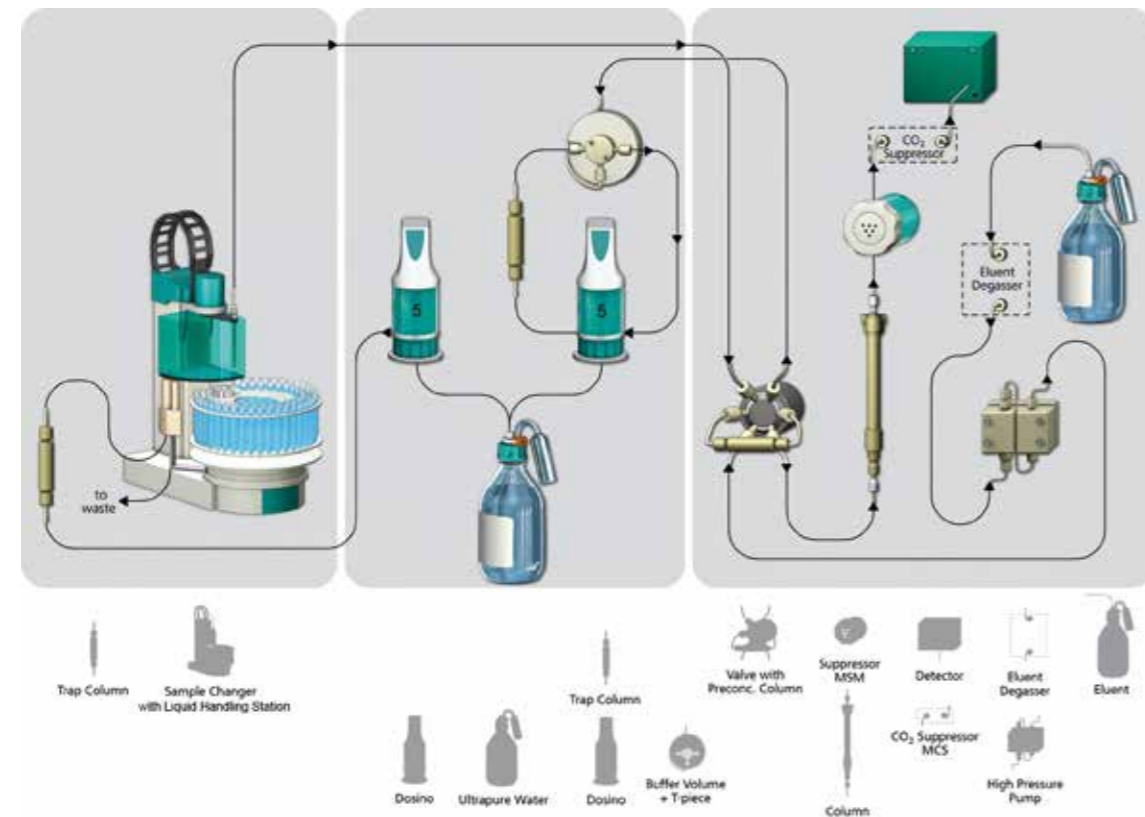
## Inline Preconcentration with Inline Matrix Elimination

Inline Preconcentration and Inline Matrix Elimination can be combined into Metrohm intelligent Preconcentration Technique with Matrix Elimination (MiPCT-ME), a high-performance sample preparation technique. With MiPCT-ME, low concentrations of analytes present in a non-ionic matrix can be determined with a high degree of reproducibility.

Once the sample is concentrated in a preconcentration column, the non-ionic components of the sample are flushed with ultrapure water from the preconcentration column. The advantage of this is that the non-ionic com-

ponents are prevented from interfering with the detection of the analytes, resulting in a stable baseline, which is the prerequisite for reliable and reproducible analysis.

The technique described above can be used to measure concentrations in the ng/L to mg/L range with a high degree of precision and accuracy. The high flexibility of the 800 Dosino is a decisive factor in the performance of such a system. The combination of Inline Preconcentration and Inline Matrix Elimination enables preconcentration, not only of large 20 mL volumes, but also of small volumes from 4  $\mu$ L plus.

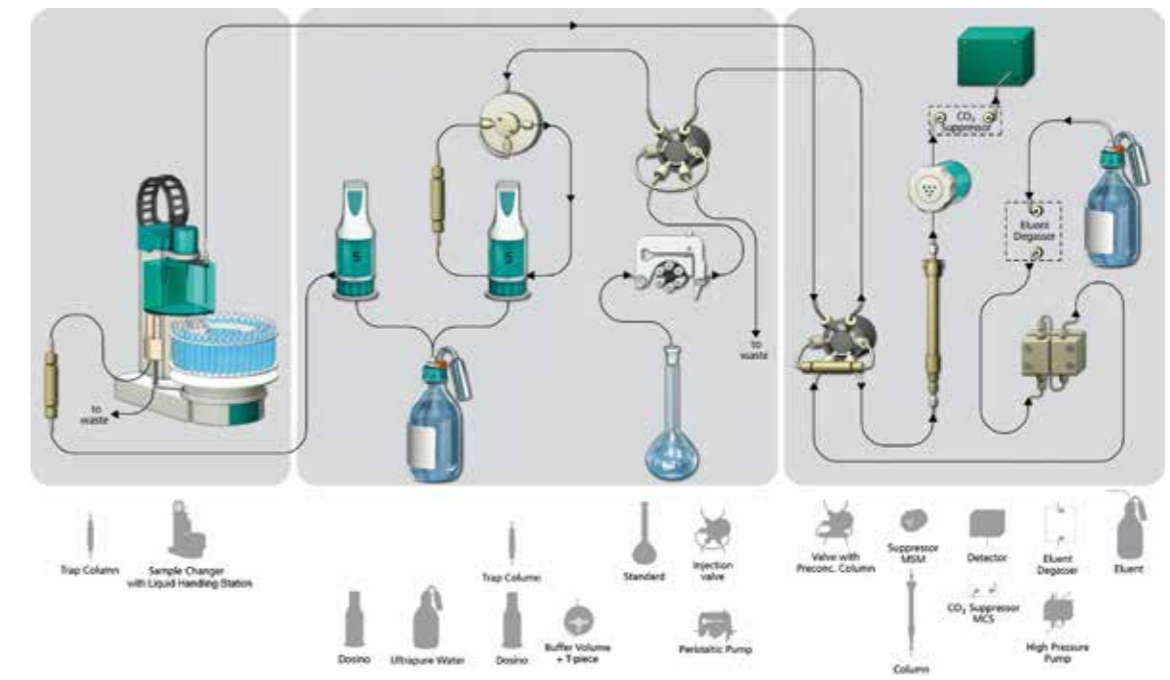


**Inline Preconcentration with Inline Matrix Elimination:** The 800 Dosino aspirates the volume to be injected and transfers the sample with transfer water into a buffer volume. The transfer water is supplied by an additional 800 Dosino in the LQH Station. Once the injection valve is switched to the «fill» position, the sample is preconcentrated, and then the non-ionic matrix components are eliminated. When the injection valve is switched to the «inject» position, the preconcentration column is rinsed with eluent, and the sample is transferred to the analytical column.

## Metrohm Inline Calibration

Inline Calibration is a unique technique that allows calibration to be carried out reliably and precisely in the ng/L range. For this, a single multi-ion standard is prepared in the  $\mu$ g/L range. This is considerably more stable and easier to prepare than a ng/L standard. The standard is introduced into the system via an additional valve, which is fitted with a sample loop (e.g., 10  $\mu$ L). A multi-point calibration emerges from multiple filling of the sample loop and preconcentration of the standard prior to injection (automatic calibration technique).

How is it possible to calibrate with a  $\mu$ g/L standard and measure samples in the ng/L range? The answer lies in the linearity of the method. If 10  $\mu$ L of a 100  $\mu$ g/L standard solution is transferred onto the preconcentration column, that corresponds exactly to the preconcentration of 10 mL of a solution of 100 ng/L. The great advantage of Inline Calibration is the elimination of the contamination risk during the preparation of various standards in the ng/L range and calibration. In this way you can calibrate reliably and precisely down to the single-digit ng/L range.



**Inline Preconcentration with Inline Matrix Elimination and Inline Calibration for samples in the single-digit ng/L range:** The injection of 1, 2 or X sample loop volumes onto the preconcentration column produces the different calibration points.

## Metrohm Inline Neutralization

Inline Neutralization is recommended when strongly acidic or alkaline samples are to be analyzed. With the help of this technique, such samples can be prepared fully automatically during sample injection and then analyzed directly. This technique is also suitable for determining ultratracess. After Inline Neutralization, even strongly alkaline samples can be preconcentrated, thus facilitating analyses in the ng/L concentration range.

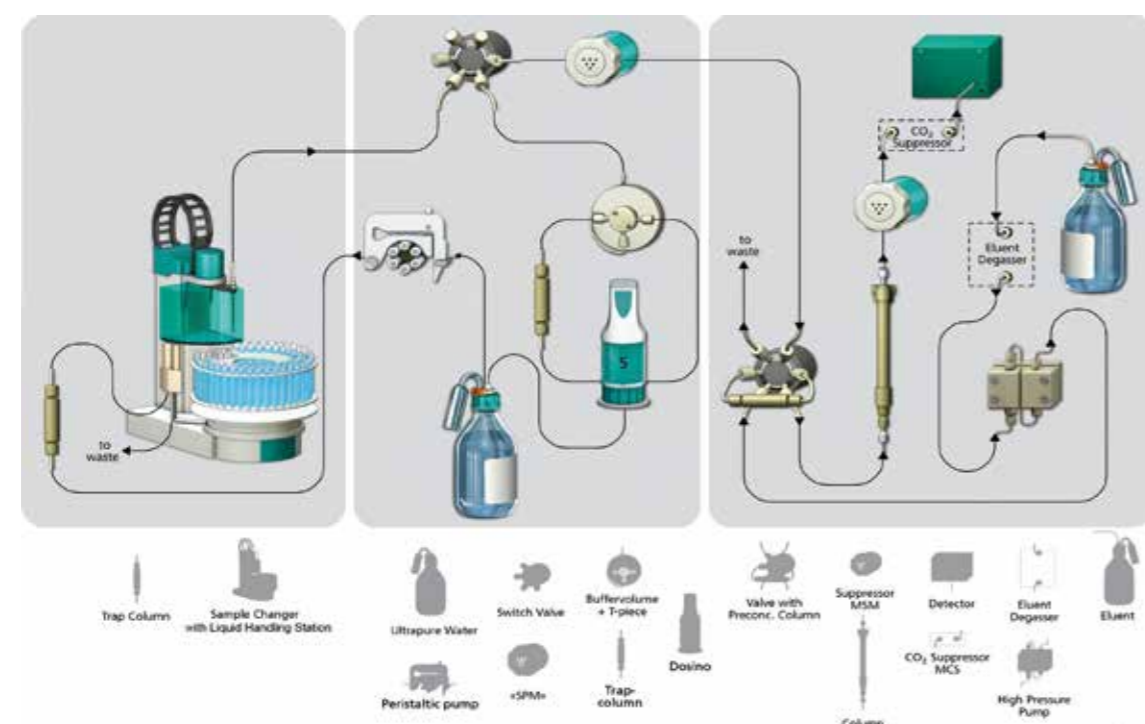
The Sample Preparation Module «SPM» is used for Metrohm Inline Neutralization. The heart of the SPM is a rotor, filled with cation-exchange resin that contains three cartridges. While one cartridge is used for sample preparation, a regeneration step takes place automatically on the second. The third cartridge is rinsed automatically during this time. Thus, a freshly regenerated cartridge is available for each sample. The choice of regenerant depends on the nature of the sample. For strongly acidic samples, sodium hydroxide is used. Thus, the protons of the sample are exchanged for Na<sup>+</sup> in the SPM and the sample is neutralized. If, however, strongly alkaline samples are analyzed, perchloric acid is used as regenerant. In this case the relevant cation is exchanged for a proton in the SPM.

### Inline Neutralization at a glance

- Neutralizes the pH-value of your sample to pH 5–7
- Fully automatic sample preparation for highly alkaline or acidic samples during sample injection
- Allows preconcentration even for highly alkaline samples
- Replaces time-consuming and expensive manual sample preparation with SPE cartridges
- Ultratrace analysis in combination with Inline Calibration
- Eliminates the risk of contamination by avoiding manual sample preparation steps
- Practically maintenance-free and very robust
- Can be combined with Inline Preconcentration and Inline Matrix Elimination

### Applications with Inline Neutralization

- Trace anion analysis in concentrated alkaline solutions and acids
- Samples from aluminum production, such as Bayer Liquor samples
- Starter substances from the electroplating industry
- Ultratrace analysis for nuclear power plants in matrices such as lithium hydroxide/boric acid or with high amine concentrations



**Inline Neutralization in the trace range:** The 800 Dosino draws an exactly measured volume of sample through a valve into the buffer volume. To ensure that the entire sample volume is placed in the buffer volume, ultrapure water is aspirated from the LQH Station after the sample. The valve is then switched and the sample passes through the SPM where it is neutralized. The neutralized sample is then transferred to the preconcentration column. Finally, the sample is injected and the chromatogram recorded.

## Metrohm Inline Cation Removal

Inline Cation Removal is used especially to remove transition metals from electroplating samples. Inline Cation Removal is similar to Inline Neutralization in both its setup and mode of operation. As in the case of Inline Neutralization of highly acidic samples, sodium hydroxide or lithium hydroxide is also used here as regenerant.

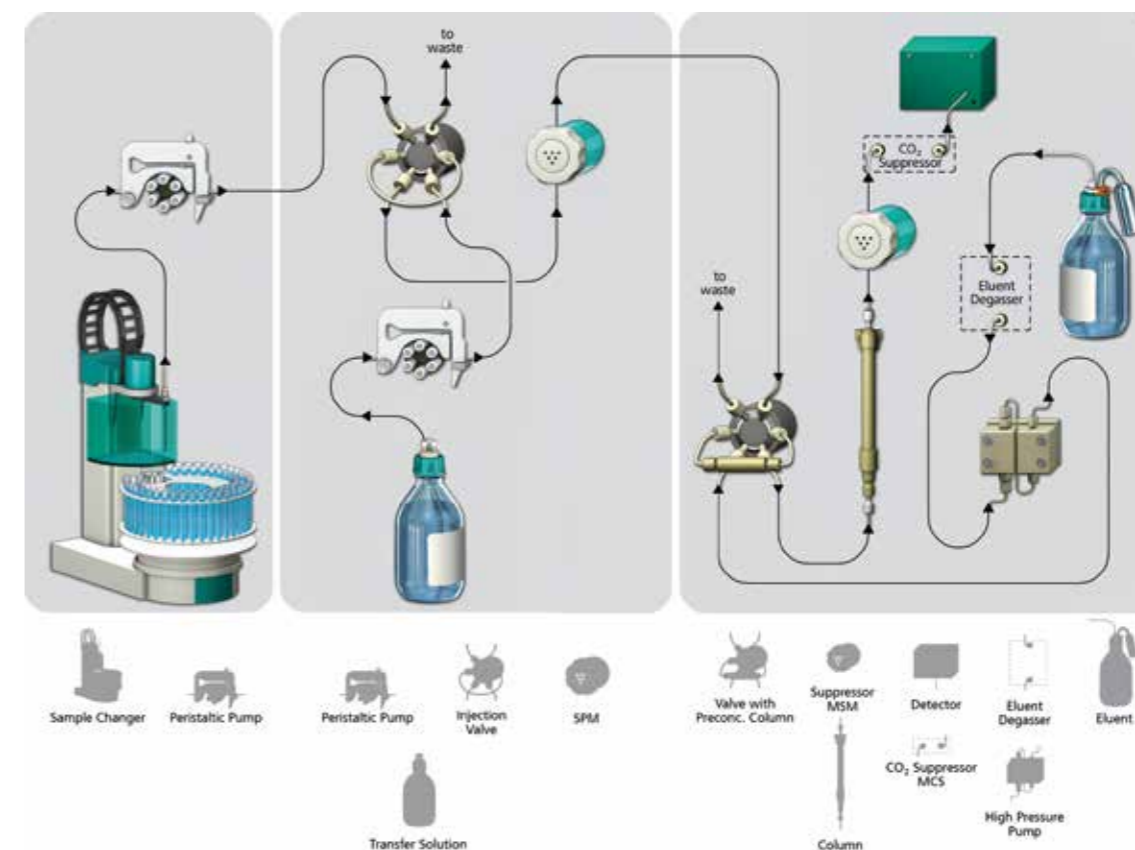
The metal ions are exchanged for Na<sup>+</sup> in the SPM. A simple exchange for protons is sometimes unsuitable, specifically in the case of samples from the electroplating industry, since this would render the sample too acidic. Inline Cation Removal prevents the precipitation of metal hydroxides in the system and/or a preconcentration in the chemical suppressor. Analysis with integrated Inline Cation Removal functions fully automatically, robustly and reliably.

### Inline Cation Removal at a glance

- Fully automated sample preparation for the removal of metals and transition metals during sample injection
- Eliminates the risk of precipitation and deposits in the system
- Increases the lifetime of the column and chemical suppressor
- Replaces the time-consuming and expensive manual sample preparation with SPE cartridges
- Practically maintenance-free system
- Can be combined with Inline Preconcentration and Inline Matrix Elimination

### Applications with Inline Cation Removal

- Analysis of anions in the ng/L to g/L range
- Analysis of electroplating samples contaminated with various transition metals
- Analysis of anionic impurities in electroplating baths, e.g., nickel or zinc baths
- Samples from aluminum production, e.g., Bayer Liquor samples



**Inline Cation Removal for samples from the electroplating industry:** The sample is measured in a sample loop on an additional valve. The sample is then washed with a transfer solution onto a preconcentration column by way of the SPM. The transfer solution usually consists of ultrapure water.

## Inline Sample Preparation by Professional Liquid Handling

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The 940 Professional IC Vario is a modern, compact ion chromatograph that is highly flexible with respect to the configuration of its modular components. The instrument grows with its tasks. If your analytical requirements should change, you can adapt the configuration of the 940 Professional IC Vario at any time. One option is the use of the 942 Extension Module Vario.

For Inline Sample Preparation, Metrohm offers the 942 Extension Module Vario Prep 2. It is used, if a sample preparation technique requires an additional injection valve or a peristaltic pump (e.g., Inline Preconcentration with Inline Calibration).

The 942 Extension Module Vario LQH was developed specifically for professional Liquid Handling. Apart from a peristaltic pump and an injection valve, it also features a 10-port selector valve. This enables the direct linking of Inline Sample Preparation with sophisticated Liquid Handling. In addition, the instrument can accommodate a reaction vessel, a buffer volume, and up to six auxiliary solutions. Short paths ensure very short rinsing times. The accuracy of the volumetric transfer is ensured in this instrument, once again, by an 800 Dosino. This means work can be carried out very precisely and reliably. A whole range of new possibilities open up for Inline Sample Preparation.



**942 Extension Module Vario** extends the configuration of the Professional IC systems. Here an 940 Professional IC Vario TWO/SeS/PP is combined with a 942 Extension Module Vario HPG and an 858 Professional Sample Processor.

**Professional Liquid Handling** is made possible by the 942 Extension Module Vario LQH.

### Applications for the 942 Extension Module Vario LQH

- Mixing of solutions
- Variations in the pH-value of samples
- Pre-column derivatizations, reactions of samples prior to analysis (e.g., complexing reactions)
- Sample preparation steps (e.g., sample dilution or inline SPE cartridge use)
- 10-port selection valve for sample injection

## Inline Sampling for IC Online Monitoring

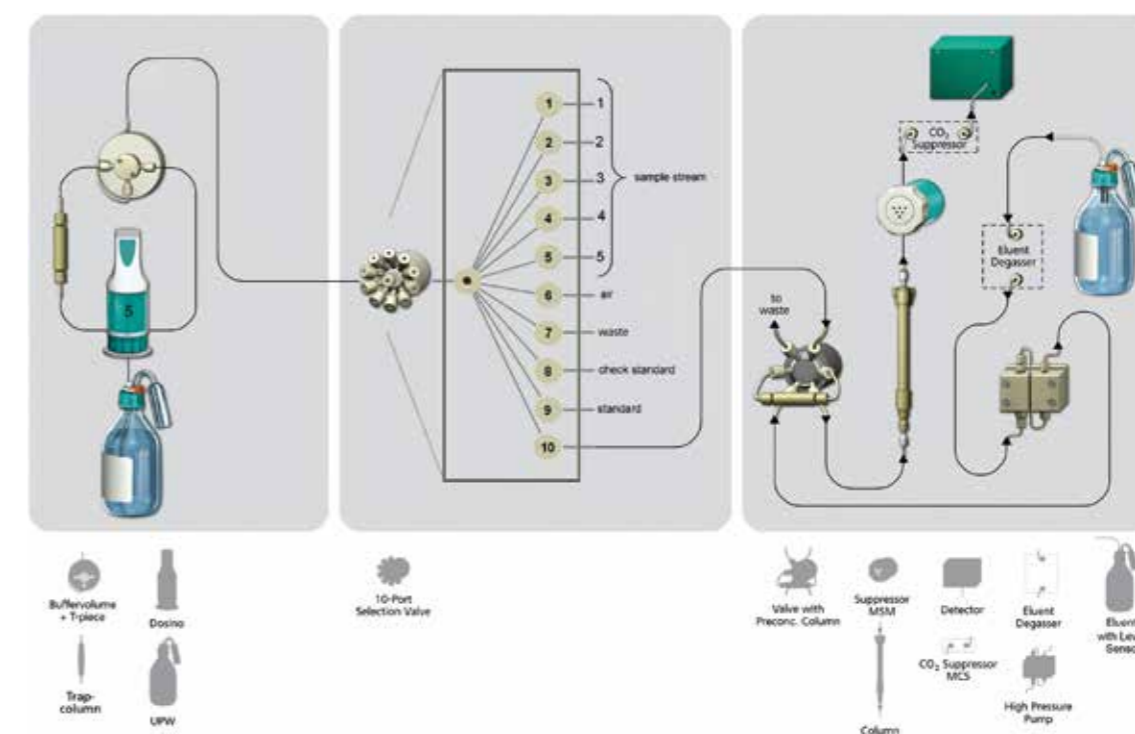
25

The 942 Extension Module Vario LQH can be used for Inline Sampling in processes. Up to 10 different liquid flows can be connected to the 10-port selection valve – samples, standards and check standards, for example. This system reduces sampling risks to a minimum because the sample flow is connected directly to the ion chromatograph. This eliminates the high contamination risk associated with manual sample filling. The system also enables a more rapid and effective reaction to changes in the process. MagIC Net, the Metrohm ion chromatography software, monitors results and reports when limit values are exceeded.

The system including Inline Sampling can be combined with the intelligent Partial Loop Injection Technique or Inline Preconcentration with Inline Matrix Elimination. This system can also be calibrated with a single multi-ion standard (automatic calibration).

### Applications for IC Online Monitoring

- Analysis of anions, cations, organic acids, and carbohydrates in the ng/L to g/L range
- Continuous analysis of processes
- Monitoring of cooling water



**Inline Sampling for IC Online Monitoring in trace analysis:** The 942 Extension Module Vario LQH with its 10-port selection valve is the heart of this system. Depending on the sample ID, the 10-port selection valve is actuated and the sample is aspirated by an 800 Dosino into a buffer volume. Then, the 10-port selection valve is switched and the sample is concentrated in the preconcentration column.

## Inline Sample Preparation for gaseous samples

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The old cliché that ion chromatography can only be used to analyze liquid samples is no longer valid. Modern Inline Sample Preparation techniques also allow precision analysis of gases and solids, thus opening up new fields of application.

Air analysis, in particular, has become ever more important in recent years in the wake of the awareness of the adverse effects of atmospheric pollution on human health. No matter whether you want to analyze air or other gaseous samples – Metrohm offers you two possibilities for determining the ionic constituents in your samples.

### Particle Into Liquid Sampler «PILS»<sup>1</sup>

PILS is a sample preparation module that samples aerosol particles from an air stream and transfers them to the aqueous phase. When it is combined with an ion chro-

matograph, it is very simple to determine simultaneously all of the water-soluble anions and cations in aerosols. The advantages of this hyphenated technique are obvious. The ionic profile of aerosols can be determined with a high time resolution. Thus, for example, diurnal variation analyses are possible at 15 minute intervals. Further advantages include the fact that on-site analysis makes it possible to eliminate completely the problems connected with sample storage and transportation. In-line coupling with the ion chromatography guarantees contamination-free analysis. Typical application areas of PILS-IC hyphenation are the monitoring of pollutants inside buildings, emission controls at workplaces, monitoring of ambient air, measurements of tunnel air, determination of stack emissions, analysis of fine dust or mobile use, e.g., on aircrafts.



«PILS» puts aerosols into a supersaturated water steam phase where they quickly grow into droplets. The droplets are separated out and transferred with a carrier solution into an ion chromatograph. The size of the aerosol particles to be determined can be limited by a preceding cyclone or impactor (e.g., PM<sub>1</sub>, PM<sub>2.5</sub>, PM<sub>10</sub>).

<sup>1</sup> PILS is a co-production of Metrohm Applikon and Metrohm.

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### Monitor for Aerosols and Gases «MARGA»<sup>2</sup>

MARGA is an online ion chromatograph integrating sample preparation for gaseous samples. MARGA determines the entire water-soluble ionic load of aerosols and the gas phase. Anions and cations are measured in parallel. Compared with filter packs, the MARGA system is more economical to maintain and allows a better time resolution. MARGA provides precise results 24/7 and communicates results in real time anywhere via the Internet. The results can be used to establish trends, monitor pollution, examine movements of air masses, and to study day-night rhythms.

The largest area of application is environmental research. Here, the MARGA is used for online monitoring of environmentally relevant parameters such as SO<sub>x</sub>, NO<sub>x</sub> and NH<sub>4</sub><sup>+</sup>. In this way it is possible to carry out extremely accurate analyses of climatic influences or of acid rain and also to monitor local occurrences such as emissions from the burning of biomass.



The MARGA System simultaneously measures gases such as NH<sub>3</sub>, HNO<sub>2</sub>, HNO<sub>3</sub>, HCl, SO<sub>2</sub>, as well as the ionic load of aerosols such as NH<sub>4</sub><sup>+</sup>, Na<sup>+</sup>, K<sup>+</sup>, Ca<sup>2+</sup>, Mg<sup>2+</sup>, Cl<sup>-</sup>, NO<sub>3</sub><sup>-</sup>, SO<sub>4</sub><sup>2-</sup>, SO<sub>3</sub><sup>2-</sup>, NO<sub>2</sub><sup>-</sup>, PO<sub>4</sub><sup>3-</sup>. The system operates autonomously. Solutions need only be replenished once a week.

<sup>2</sup> MARGA can be obtained from Metrohm Applikon.

## Inline Sample Preparation for solids

Complete automation of manual working steps is a clear aim of any modern analysis. The goal is to achieve better precision and accuracy of results and also ensure the traceability of every working step that the sample has been through. With the 815 Robotic Soliprep, designed especially for Liquid Chromatography, Metrohm offers you a modern solution for automation that achieves this aim.

The 815 Robotic Soliprep is more than just an auto-sampler. The instrument is able to homogenize, extract, dilute, and filter your solid or liquid samples. The sample can then be transferred directly to your IC or HPLC system. Depending on the requirements of the application, the 815 Robotic Soliprep offers enormous flexibility in system configuration and integrates all manual sample preparation steps into a fully automated analysis system. This saves time and costs, while at the same time offering the benefit of added convenience with increased analytical reliability.



**Automated sample preparation:** In the first step, solvent is added and the sample is pulverized and homogenized. After that, sample is drawn up with a metal-free needle, filtered, and finally transferred directly to the IC system by way of a connection port.



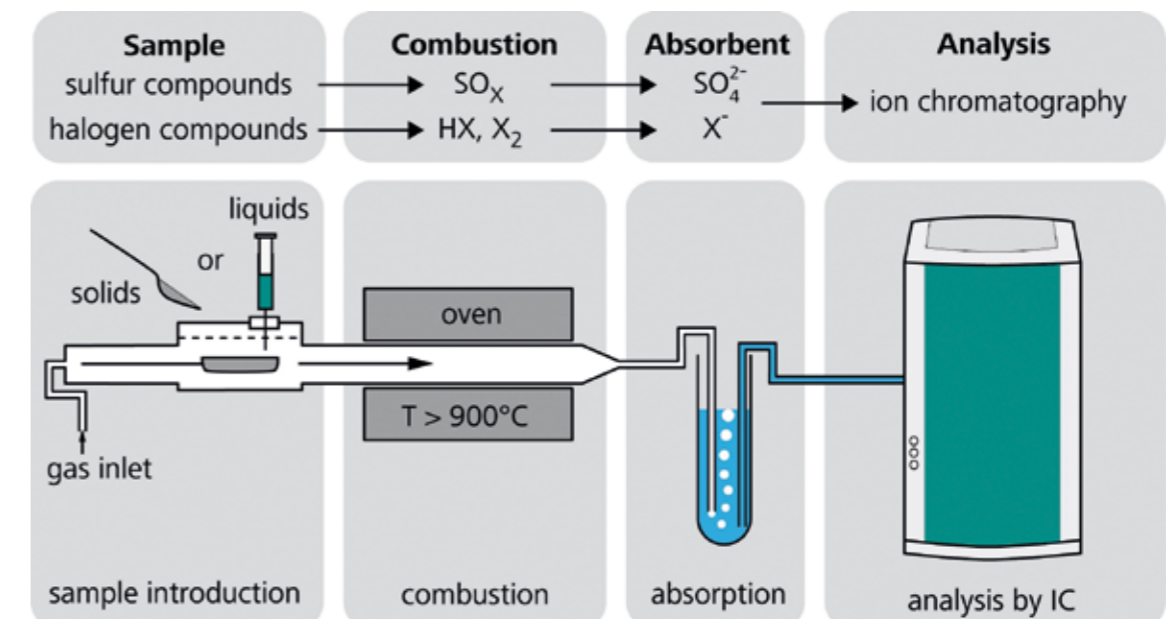
**The 815 Robotic Soliprep for LC** for Inline Sample Preparation of solid samples. The prepared sample is directly transferred to an IC or HPLC instrument. This fully automated analysis system minimizes manual steps and ensures complete traceability.

## Inline Sample Preparation for combustible samples with Combustion Ion Chromatography «CIC»

Combustion Ion Chromatography (CIC) extends the range of ion chromatography to all types of combustible samples. The focus here is primarily on the simultaneous determination of the various halogens and sulfur in various matrices. The CIC system from Metrohm, including sample preparation, is completely automated. CIC is superior to offline digestion methods, not only with respect to sample throughput but also in terms of precision and accuracy of the results. In contrast to alternative methods, the concentration of the different kinds of halogens can be specified with CIC.

### Combustion IC at a glance

- Fully automated sample preparation for solids, gases, and liquids and subsequent analysis by ion chromatography.
- Simultaneous determination of sulfur and halogens
- Quantification of the concentration for each of the different halogens
- High sample throughput
- High precision and accuracy
- Material tests with regard to halogen-free products



**Configuration of a CIC system.** The sample is pyrolyzed at a temperature of up to 1100 °C. The resulting gaseous compounds are transferred into an absorption solution that is then injected into an ion chromatograph.

## Ordering information

Depending on your application, we can offer you a variety of ProfIC Vario systems. These systems consist of automated Metrohm Inline Sample Preparation techniques combined with a 940 Professional IC Vario, an intelligent conductivity detector, and an 858 Professional Sample Processor. In addition, the package includes all of the peripheral devices and accessories that are required for the respective technique.

Professional IC Vario system with Inline Ultrafiltration	ProfIC Vario 2 Anion ProfIC Vario 2 Cation ProfIC Vario 2 AnCat
Professional IC Vario system with Inline Dialysis	ProfIC Vario 3 Anion ProfIC Vario 3 Cation
Professional IC Vario System with Inline Dilution (MIDT)	ProfIC Vario 4 Anion ProfIC Vario 4 Cation ProfIC Vario 4 AnCat
Professional IC Vario system with Inline Dilution and Inline Ultrafiltration	ProfIC Vario 6 Anion ProfIC Vario 6 Cation ProfIC Vario 6 AnCat
Professional IC Vario system with Inline Dilution with Inline Dialysis	ProfIC Vario 7 Anion ProfIC Vario 7 Cation
Professional IC Vario system with intelligent Partial Loop Injection Technique (MiPT)	ProfIC Vario 15 Anion ProfIC Vario 15 Cation ProfIC Vario 15 AnCat
Professional IC Vario system with intelligent Pick-up Injection Technique (MiPuT)	ProfIC Vario 14 An ProfIC Vario 14 Cat ProfIC Vario 14 AnCat
Professional IC Vario system with Inline Extraction	ProfIC Vario 7 Anion ProfIC Vario 7 Cation
Professional IC Vario system with Inline Matrix Elimination	ProfIC Vario 8 Anion ProfIC Vario 8 Cation
Professional IC Vario system with Inline Preconcentration (MiPCT)	ProfIC Vario 5 Anion ProfIC Vario 5 Cation ProfIC Vario 5 AnCat
Professional IC Vario system with Inline Preconcentration and Inline Matrix Elimination (MiPCT-ME)	ProfIC Vario 9 Anion ProfIC Vario 9 Cation ProfIC Vario 9 AnCat
Professional IC Vario system with Inline Neutralization	ProfIC Vario 10 Anion
Professional IC Vario system with Inline Neutralization, Inline Preconcentration and Inline Matrix Elimination	ProfIC Vario 11 Anion
Professional IC Vario system with Inline Cation Removal	ProfIC Vario 10 Anion
Professional IC Vario system with Inline Cation Removal, Inline Preconcentration and Inline Matrix Elimination	ProfIC Vario 11 Anion
Professional IC Vario system for IC Online Monitoring	ProfIC Vario 12 Anion

Of course, you can also set up your ion chromatography system according to your own particular requirements. The 940 Professional IC Vario and 930 Compact IC Flex configurators help you to do just that ([ic940.metrohm.com](http://ic940.metrohm.com) and [ic930.metrohm.com](http://ic930.metrohm.com)):

Ion chromatograph		Inline Sample Preparation for gaseous samples	
940 Professional IC Vario		2.136.0400	Particle Into Liquid Sampler ADI 2081
930 Compact IC Flex		2.136.0500	Peristaltic pump, 8 channels with 6 rollers
		6.5335.000	Liquid Handling Set for PILS
			MARGA systems can be ordered via Metrohm Applikon.
Automation		Inline Sample Preparation for solid samples	
2.858.0010	858 Professional Sample Processor		
2.858.0020	858 Professional Sample Processor – Pump		
2.858.0030	858 Professional Sample Processor – Pump – Valve		
2.919.0020	919 IC Autosampler plus		
6.5330.100	IC Equipment: Inline Dialysis	2.815.4110	Robotic Soliprep for LC
6.05330.010	IC Equipment: Inline Ultrafiltration 2 – pull mode		
6.05330.110	IC Equipment: Inline Ultrafiltration 2 – push mode		
6.05330.210	IC Equipment: Inline Ultrafiltration 2 – MiPT	2.930.9010	930 Combustion IC PP (AJ)
6.5330.210	IC Equipment: Inline Ultrafiltration – MiPT	2.136.0730	Combustion Module (Oven + LPG/GSS, AJ)
6.5330.120	IC Equipment: Inline Dilution (MIDT)	2.136.0800	MMS 5000 Autosampler (AJ)
6.5330.140	IC Equipment: MiPCT	6.7302.000	Kit for solid samples for MMS 5000
6.5330.160	IC Equipment: MiPCT-ME	6.7303.000	Kit for liquid samples for MMS 5000
6.5330.170	IC Equipment: MiPuT		
6.5330.180	IC Equipment: MiPT	2.930.9030	Metrohm Combustion IC Manual – Quartz
		2.930.9040	Metrohm Combustion IC Manual – Ceramic
Liquid Handling		Inline Sample Preparation for combustible samples with Combustion IC «CIC»	
2.942.0020	942 Extension Module Vario Prep 2	2.0136.0610	Liquid Autosampler CIC (TEI)
2.942.0070	942 Extension Module Vario LQH	2.0136.0620	Solid Autosampler CIC (TEI)
2.800.0010	800 Dosino	2.0136.0630	GLS Sampler CIC (TEI)
6.3032.120	Dosing Unit 2 mL		
6.3032.150	Dosing Unit 5 mL		
6.3032.210	Dosing Unit 10 mL		
6.3032.220	Dosing Unit 20 mL		
6.3032.250	Dosing Unit 50 mL		
6.2841.120	Liquid Handling Station, left		
6.5330.130	IC Equipment: Liquid Handling Station, left		



[www.metrohm.com](http://www.metrohm.com)