Related Dionex Applications Literature

Dionex has an extensive library of methods and techniques for determining a wide variety of analytes important to chemical industries. Below is a selected list of applications covered in this brochure. For more information, please visit www.dionex.com, click on the Markets tab, and select Chemicals. All of the literature below and more can be found by clicking the Documents tab and selecting Application Notes and Updates, or by contacting your local Dionex representative.

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ISO 9001

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Dionex
Quality, Safety, and the Environment

Industrial manufacturers such as petroleum refineries and chemical producers struggle to obtain reliable, low-cost sources of raw materials for their process needs. Trace contaminants present in solvents or starting reagents such as bases, acids, or feed gasses used during manufacturing can introduce contaminants, which can not only cause corrosion damage to costly chemical infrastructure and reduce product yields, they can be potentially dangerous.

Ensuring the quality of monomers used in food-grade plastics, as well as the chemical formulations used in the production of consumer products like adhesives, paints, inks, cosmetics, detergents, and many pharmaceutical products is extremely important to ensure product quality and safety. For example, phthalates used as plasticizers are potential carcinogens. Cation contamination of acids, such as phosphoric acid used in the production of soft drinks, has been linked to increased urinary calcium which is associated with hypertension. Ions such as bromate or chromium VI are carcinogenic at very low concentrations.

The pollution emitted by internal combustion engines greatly impacts the quality of our air. With more stringent regulatory standards by the US EPA limiting the sulfur content of fuels such as diesel, gasoline, and ethanol, the analysis of total sulfur and individual sulfur-containing components is becoming more challenging and important.

Dionex has developed products and solutions that address the challenging task of isolating and identifying contaminants in chemical and petrochemical products to protect manufacturing equipment, increase productivity, and ensure only safe, reliable products come to market. Dionex innovation coupled with years of experience working with industry and regulatory experts has produced a broad range of liquid sample prep, extraction, IC, and HPLC solutions for the analysis of trace-level contaminants in raw materials, chemical intermediates, and finished products.
**Solvent Extraction**

Extraction of plasticizers from PVC polymers, water-soluble compounds in plant biomass, azo dyes in textiles, and active ingredients in consumer product formulations, including adhesives, paints, inks, cosmetics, detergents and many pharmaceutical products, is required to ensure the safety and efficacy of industrial products. Dionex Accelerated Solvent Extraction (ASE®) systems use elevated temperatures and pressures to extract analytes quickly and efficiently. Alternative techniques, including Soxhlet extraction, microwave-assisted extraction, and supercritical fluid extraction, are not only much slower than ASE systems, they also require the handling and disposal of large volumes of hazardous organic solvents, and additional cleaning steps after extraction.

- Extraction of sample sizes from 1 to 100 g in minutes, not hours
- Automation reduces operator time and labor
- Dramatic solvent reduction compared to traditional extraction methods
- Compatible with a wide variety of matrices, including acidic and alkaline

---

**Ion Chromatography**

Ion chromatography (IC) is well established as a routine analytical technique, and is specified in many required ASTM regulatory methods for the production of fuels and chemicals. Dionex is the leading provider of IC instrumentation, with innovative solutions that fit your workflow and your budget.

- Reagent-Free™ IC (RFIC™) systems reduce eluent and regenerant preparation while providing greater reproducibility and confidence in your results
- Dual systems allow double throughput and simultaneous analysis
- Configurable for on-line process monitoring using Integral™ process analytical systems
- Suppressed conductivity, pulsed amperometry, UV-vis, fluorescence, and MS detectors
- Ion-exchange, ion-exclusion, carbohydrate, and organic acid columns
- Integrated control and data processing with the Chromeleon® Chromatography Data System

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**Liquid Chromatography**

The Dionex UltiMate® 3000 series of liquid chromatography systems are ideally suited for the determination of monomer quality for polymer production, PAHs in fuels, chemical formulations in consumer products such as herbicides, disinfectants, and cosmetics, and monitoring workplace contaminants to ensure compliance with regulatory methods. Dionex offers a wide variety of modules, detectors, and configurations to suit your application needs.

- Excellent retention time precision, detector sensitivity, linearity, and drift specifications
- x2 dual systems for doubled throughput or multidimensional separations
- Rapid Separation LC (RSLC) systems for fast, high flow-rate, ultrahigh-pressure applications
- Configurable for on-line process monitoring using Integral process analytical systems
- Reversed-phase, ion-exchange, mixed-mode (HLIC, reversed-phase, and ion-exchange combinations), and monolith columns
- Diode array, multi-wavelength, fluorescence, electrochemical, and MS detectors
**Analysis of Ionic Liquids**

Ionic liquids (IL) are a new generation of solvents with a substantial potential for replacing conventional organic solvents in numerous technical applications. They are organic salts with a melting point below 100 °C. They have very low vapor pressure and flammability, conduct electric current, and have selective dissolving properties. Modifying the functional groups of the cation or the anion allows ILs to be used as tailor-made solvents, modifiers, and reagents in organic synthesis and homogeneous catalysis.

Process monitoring during IL production and process control during their use require efficient qualitative and quantitative analysis. The inherent charges of ILs make IC with suppressed conductivity detection an ideal analytical method for determining these complex electrolyte systems. Chromatographic separations of ILs can be optimized by varying the acidic or basic eluent concentration, adding an organic modifier, and using an elevated separation column temperature.

**Trace Anions in Organic Solvents**

Anion contamination introduced during manufacturing processes can damage equipment and ruin final products. This is especially important in the manufacturing of semiconductors and computer components, where trace contaminants can cause short circuits, defects in deposition, and corrosion, reducing yields and increasing manufacturing costs and waste. IC with automated eluent generation provides a convenient method to successfully determine trace anions from high ng/L to low µg/L concentrations in solvents. Automated matrix elimination prevents column fouling, and analyte concentration improves detection limits. The method easily meets the Semiconductor Equipment and Materials International (SEMI®) specifications for solvents.

**Effect of column temperature on retention time of structurally similar cations in ionic liquids, using an IonPac® CS17 column and suppressed conductivity detection.**

**Trace anionic contaminants found in a 2-propanol sample, after automated concentration and matrix elimination.**
Contaminants in Acids and Bases

Determination of ions and metals in concentrated acids and bases is important to many industries, including chemical, electronics, pharmaceutical, food, and beverage manufacturing, as well as industrial plating, environmental monitoring, and mining. Ionic contaminants can combine with their respective counterions to form insoluble compounds that can cause manufacturing defects. Calcium in phosphoric acid enhances the extraction of uranium, but when present in phosphate fertilizers may contaminate soil. Excessive amounts of potassium and sodium in foods can be a health risk. Contaminants in concentrated acids and bases must be monitored for safety and quality control.

Direct injection of concentrated acid or base samples often results in overloading of the IC column, resulting in poor chromatography and unreliable quantification. Sample dilution can reduce column overloading, but sacrifices detection limits. An AutoNeutralization™ suppressor eliminates the need to dilute concentrated acids or bases to avoid column overloading, permitting the determination of μg/L and ng/L concentrations of anions and cations.

Chelation IC is ideal for determination of transition metals in organic solvents and concentrated acids and bases.

Ions and Amines in H₂O₂

Hydrogen peroxide is an essential chemical used in a number of manufacturing processes. For polymerization and especially for semiconductor manufacturing, purity is critical. An IonPac CS17 column can be used to separate amines without the organic modifiers required with older cation-exchange columns, and an RFIC system with eluent generation permits gradient separation with the ease of use of an isocratic system, using Chromeleon software to program the gradient.

Cations or anions can be determined using the online matrix elimination technique described in Dionex Application Update 163. However, exposure to hydrogen peroxide may reduce the concentrator column lifetime.
Surfactant Analysis

Benzalkonium chloride is a cation surfactant sometimes used as an antiseptic in consumer products. It has applications in products such as fungicides, antiseptics, and anti-bacterial consumer products. Cationic surfactants have traditionally been difficult to analyze by reversed-phase HPLC. That changed with the introduction of the Acclaim Surfactant column. While the Acclaim Surfactant column was designed to analyze all classes of surfactants, it was especially designed for cationic surfactants. The Acclaim Surfactant column and an UltiMate 3000 system can be used to determine both the quantity and the polymeric distribution of benzalkonium chloride in a range of consumer products, for example disinfectant sprays, eye drops, and sterile elastic bandages.

Allantoin and Urea in Cosmetics

Allantoin is frequently added to preparations used to treat minor cuts, scrapes, burns, sunburn, fever blisters, diaper rash and chapped skin and lips, and to cosmetic products to support skin protection and regeneration. Urea is frequently added as an antiseptic to prevent the growth of bacteria, mildew, and yeast in creams, shampoos, lotions, and cosmetics. However, when used in large quantities in the raw materials, they may adversely affect health and must be analyzed for quality control purposes.

Reversed-phase C18 and polar-embedded reversed-phase columns retain urea and allantoin poorly, and demonstrate limited resolution. An Acclaim Mixed-Mode HILIC-1 column operated in the HILIC mode is the best choice for retention and resolution of urea and allantoin.
Glyphosate in Consumer Weed Killer Formulations

Glyphosate is a popular herbicide available in many formulations. Waterproofing agents are often present in the formulation along with glyphosate, which are hydrophobic, and can interfere with glyphosate retention. The Acclaim Mixed-Mode WAX-1 column cleanly separates glyphosate from the other ingredients. Glyphosate’s lack of a UV chromophore and high concentration in the sample make detection by evaporative light scattering a convenient option.

Engine Coolant Corrosion Inhibitors

Corrosion inhibitors are added to ethylene glycol coolant solutions because glycolic acid can erode cooling systems, especially if copper ions are present. No single inhibitor can protect against all corrosive agents; therefore, multiple inhibitors are typically added to antifreeze formulations. The Acclaim Mixed-Mode WAX-1 column can be used to separate glycolic acid and numerous corrosion inhibitors, including benzotriazole (BT), tolyltriazole (TT), 2-mercaptopenthiazole (MBT), sebacic acid, 2-ethyl hexanoic acid, and benzoic acid, in a single injection.

Anions in Toothpaste and APF

Fluoride is well known to play a critical role in preventing tooth decay. The U.S. Food and Drug Administration has approved the use of three decay-preventing compounds in toothpaste: stannous fluoride, sodium fluoride, and sodium monofluorophosphate (MFP). However, fluoride can react with other ingredients in toothpaste to form insoluble compounds, and MFP can hydrolyze during storage, interfering with the efficacy of the product. Acidulated phosphate fluoride (APF) is approved for use as a topical solution or gel, and has strict requirements for fluoride concentration. Therefore, the determination of fluoride and MFP in toothpastes and APF is important for quality control purposes. IC provides a convenient and simple method for the direct determination of fluoride and MFP in a single analysis, with minimal sample preparation.
Manufacturing processes are often complex, and depend on steps that use chemicals or produce byproducts that can affect product quality, worker health, or environmental safety. Dionex IC and HPLC systems and columns are used in a number of industries to help monitor process intermediates, occupational exposure, and waste streams for process control and regulatory compliance.

Sulfur Speciation
The measurement and characterization of total sulfur content, as well as identification of sulfur species at trace levels, is important in several industrial processes. Catalytic hydrotreating processes, for example hydrodesulfurization, remove sulfur compounds from refinery product streams, and sweetening processes remove sulfur compounds or convert them to disulfides, as in the case of mercaptans. This can be a challenging application given their redox chemistry, and the tendency of many sulfur-containing species to readily react with each other, decompose over time, or oxidize in the presence of air. They are also very sensitive to the solution pH, which would affect the distribution of the species over time. All of these factors make the determination of these sulfur-containing anions a very challenging task. Traditional wet chemical methods for sulfur speciation are often unreliable for quantification at trace levels concentrations. However, modern IC provides an accurate and convenient method for the speciation of sulfur-containing species. OnGuard® single-use or InGuard™ in-line multiuse sample preparation cartridges can be used to help remove matrix ions and reduce solution pH to improve chromatographic separation.

Oxalate in Bayer Liquor
To isolate alumina, bauxite is dissolved in sodium hydroxide, forming a solution referred to as Bayer liquor. Aluminum hydroxide is precipitated and used in the aluminum smelting process. After precipitation, only the large crystals are put into the kiln for calcination; small crystals are returned to the precipitator. Oxalate can interfere with crystal formation, and therefore measurement of the oxalate concentration helps predict the success of forming large crystals from a given Bayer liquor. The high ionic strength and metal content typically present in these solutions make it a challenging sample. Dionex has developed a direct injection method using an RFC system with in-line sample cleanup to accurately and reproducibly measure oxalate in Bayer liquor.

[Graphs and figures as described in the text]
Analysis of Cations in Wastewater

To prevent nutrient enrichment and the undesirable ecological impacts associated with them, anionic and cationic species must be closely monitored in chemical wastewater streams. IC has proven to be a useful technique for the determination of amines and their breakdown products (usually other smaller amines and ammonium), as well as Group I and Group II metals. Alternate techniques using GC and HPLC require derivitization for separation and detection. Typically, these samples are water based since amines are used extensively as organic bases for pH adjustment in aqueous process streams, for example boiler water, or product formulations (scale inhibitor). IC with suppressed conductivity detection offers the convenience of analyzing water based systems with excellent sensitivity and minimal effort. The IonPac CS16 column can separate these cations rapidly and reliably using electrolytically generated methanesulfonic acid (MSA) eluent, and is compliant with ASTM Method D6919-03.

Occupational Safety

Analysis of Diisocyanates

Toluene diisocyanate (TDI) and hexamethylene diisocyanate (HDI) are commonly used in the manufacture of urethane polymers, are highly toxic by inhalation, and are carcinogenic. OHSA method 42 is a standard method for testing workplace air for contamination. The Acclaim RSLC PolarAdvantage II (PA2) 2.2 μm column not only provides suitable selectivity for these diisocyanates but also allows an acceleration of about eightfold over the conventional method. Elevated temperature improves resolution while reducing backpressure to about 210 bar.

Analysis of Azodicarbonamide

Azodicarbonamide (ADC) is a blowing agent used in the production of foamed rubber and plastics, and as a flour bleaching agent that also promotes stable, even baking. But ADC is also a known respiratory sensitizer, and occupational exposure is monitored with air filters. The collected ADC is dissolved in EtOAc:DMSO and then quantified by HPLC. As ADC is not retained by reversed-phase or ionic interactions, the Acclaim Mixed-Mode WAX-1 column can be used in normal-phase mode for analysis of the filter extracts. The 3 μm, 3.0 × 150 mm format column provides excellent resolution and reduces solvent consumption as compared to 4 mm columns.

Peaks*:
1. Sodium 26,345 mg/L (ppm)
2. Ammonium 5.6
3. Potassium 45.3
4. Magnesium 11.3
5. Calcium 5.5

*Calc. (in original sample)

Determination of ammonium and cations in a high-sodium wastewater sample.

Peaks:
1. 2,6-Toluenediisocyanate
2. 1,6-Hexamethylenediisocyanate
3. 2,4-Toluenediisocyanate

Samples:
A. Reagent blank
B. 0.16 µg/mL in matrix
C. 8.0 µg/mL each in acetonitrile

Fast determination of diisocyanates using the Acclaim PA2 2.2 μm column.
The refining and use of fossil fuels in a number of industries poses challenging analytical problems. Raw materials and finished products must be tested for quality to ensure product yields, protect refinery equipment, increase the lifetimes of engines or equipment using the fuels, and to protect the environment. Dionex has developed equipment and applications for testing raw material and product quality, and for compliance with regulations for fuel production and use.

**Combustion Ion Chromatography**
Fluorine, chlorine, bromine and sulfur can cause corrosion in many industrial processes, decreasing the lifetime of many catalysts and causing environmental pollution. Combustion IC permits automated qualitative and quantitative analysis of halogens and sulfur in petrochemicals, coal-based chemicals, and construction materials, chemicals, and polymers. Solid or semisolid samples are pyrolyzed, absorbed in an aqueous solution, and injected onto an IC system for analysis of the combustion products. This system can be used to identify and measure:

- Sources of contaminants in production and manufacturing
- Additives for fire retardants and antioxidants (plastics, polymers, textiles)
- Environmental impact of use (coal, disposal and recycling (plastics and solvents)
- Product specification and QC/QA

For example, total halides and sulfur can be determined in an LPG (liquefied petroleum gas) sample, to monitor HF alkylation unit effectiveness.

**Refinery Heat-Stable Salt Monitoring**
Alkanolamine is a gas-conditioning scrubbing solution used in petroleum refineries to remove H₂S and CO₂ that may be present in the feed gas. Heat stable salts (HSSs) can form from amines in these solutions. While H₂S and CO₂ gasses are retained when they are passed through the amine stripper and later removed by heat, inorganic cations such as formate, acetate, glycolate, sulfate, and chloride can not be removed. The buildup of HSSs in the amine unit decreases the acid gas carrying capacity of the amine, increases solution viscosity, and can cause corrosion and foaming problems, thus increasing operating costs.

IC is the preferred technique for monitoring several points throughout the amine unit. It can unambiguously identify and quantify trace-level organic acids such as acetate, formate, and glycolate while simultaneously resolving sulfur species from sulfite and sulfate to the strongly retained anions such as thiosulfate and thiocyanate, within a single chromatographic run.

**Determination of sulfur and halogens in a liquefied petroleum gas sample, using combustion IC with an IonPac AS11-HC column and suppressed conductivity detection.**

**Determination of heat-stable salts in a gas conditioning scrubbing solution, using an IonPac AS11-HC column and suppressed conductivity. Gradient elution accelerates the elution of strongly retained species, such as thiocyanate.**
Analysis of Polycyclic Aromatic Hydrocarbons in Fuel Oil

The content of polycyclic aromatic hydrocarbons (PAHs) in diesel fuels is regulated, and most often determined using standard methods EN-12916 or ASTM D-6591. Not only does the presence of aromatic hydrocarbons pose a health risk because they are known carcinogens, they also affect fuel quality and performance. To ensure optimum engine performance and lifetime, the amount of PAHs in diesel fuel should be as low as possible. For this reason it is necessary to be able to detect and quantify trace-level PAHs in complex matrices such as petroleum distillates. The UltiMate 3000 x2 dual system facilitates the automation of on-line sample preparation and matrix elimination, permitting direct injection of complex samples using a split in-line loop injection.

Anticorrosion Amines and Cations

Efficient management of process streams in petrochemical production requires frequent monitoring for contamination prior to use or disposal. For example, natural gas liquids (NGL) and liquid petroleum gas (LPG) streams are typically washed with dilute caustic, 2–14 wt% NaOH, to remove residual organic sulfur compounds, such as mercaptans. Alkanolamine solutions are used to remove acidic components (H₂S, CO₂) from these hydrocarbon streams. Caustic washing may also be employed to neutralize the acid alkylation process effluents to minimize corrosion of plant piping and mechanical components. IC is an effective analytical tool for measuring cation contaminants, for example alkali and alkaline earth metals, ammonium, and alkanolamines in spent caustic washes, alkanolamine solutions, and other process streams such as wastewater.

Determination of amines and cations at concentrations from 0.5–5 ppm in a wastewater sample using an IonPac CS16 column and suppressed conductivity detection.

Peaks:
1. Lithium
2. Sodium
3. Ammonium
4. Monoethanolamine
5. Methylamine
6. Diethanolamine
7. Ethylenimine
8. Potassium
9. Dimethylethanolamine
10. Triethanolamine
11. Methyltriethanolamine
12. Dimethylaminopropylamine
13. Morpholine
14. 1-methoxypropanol
15. Dimethylamino-2-propanol
16. Magnesium
17. Calcium

Determination of PAHs in diesel fuel. Split in-line loop injection using isocratic elution provides baseline separation of all analytes.

Peaks:
1. Paraffins
2. Toluene
3. Naphthalene
4. Phenanthrene
5. Pyrene
6. Nitrobenzene

Determination of PAHs in diesel fuel. Split in-line loop injection using isocratic elution provides baseline separation of all analytes.
Chloride and Sulfate in Alcohols

The National Institute of Standards and Technology (NIST) recently made recommendations for the minimum acceptable limit for contamination of ethanol with ions such as sulfate and chloride, with the goal of harmonizing US, European Union, and Brazilian standards for biofuels quality assurance. Excessive amounts of sulfate and chloride anions can clog automobile filters and fuel injector nozzles, negatively impacting engine performance. The NIST study recommends IC as the preferred analytical method for determining sulfate and chloride in ethanol, and also recommends lowering the regulated limit of chloride ion to more closely match the specification of 1 ppm adopted by Brazil.

Using the matrix elimination method with the Dionex ICS-3000 ICS system, chloride and sulfate ions are concentrated automatically for detection limits as low as 1 ppm chloride and sulfate in denatured ethanol and alcohol-gasoline blends, without arduous sample preparation. Dionex IonPac AS24 and AS22 columns provide accurate, reproducible results in even the most complex matrices. Choose between hydroxide (IonPac AS24) or carbonate (AS22) electrolytically generated eluents for fast run times (<12 min) with excellent retention time stability.

Cations in Biodiesel

Biodiesel is produced by reacting plant or animal oils with an alcohol in the presence of a catalyst to produce the desired methyl esters and the byproduct glycerol. Basic catalysts, for example, sodium or potassium hydroxide or alkoxides, are most commonly used, and leave residual sodium or potassium that must be removed. Magnesium and calcium contamination can also occur if hard water is used in the manufacturing process. These cations can form soaps and ash that can clog engines.

ASTM D6751 and EN 14214 standards set a limit for these cations at <5 ppm combined sodium and potassium, and <5 ppm combined magnesium and calcium, and limits as low as <0.3 ppm total combined cations are required for a 6% biodiesel blend. The methods specified in these standards, ICP-OES and atomic absorption spectroscopy, suffer from matrix interference, difficulty in simultaneously determining contaminants, and complicated sample preparation. IC can quickly and specifically determine multiple cations simultaneously, with direct injection after only a simple water extraction and filtration. Detection limits are routinely at the 1 ppm level, far below the 5 ppm concentrations specified in the standard methods.
Carbohydrate Profiling of Biomass

Accurate, precise compositional analysis of biomass is critical for understanding and assessing biomass conversion technology. Analytical methods that provide a high degree of confidence are required for accurate yield and mass balance calculations, which in turn are necessary for sound cost estimates for biofuels production. The Dionex method for monosaccharide analysis permits determination of carbohydrates by direct injection using high-performance anion-exchange chromatography with pulsed amperometric detection (HPAE-PAD). Our new low-volume microloop injection valve technology provides baseline-resolved separation of highly concentrated samples (up to 100 g/L) without dilution, thus eliminating dilution errors while delivering stellar performance.

Lipid Profiling of Algal Biomass

Many plants, including algae, store large amounts of oil as carbon storage reserves, making them an important biomass feedstock for the development of alternative fuels. Profiling of the mixture of microalgal lipids is critical in order to screen out polar phospholipids from the feedstock because they can contaminate the precious metal refining catalysts used in the production of a form of biodiesel known as renewable diesel. The Corona® ultra™ with Charged Aerosol Detection® (CAD®) technology permits detection of multiple lipid classes including neutral lipids such as triacylglycerols and sterols, polar lipids such as phospholipids, as well as the non-acyl lipids including phytols in a single analytical run. Methods based on charged aerosol detection are more convenient than older, ELSD technology, often requiring multiple different chemistries, from normal-phase to reversed-phase chromatography, employing more complex method development, and the need for multiple analytical runs.

Fermentation Process Monitoring

Precise monitoring of fermentation in ethanol production is critical for maximizing fermentation rates and minimizing organic acid inhibitors. A key requirement is determining three different analyte classes—carbohydrates, organic acids, and alcohols—in a single analytical run. For this application, the Dionex Integral Process Analytical System using HPLC with refractive index detection, permits simultaneous monitoring of multiple analyte classes.
Bisphenol-A Diglycidyl Ether (BADGE) and Related Impurities

BADGE is a widely used epoxy monomer derived from bisphenol-A. It is used to manufacture many kinds of coatings, such as powder coatings, solid coatings, solvent-based coatings, and anti-corrosive coatings. The purity of the monomer is critical because it is used to produce polycarbonate, epoxy, phenolic, polyester, and other resins. Residues of epoxies used in food-contact applications are of great health concern, because they are endocrine disruptors. For these reasons, it has become necessary to examine the quality of the raw materials of such monomers prior to polymerization and scale-up for industrial purposes. Most analytical methods for these contaminants use organic solvent-water gradients and a relatively long column to provide acceptable selectivity. The high flow-pressure footprint of the UltiMate 3000 RSLC system permits use of Acclaim RSLC columns with smaller particle sizes, such as the 2.2 µm Acclaim RSLC C18 2.1 mm i.d. column. This column can resolve BADGE and related impurities in less than 5 min, a quarter of the time necessary to resolve the same components using the conventional 5 µm Acclaim 120 C18 column.

Acrylic Acid and Oligomers

Acrylic acid is an important monomer that can be polymerized to yield a class of hydrophilic polymers with high absorption capacity for aqueous solutions. Hydrophilic polymers are capable of absorbing several times their own weight in water, transforming them into gels with agricultural, horticultural, and sanitary applications. Ensuring the purity of the acrylic acid monomer is critically important to meet the demanding market requirements for products which come into contact with food, beverages, or human skin. Acrylic acid can also spontaneously form oligomers that can affect the properties of the finished product. The Acclaim Organic Acid (OA) column is well suited for quality-control assays related to this important class of polymers.

Separation of BADGE and related impurities using A) conventional LC: Acclaim 120 C18, 5 µm, 4.6 × 150 mm column and B) UHPLC: Acclaim RSLC C18, 2.2 µm, 2.1 × 150 mm column, and detected using UV absorbance.

Separation of acrylic acid monomers and oligomers using an Acclaim OA column, with detection by UV absorbance. A) Acrylic acid sample showing dimer and trimer impurities. B) Separation of a mixture of acrylic acid oligomers.
Extraction of Plasticizers from PVC

Poly(vinyl chloride) PVC is a popular, versatile polymer used in many different products including water pipes, toys, and shower curtains. PVC is typically composed of resins, stabilizers, pigments, and plasticizers. Plasticizers soften the polymer, aid in the manufacturing process, and provide form and function to various PVC materials. Plasticizers may account for 30-35% of the PVC formulation. Extraction and determination of plasticizers in a PVC material are critical steps in evaluating a polymer for an intended use. Traditionally, plasticizers are extracted from PVC using a 6 h Soxhlet method and identified using infrared spectrometry or gas chromatography. Compared to Soxhlet extractions, ASE methods decrease extraction times from hours to minutes and reduce solvent consumption while delivering equivalent recoveries.

Analysis of Polymer Additives

Polymer additives are used as processing and long-term thermal stabilizers to protect the polymer from breakdown caused by UV light or oxidation. These antioxidant additives are critical to maintain the lifetime of consumer products containing thermoplastic polyurethane (TPU) resins. Tinuvin® is a common UV stabilizer used as an additive (for example, in polyethylene and polypropylene). Irganox® is the trade name for a class of phenolic-based antioxidants used widely as additives (for example, in PET and polyolefins). In order to control formulation levels and to conduct stability studies, the additive content of the polymer must be determined.

An ASE system is ideal for extraction of additives from in-process materials and final products. The additives can be separated using an UltiMate 3000 HPLC system with the Acclaim 120 C18 column using a CH₃CN/H₂O gradient. For identification and analysis of decomposition products of polymer additives, MS detection by positive ion APCI is required.

Overlay of selected ion mode (SIM) chromatograms of a polymer UV stabilizer and three antioxidant additives.