

White paper

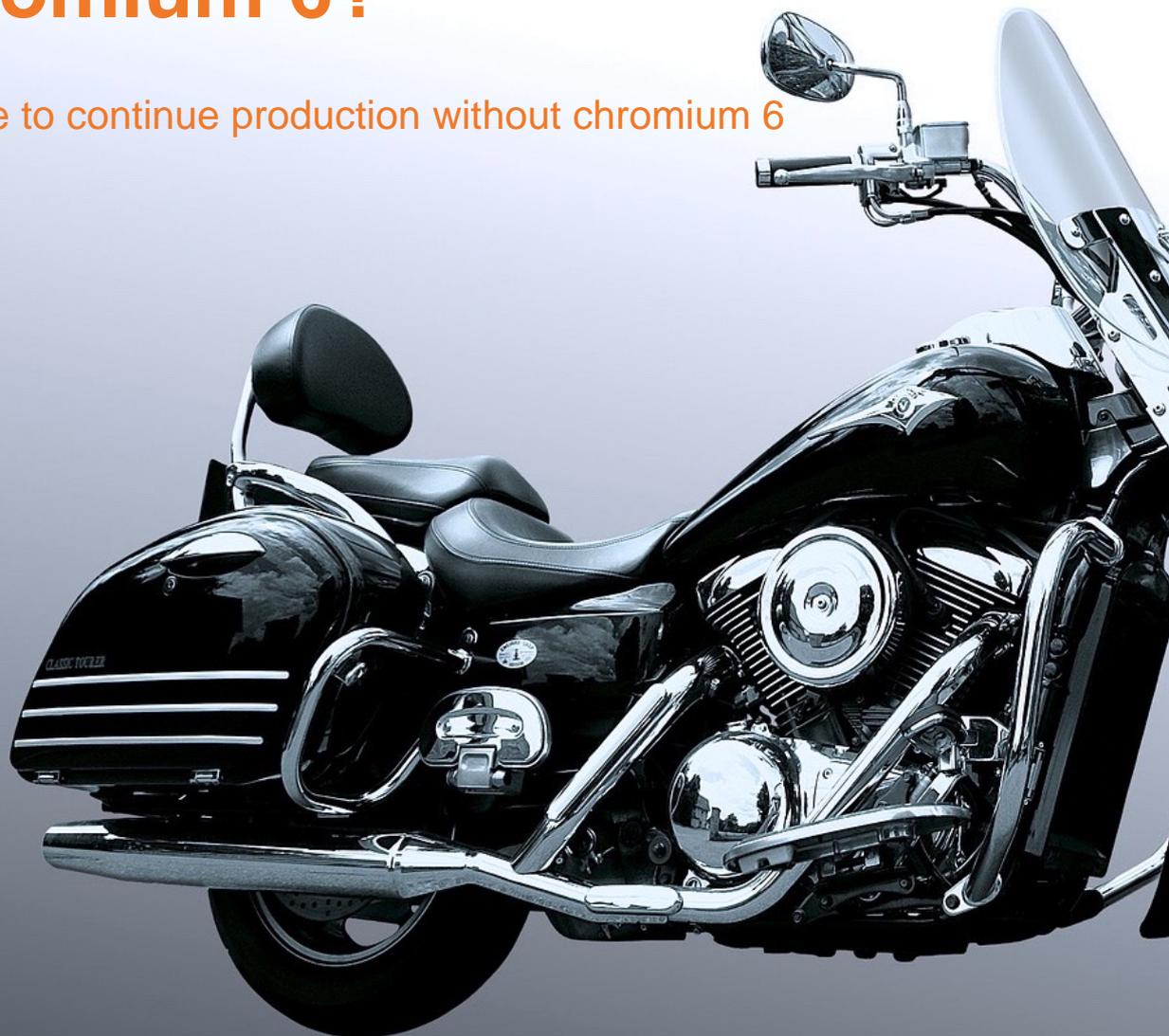


Aquarden
TECHNOLOGIES

Your water. Our business.

Are you ready to phase out chromium 6?

A guide to continue production without chromium 6



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Summary

From September 2017 EU tightens the requirements for use of the chemical compound chromium 6 in surface treatment processes. This means that many companies now must use other chemicals if they want to continue their production. But new chemicals produce new waste streams. Many companies will therefore need new wastewater treatment plants and new environmental permits. Aquarden has introduced a new solution, specifically designed to remove heavy metals in both large and small wastewater streams. The compact solution is smaller than other conventional systems, and can be integrated into existing production environments. This white paper guides you through the rules, regulations, options and alternatives – so you can continue your production – even after the EU has imposed more stringent requirements.

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1. Introduction

Bathroom mixers, exhaust pipes, nails, screws and brackets are all made of steel or metal – and often product surfaces have been treated with the heavy metal chromium in special chemical compounds. Treatments that can either provide a particularly beautiful chrome look, as in motorcycle parts, or give the products an effective corrosion protection as for example seen on quality screws for outdoor use. The coveted properties are particularly achieved by using chemicals with chromium 6, also known as hexavalent chromium.



But from September 2017 EU introduces restrictions on the use of chromium 6. The reason is that chemical compounds with chromium 6 are hazardous and environmentally harmful. This means that manufacturers using processes with chromium 6 – whether it is for decoration or corrosion protection - need to find out soonest possible how and whether they can continue production.



Continued production with the use of chromium 6 requires special authorization from the EU, which is far from achievable for all kinds of surface treatment processes with chromium 6. If your business is subject to the new regulation, it is important that you find out whether you can get an exemption from the rules – i.e. an approval for continued use – or whether you need to find alternatives to chromium 6. We would like to guide you through the rules, options and alternatives – so you can continue your production – even when the EU imposes more stringent requirements.



Fact: What is chromium 6?

Chromium is a heavy metal and a chemical element. It is the 24th element in the periodic system and has the chemical symbol Cr. South Africa, Zimbabwe, Kazakhstan, India, Brazil, Finland and Turkey account for about 90% of the production. Chromium normally occurs in a metallic form or as ions – a kind of chemical building blocks - in solutions or salts. Chromium ions may be present in three different forms, the so-called oxidation states, which determine how the chromium ions react with other substances. The two most common oxidation states for chromium ions are 3 and 6, but chromium ions can sometimes also occur in oxidation state 2. Chromium in oxidation state 6 is also referred to as hexavalent chromium because the atom can form 6 bonds to other atoms. Other denominations are chromium 6, chromium (VI), chrome 6 or Cr (VI). (Source 1 and 2).

2. Processes for surface treatment

Chromium 6 is used in a variety of industries - particularly in surface treatment because it is highly effective to prevent corrosion, to improve product durability and to provide a beautiful smooth surface. In addition, chromium 6 is also used for production of color pigment in paints and plastics and to a lesser extent for manufacturing of catalysts.

The most common processes for surface treatment are:

Chrome plating

Also called decorative chromium plating. Here a thin chromium layer is applied upon a layer of nickel. This is used for e.g. furniture frames, fittings, prams, tailpipes on exhaust pipes for cars, or for parts for motorcycles.

Hard Chrome Plating

Here a thick chromium layer is applied directly on steel to obtain an effective corrosion protection and protection against wear. This could be used for shafts and machine parts.

Chromating or passivation

Chromating - also referred to as passivation - is a chemical process that takes place between chromium 6 and the metal surface – typically zinc, aluminum, or phosphated steel. Another professional term is also 'chromate conversion coating'. The chromate layer makes the products more corrosion-resistant than the untreated metal surface. This could be used to increase the durability of electro-galvanized screws and fittings. At the same time chromating acts as a kind of binder on aluminum and steel to prevent lacquer and paint to crack and fall off.

"Chromium 6 is an effective and useful chemical ingredient, for instance for surface treatment of metals and manufacture of certain catalysts. But consumption in Denmark has been declining in recent years, and it is no wonder that the authorities have continuously introduced restrictions on the use of chromium 6," says Flemming Dahl. He is a chemical engineer and wastewater consultant at Aquarden Technologies. He is also the author of the report "Environmentally friendly surface treatment", which is published by the Danish Environmental Protection Agency (source 3), and further contributor to a large Danish analysis and mapping of chromium and chromium compounds in Denmark published by the Environmental Protection Agency (source 1).

3. Cancer and allergies

The ongoing restrictions exist because chromium 6 has strong oxidizing properties and is very harmful to humans and our environment. The substance is carcinogenic and can cause allergy (source 4 and 5). This is a problem not least for the people who work in industries where chrome-containing chemicals are used. But chromium 6 can also harm wildlife and flora if it is discharged into the aquatic environment with the wastewater. Therefore, the EU has long had a critical eye on the use of chromium 6.

Carcinogenic, mutagenic and reprotoxic substances

In EU's chemical legislation REACH (source 6) chromium 6 has been placed on the list of substances to be phased out or limited in industrial processes as chromium 6 compounds can cause

cancer, damage genes, or damage human fertility. Thus, they are categorized as CMR compounds (carcinogenic, mutagenic or toxic for reproduction). Several chromium 6 compounds even have all three harmful properties. In the annex to EU regulation no. 348 (source 7) it is specified which CMR properties apply for each chromium 6 substance. Substances with numbers 16-22 all contain chromium 6, and are the substances used in chemical solutions in chrome plating and passivating processes. Now further restrictions on the use of the chemical compound are being effectuated.

Chromium 6 in drinking water

"Most people probably know the movie Erin Brockovich, where Julia Roberts fights to get compensation for a group of residents in a village in USA. They have become sick from drinking water contaminated with chromium 6. The film is an example of how wrong things can go because it's based on a true story," says chemical engineer Martin Dau from Aquarden Technologies and continues:

"If chromium 6 ends up in drinking water or wastewater, the problem is that it is a heavy metal and heavy metals do not decompose in nature. Fish and animals absorb it - and it accumulates in the food chain and eventually ends in us humans – the final link in the chain – in too large and harmful quantities. The increase of heavy metals in our aquatic environment means that the environmental problems accumulate over time. Therefore, we must be careful not to discharge heavy metals into nature."

However, it is not that you have to be afraid of chromium in general. In fact, the human body needs trivalent chromium in very small quantities to for instance break down sugar.

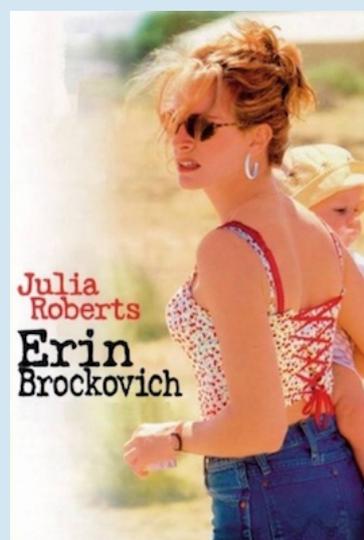
Fact: Erin Brockovich and chromium 6

In the Hollywood movie Erin Brockovich from 2000, starring Julia Roberts, she plays an unemployed single mother of three who looks for work at a small law firm. During her work, she one day finds a suspect real estate deal, which she investigates further, leading her to a much larger and more complicated case involving groundwater contamination. Here begins her persistent struggle for the sick people living around the large gas and electricity company PG&E.

The company has used chromium 6, hexavalent chromium, for years as a corrosion inhibitor in cooling water in cooling towers. The water with chromium 6 from the cooling towers is stored in open tanks and penetrates to the groundwater. Groundwater pollution spreads to nearby drinking water wells and residents of the village Hinkley starts to get sick. By ringing doorbells and gradually gaining the citizens' confidence Erin Brockovich gathers more than 600 plaintiffs and wins the lawsuit in 1996, which at the time was the largest private compensation in the US amounting to 333 million dollars.

To this day pollution still spreads in groundwater under California.

(Source 8 and 9)



4. Understand the new EU regulations

The new EU rules for use of chromium 6 take effect from 21st of September 2017 (source 7). The main rule is that it is forbidden to use chromium 6 in production, unless the company is given a special EU approval – an authorization - to use the substance for a specific process. Approval may be granted if it can be shown that chromium 6 can be used without risk – or if it is impossible or excessively expensive to find alternative substances.

The deadline for applications for authorization was in March 2016, so it has passed today. But EU's chemicals agency ECHA has evaluated a number of applications during 2016 – and has granted several permits, which is now undergoing final approval by the EU Commission.

"It's typical importers or suppliers of chromium 6-containing chemicals that have used the opportunity to apply for authorization from ECHA. End users – for example a galvanic business – can then be allowed to use chromium 6 if it is purchased from a supplier who has received an authorization. This only applies if the company complies with the labeling rules and user instructions from the supplier. Furthermore, the company must report it to the EU before it can start using chromium 6 from an approved supplier. But the last is a formality," says Flemming Dahl.

On the ECHA website (source 10), it is possible to see which exemptions have been granted and treated so far. An authorization from ECHA will typically be valid for 4-7 years.

"A company using chromium 6 in its production must soonest possible find a supplier who has received an authorization to use chromium 6. Otherwise, the company risks having to stop its production in September. The company may purchase the necessary chromium 6-containing chemicals at the supplier or importer, but only after the purchase is reported to the EU. The rules underlying the authorization shall be respected. This means that it is not possible to buy chromium 6-containing chemicals from a supplier with a derogation covering chrome plating - and then use them for passivation of aluminum," says Flemming Dahl and continues:

Fact: EU and chromium 6



REACH

Substances of very high concern (SVHC) will gradually be identified in the ECHA 'candidate list' and finally included in annex XIV of the REACH Regulation. When substances are listed in the annex, they cannot be marketed or used after a specified date (the so-called 'sunset date'), unless permission is given.

List of substances subject to authorizations

(Annex XIV under REACH)

<https://echa.europa.eu/addressing-chemicals-of-concern/authorisation/recommendation-for-inclusion-in-the-authorisation-list/authorisation-list>

The candidate list over SVHC

<https://echa.europa.eu/candidate-list-table>

EU regulation

Commission Regulation (EU) No. 348/2013

(includes substances with chromium 6)

<http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0348&qid=1487685993229&from=EN>

"The alternative is to use other suitable chemicals. It will not be possible for everyone – but for many processes there are alternatives almost as effective. However, the use of alternatives brings about new challenges."

5. Alternatives – with challenges

Companies that use chromium 6 for passivation of aluminum, steel or zinc, will hardly be able to get dispensation. Today there are already alternative chemicals available on the market for e.g. passivation before coating. But utilizing new chemicals typically calls for a new wastewater treatment process and a new process for recirculating the rinse waste after passivation. This means new waste streams, new treatment plants, new environmental permits.

"It is especially companies that passivates aluminum and steel, which have the biggest challenges. They need to use a new process and that may require an entirely new production plant. The new passivation chemicals typically contain titanium and zirconium along with hydrofluoric acid and/or fluorides. Some may also contain silanes," says Flemming Dahl and elaborates on the problem:

"So far, companies have saved a lot of water by recycling the rinse water over an ion exchange plant where salts are removed. That is not possible when the rinse water contains titanium and zirconium. Fluoride in the wastewater also requires a new cleaning process to precipitate the fluoride, and at the same time precipitate sulfate and phosphorus. This generates more sludge in wastewater, and the new processes require a renewed environmental permit."

6. Aquarden has a solution

Is your business among the many who cannot continue to use chromium 6 and now needs to use alternative chemicals in the production process, then you can benefit from Aquardens latest technology in this field. Waterbrane™ is a micro filter that is specially designed for separating heavy metals in both large and small wastewater streams.

"Waterbrane is the core product of a new solution developed by Aquarden. It can for instance be used in a process where the water is continuously treated with chemicals, followed by treatment in an ion exchanger. Afterwards, the very clean water can be recycled and used as rinse water in the chrome-free passivation processes, where the passivation chemicals contain titanium, zirconium, and fluoride. During the cleaning process the rinsing water is continuously neutralized and filtered in Waterbrane. This removes titanium, zirconium, aluminum, and most of the fluoride. Then, the water can easily be ion exchanged, which removes all the salts. The ion exchanged water has very low conductivity, and it can be reused for rinsing," Flemming Dahl explains

Fact: Aquarden

Aquarden Technologies is a Danish cleantech company. We are experts in sustainable treatment of problematic wastewater. Our vision is to solve some of the planet's greatest wastewater challenges for the benefit of both the aquatic environment, fauna and future generations. We provide consulting, turnkey systems, service and support – all customized to meet our customers' individual requirements. Aquarden received the EU Environmental Award 2016-2017 for the most sustainable product.



and continues: "The benefits of Waterbrane, among other things, is that the relatively small unit it can be integrated into existing production environments. Waterbrane is suitable for treatment of all types of wastewater containing heavy metals. With Waterbrane large investments in new treatment plant with sedimentation tanks and sand filter can be avoided. At the same time it is a fully automated system that does not require much daily monitoring of technicians. The production and economic benefits are obvious," says Flemming Dahl.

Fact: Benefits of Waterbrane

- Compact system - takes up only 10-20 percent of similar facilities
- Fully automated
- Can be integrated into existing production environments
- Lower maintenance costs



Waterbrane is installed in close cooperation with the customer after thorough analysis of the particular waste stream - and a possible test period. In this way, the technology can prove its worth. Ion exchange and circulation of rinsing water after filtration in Waterbrane is a new BAT process, expected to be included in the new BREF document for the surface treatment of metals and plastics, scheduled to commence in 2019.

New environmental permit

For most companies, the introduction of new chemicals in their production also results in the need for a revised environmental approval, and explaining new processes and treatment methods to the environmental authorities requires expert knowledge. Aquarden Technologies offers assistance with applying for a new environmental permit.

"At Aquarden we are experts in wastewater and treatment technologies. We have experience with describing wastewater treatment solutions to the authorities and know exactly what their main points of attention are. Therefore, we can help companies when they need new treatment plants approved by the authorities," says chemical engineer at Aquarden, Vibeke Dorf Nørgaard.

The first full-scale Waterbrane plant is expected to become operational during summer 2017.

Read more ...

about Aquarden
aquarden.com

and about Waterbrane™
aquarden.com/technology/waterbrane/

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Third edition, Catherine E. Housecroft and Alan G. Sharpe. Pearson Prentice Hall (2008)
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<http://mst.dk/service/publikationer/publikationsarkiv/2007/jan/miljoerigtig-overfladebehandling-af-metaller-og-plast/>
PDF: <http://www2.mst.dk/Udgiv/publikationer/2007/978-87-7052-358-5/pdf/978-87-7052-359-2.pdf>
- 4) **Environmental Protection Agency – list of substances**
The European Commission has selected 91 hazardous substances, presented in Annex II of the regulation. The EU has estimated that these 91 substances are characterized as very environmentally problematic.
<http://www3.mst.dk/miljoeplysninger/prtrpublicering/stoflisten> Look under 'Chrom og chromforbindelser (som Cr)'
- 5) **Allergies Knowledge Center (Videncenter for allergi)**
<http://www.videncenterforallergi.dk/?s=krom+6>
- 6) **REACH**
(Registration, Evaluation, Authorisation and Restriction of Chemical substances)
List of substances included in Annex XIV of REACH ("Authorisation List")
<https://echa.europa.eu/addressing-chemicals-of-concern/authorisation/recommendation-for-inclusion-in-the-authorisation-list/authorisation-list>
About chromium trioxide: <https://echa.europa.eu/substance-information/-/substanceinfo/100.014.189>
Candidate List of substances of very high concern for Authorisation: <https://echa.europa.eu/candidate-list-table>
- 7) **COMMISSION REGULATION (EU) No 348/2013 of 17 April 2013**
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