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NICHRO
HARD SURFACES

CROME IN FOOD

Chrome in food processing equipment is regulated differently in the US and EU (incl. Denmark). In the US a producer may obtain FDA approval of chrome coatings, but normally such an approval is not requested. The EU wants to phase out hexavalent chromium starting in 2017 (the REACH Regulation), but expects realization around 2029 – 2034. Currently EU has no requirements for coatings containing metallic chrome or trivalent chrome, i.e. the composition of any hard chrome coating.

Metal coatings protecting equipment against wear and corrosion is defined by FDA as *Food Contact Substances* (FCS); http://www.fda.gov/Food/FoodIngredientsPackaging/FoodContactSubstancesFCS/ucm116567.htm i.e..: *FCS is any substance intended for use as a component of material used in manufacturing --- if such use is not intended to have a technical effect in such food.*

The FDA regulates such substances. The FDA website shows that neither acceptance nor rejection of hard chrome coatings has been given so far. We believe it is because FDA does not see any problems in hard chrome coatings as the FDA does focus on the toxicity of any substance to be released and absorbed in food during operation unlike the EU which also focuses on the production process. Indeed the aim of REACH is to protect the health of the workers when producing hard chrome coatings.

The Food Contact Substance being in contact with food during processing is metallic chromium, CR^0. Metallic chrome is not toxic to humans. The chrome coating is passive and corrodes very slowly; chromium may be dissolved but only as trivalent chromium Cr^{3+}, which indeed is essential for life. Cr^{3+} can oxidize to hexavalent chromium Cr^{6+}, but such processes are not voluntary taking place in nature; Cr^{6+} is toxic and can cause cancer. Surprisingly the EU believes that chrome does not pose a toxicological problem (*Policy Statement concerning metals and alloys*), because the measured chrome concentrations are below the recommended daily chromium intake.

In rare cases chrome particles may be found in food as a result of tearing, releasing metallic chrome particles from the hard chrome coating. These particles are foreign bodies and according to Danish law food producers are not allowed to accept or sell any food or ingredients that are contaminated with foreign bodies. In such cases food are by definition unfit for human consumption.

EU, including Denmark, is in the process of tightening up the regulation of the future use of chromium (the REACH-directive). The problem is legal, but Cr^{6+} is on the EU list of candidates and is planned to be phased out starting from 2017. The EU has recognized that this objective cannot be reached in practice, why hexavalent chromium, Cr^{6+}, is recorded on the so-called authorization list; i.e. EU dispenses and gives permission to use six valid chromium in production processes, provided that the producer has the authority to do so. The idea is that the EU authorization is given to manufacturers or importers of chromium trioxide and that the users such as hard chrome producers do produce under the manufacturer's or importer's authorization. This authorization scheme is still in the pipeline, but rumors will know that exemption for continued use of CrO_3 will be given for another 12 - 17 years.

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STATEMENT

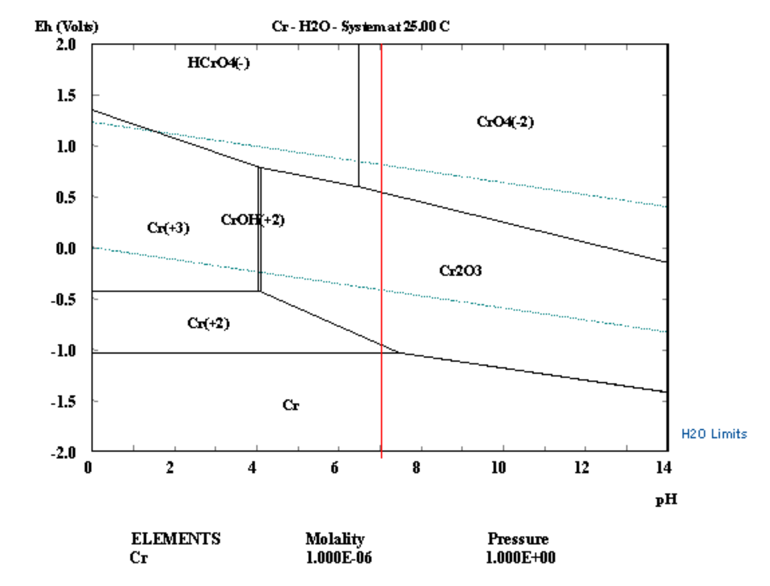
a. h. Nichro HAARDCHROM A/S produces hard chrome coatings in a hexavalent chrome bath (Cr^{6+}) in accordance with the manufacturer's instructions. The plated surface coating consists of a hard metallic chromium layer (Cr^{0}) containing micro-cracks with a crack density of 300 - 800 cracks / cm. Production of hard chrome coatings in a trivalent chrome bath is currently technically impossible, but we do follow the technical development closely, as we expect it will be possible in an unknown future.

The oxygen of the air oxidizes the outer chromium layer forming a thin and dense oxide film of Cr_2O_3 on the surface. This film acts as an effective barrier against further oxidation. The passive oxide film improves the corrosion resistance of chromium even in aggressive environments such as diluted nitric acid or dilute sulfuric acid. However it is important that the operating conditions allows the oxide film to remain intact. The Pourbaix diagram can be used to predict the stability of the oxide film.

The film is dissolved in halogen-containing environments; i.e. environments with F^-, Cl^-, Br^-, I^- ions, or in environments where the pH or the electrode potentials are unfavorable. The chrome surface will be passive in the area called Cr_2O_3:

The Pourbaix diagram shifts shape and borders depending on the media, the pH and the electro-chemical conditions. The shown diagram is based on information from a customer; i.e. .:

- neutral acidity; pH = 7
- room-temperature = 25 °C
- Carbamid Peroxid, approx. =3 wt%
- product spec.: 32p1-desc-comp-d-1-02
- product spec.: 32p1-desc-comp-b -02



The low concentration of H_2O_2 (the peroxide) and the electrically neutral solution at neutral pH cannot break down the oxide film of the coating.

The chrome coating remains passive under the specified operating conditions.

a.h. Nichro's hard chrome coatings do not contain any hexavalent chromium, Cr^{6+}. The coating consists of metallic chrome, Cr^{0}, which is neither dangerous to health nor to environment.

Hvidovre, May13, 2015

a. h. nichro Haardchrom A/S
Kristian Eg Løkkegaard

Partial Agreement
in the Social and Public Health Field
Accord Partiel
dans le domaine social et de la santé publique

COUNCIL OF EUROPE CONSEIL DE L'EUROPE

COUNCIL OF EUROPE'S POLICY STATEMENTS CONCERNING MATERIALS AND ARTICLES INTENDED TO COME INTO CONTACT WITH FOODSTUFFS

POLICY STATEMENT CONCERNING METALS AND ALLOYS

TECHNICAL DOCUMENT

GUIDELINES ON METALS AND ALLOYS USED AS FOOD CONTACT MATERIALS

(13.02.2002)

Guideline for chromium

Introduction

Chromium is found in the environment mainly in the trivalent form. Hexavalent chromium, or chromate, may also be found in very small amounts, arising usually from anthropogenic sources (Beliles, 1994). Cr(III) has the ability to form strong, inert complexes with a wide range of naturally occurring organic and inorganic ligands (Florence and Batley, 1980). In most soils and bedrocks, chromium is immobilised in the trivalent state (Florence and Batley, 1980). Chromium is an essential element to man. Chromium is found at low levels in most biological materials.

Main sources of chromium in the diet

The main sources of chromium are cereals, meat, vegetables and unrefined sugar, while fish, vegetable oil and fruits contain smaller amounts (Codex, 1995). Most foodstuffs contain less than 0.1 mg chromium per kg (Nordic Council of Ministers, 1995). Chromium is present in the diet mainly as Cr(III) (Codex, 1995). As with all metals, food contamination may be caused by atmospheric fall-out (Codex, 1995).

Metallic food contact materials

Chromium is found in some types of cans and utensils. In cans it serves to passivate the tinplate surface. Chromium is used in the production of stainless steel of various kinds and in alloys with iron, nickel and cobalt. Ferro chromium and chromium metal are the most important classes of chromium used in the alloy industry (Langaard and Norseth, 1986). Chromium containing stainless steels (see guideline on stainless steel) are important food contact materials used for transportation, e.g. in milk trucks, for processing equipment, e.g. in the dairy and chocolate industry, in processing of fruit such as apples, grapes, oranges and tomatoes, for containers such as wine tanks, for brew kettles and beer kegs, for processing of dry food such as cereals, flour and sugar, for utensils such as blenders and bread dough mixers, in slaughter-houses, in processing of fish, for nearly all of the equipment in big kitchens, such as restaurants, hospitals, electric kettles, cookware and kitchen appliances of any kind such as sinks and drains, for bowls, knives, spoons and forks. Chromium is also used to coat other metals, which are then protected from corrosion because of the passive film which forms on the surface of chromium.

Other food contact materials

Chromium compounds are found in pottery, glazes, paper and dyes (Langaard and Norseth, 1986).

Migration information

Canned foodstuffs in non-lacquered cans and other processed foodstuffs, particularly acidic foodstuffs such as fruit juices, may be significantly higher in chromium than fresh foodstuffs. A small contribution to chromium intake can be made by uptake from cans. However, the significance of this is probably negligible. Chromium from materials and articles is expected to migrate as Cr(III) and not as Cr(VI) (Guglhofer and Bianchi, 1991). Cr(III) can not migrate at neutral pH in foodstuffs. Therefore, the migration of Cr(III) to foods of pH 5 or above is low. Formation of Cr(VI) as a result of a conversion in water of Cr(III) is not possible. Therefore, formation of Cr(VI) does not occur in foodstuffs. This implies, that Cr(VI) is generally not considered to be an issue of food contact materials. Also, chromium does not migrate significantly from articles made of stainless steel, and any released chromium is Cr(III) (Cunat, 1997). Due to alloying with chromium, the stainless steels resist corrosion by foods and are readily cleaned, thereby providing hygiene in food preparation and handling. Chromium is one of the metals which naturally forms a corrosion-resistant passive film when in contact with water and air (see section on corrosion in Introduction).

Safety aspects

- JECFA has not evaluated chromium.
- SCF found that the data on the essentiality and metabolism of chromium are so sparse that the Committee was unable to specify any requirements (SCF, 1993).
- WHO (1993) has set a maximum of 0.05 mg/l of Cr(VI) in drinking water.
- Recent estimates of the daily intake range from 0.025-0.2 mg/day (Codex, 1995).
- The speciation of chromium is of great importance for the toxicity. Cr(III), the most stable oxidation state in biological materials, is an essential element for normal glucose metabolism, while Cr(VI) is highly toxic (Beliles, 1994; Costa, 1997; Nordic Council of Ministers, 1995). Cr(III) has a low toxicity due to low absorption (about 0.5%) (Nordic Council of Ministers, 1995). Toxic aspects of chromium are related to Cr(VI) (Nordic Council of Ministers, 1995), due to its high absorption, easy penetration of the cell membranes and its genotoxicity and oxidising properties (Codex, 1995).

Conclusions and recommendations

Although there is no specific evaluation on chromium, is seems that anthropogenic chromium in foodstuffs is not a toxicological problem because the recommended intake is higher than actual values. However,

- A specific evaluation on chromium should be conducted, by for instance SCF, including evaluation on the aspect of allergy and chromium as at least one reference refers to chromium allergy (Veien et al., 1994).

References

1. Beliles, R.P. (1994). The metals. In: Patty's Industrial Hygiene and Toxicology, Fourth edition, Volume 2, Part C. Edited by Clayton, G.D., and Clayton, F.E. John Wiley & Sons, Inc.
2. Codex Alimentarius Commission (1995). Doc. no. CX/FAC 96/17. Joint FAO/WHO food standards programme. Codex general standard for contaminants and toxins in foods.
3. Costa, M. (1997). Toxicity and carcinogenity of Cr(VI) in animal models and humans. Critical Reviews in Toxicology. 27(5) p. 431-442.
4. Cunat, P.-J. (1997). Healthy eating and drinking with stainless steel. 1st SS congress, Thailand, Dec. 1997.
5. Guglhofer, J., Bianchi, V. (1991). Metals and their compounds in the environment. VCH Verlag, Weinheim, Germany.
6. Florence, T.M., Batley, G.E. (1980). Chemical speciation in natural waters. CRC Critical Reviews in Analytical chemistry. p. 219-296.
7. Langaard, S., Norseth, T. (1986). Chromium. In: Friberg, L., Nordberg, G.F., Vouk, V.B. Handbook on the toxicology of metals. Second edition. Elsevier, Amsterdam, New York, Oxford.

8. Nordic Council of Ministers (1995). Risk evaluation of essential trace elements - essential versus toxic levels of intake. Report of a Nordic project group. Ed.: Oskarsson, A. Nordic Council of Ministers, Copenhagen, Denmark.
9. SCF (1993). Report of the Scientific Committee for food (thirty-first series). Nutrient and energy intakes for the European Community.
10. Veien, N.K., Hattel, T., Laurberg, G. (1994). Chromate-allergic patients challenged orally with potassium dichromate. Contact dermatitis. 31 p. 137-139.
11. WHO (1993). Guidelines for drinking-water quality. Volume 1. Recommendations.