

focus on Chromatography

Straightforward Determination of Hexavalent Chromium by Ion Chromatography

Metrohm AG

Generally speaking, hexavalent chromium or Cr(VI) is classified as allergenic, carcinogenic and extremely toxic, and is subject to strict monitoring. Cr(VI) can occur in various concentrations in different areas, e.g., drinking water, toys and textiles. Metrohm has developed ion chromatography determination methods for determining Cr(VI) in various concentration ranges (ng/L to mg/L) with inline sample preparation techniques for various matrices. More information on these applications is available from Metrohm.

Application 1: Chromium(VI) in Mineral and Drinking Water according to EPA 218.7

When released in nature, Cr(VI) is a highly toxic contaminant of drinking water. Even the smallest quantities are hazardous to human health.

Even though the RoHS Directive severely has restricted the use of Cr(VI) compounds in Europe since 1 July, 2006, chromate nonetheless remains a widespread pollutant in the environment. Chromium is still used in the manufacture of batteries and stainless steels, among other things.

Some pigments formerly used in dyes also contained Cr(VI) compounds. These chromate pollutants appear in the environment when decontamination is done improperly. The carcinogenic Cr(VI) finds its way into the soil, and over time also into our water.

The EU limit value for total chromium, which corresponds to both the WHO limit value and to the German Drinking Water Ordinance, is still set at 50 µg/L. Whether to institute a considerable reduction in this limit value is currently under discussion.

Metrohm has developed an exceptionally sensitive ion chromatography method for the detection of Cr(VI), with a limit of determination of less than 0.02 µg/L Cr(VI). The application is also in compliance with the limit value stipulated to EPA Standard 218.7.

If required, the sample can be prepared for injection using Inline Ultrafiltration in an automated sequence. Detection takes place by means of post-column reaction with 1,5-diphenylcarbazide and subsequent detection at 530 nm. The procedure is controlled using the intelligent ion chromatography software MagIC Net.

Application 2: Chromium(VI) in Toys according to DIN EN 71-3

Children are exposed to heavy metals from a wide variety of sources. Cr(VI) in particular represents a potential hazard, as it is absorbed from food and drinking water, from the air, from textiles, from utensils that contain metal and from toys.

Analytical determination of the Cr(VI) content in toys for compliance with limit values is described in the European Standard DIN EN-71-3-2013 (Safety of toys Part 3 - Migration of certain elements).

The standard differentiates between three categories, depending on the type of toy:

Category I – Migration limit: 0.02 mg/kg Cr(VI)

Dry, brittle, powder-like or pliable toy materials
e.g., coloured pencil leads, chalk, wax crayons.

Category II – Migration limit: 0.005 mg/kg chromium(VI)

Liquid or sticky toy materials
Finger paint, varnish, liquid ink or soap bubble solutions...

Category III – Migration limit: 0.005 mg/kg chromium(VI)

Materials scraped off from toys
Varnish coatings, printer's inks, paint...
paper and cardboard, glass, ceramics, metallic materials, undyed and dyed materials,
e.g., wood and leather



Metrohm has developed an ion chromatography method for this application that uses preconcentration and Inline Matrix Elimination.

A portion of the migration solution produced in accordance with the regulation DIN EN 71-3:2014-12 is placed on a preconcentration column, where a rinsing solution is used to elute the matrix from the column. In the second step, chromatographic separation takes place on an anion exchanger. Detection is accomplished using a very specific post-column derivatisation in combination with UV/VIS detection.

Application 3: Chromium(VI) in Leather according to DIN EN ISO 17075

The Cr(VI) that may form during the chrome tanning process is regarded as allergenic and carcinogenic. Causes of the Cr(VI) load in leather include, among other things, contamination of the Cr(III) salts by Cr(VI) compounds. In addition, excess Cr(III) salts that are not bound to the collagen in the skin of the leather may oxidise to form chromium(VI) under certain conditions.

The Cr(VI) content in leather is determined in accordance with DIN EN ISO 17075:2007. Strongly coloured leather extracts disrupt the determination of chromium(VI), and require filtration of the extracts.

Metrohm has developed an ion chromatography method for this application using Inline Dialysis for automatic sample preparation and UV/VIS detection following post-column reaction. Before injection of the sample on the separation column, the high-molecular compounds of the sample matrix are separated from Cr(VI) with Inline Dialysis. In the second step, chromatographic separation takes place on an anion exchanger. Detection is accomplished using a very specific post-column derivatisation in combination with UV/VIS detection.

Advantages of the method in comparison with the photometric method with solid phase extraction:

• **Cost savings**

The moderate price of the membrane for Inline Dialysis keeps operating costs very low in comparison with solid phase extraction.

• **Time savings**

The automatic sample preparation of the next sample is already taking place with Inline Dialysis during the running time of the chromatogram of each sample.

• **Increased detection sensitivity**

Detection sensitivity can be enhanced considerably in comparison with the conventional photometric method thanks to the sensitivity of the UV/VIS detector after post-column reaction.



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