

## Problem Statement:

On industrial steam turbines Cr(VI) was found on threads and turbine heating systems.

Cr(VI) is a form of the metallic element chromium. Hexavalent chromium or chromium (VI) is one of the valence states (+6) of chromium. Cr(VI) has been classified as a human carcinogen.

According to the US National Institute of Occupational Safety and Health (NIOSH), ingested or inhaled Cr(VI) can damage the respiratory tract, kidneys and liver. In addition, contact with Cr(VI) can cause skin inflammation (skin irritation or allergic reaction) and severe eye irritation.

Many countries have limit values for air pollution with Cr(VI). In Germany, for example, a limit value of 1 µg/m<sup>3</sup> is considered to be risk-based assessment standard.

**Conclusion:  
Contact with Cr(VI) must be avoided.**

**It is assumed that calcium chromates in the presence of chromium(III) oxide and calcium oxide of subsequent formula is formed:**



This reaction is very slowly, but accelerates at temperatures around 500 °C (Fiona Low, 2015).

Calcium oxide and other calcium compounds are contained in various materials on the steam turbine, on which Cr(VI) was later also detected. Laboratory tests also confirmed this hypothesis, so that this was ultimately determined to be the cause.

In summary, calcium chromate (Cr(VI)) is formed when the following four conditions are simultaneously met:

1. a material containing chromium is
2. a calcium-containing material in I<contact,
3. at a temperature above 400 °C and
4. the presence of oxygen.

**Materials containing chromium on steam turbines:**

- Housing
- Screws
- Bolt
- Nuts
- Heating wires
- Stainless steel foils
- Stainless steel mesh

**Calcium-containing materials on steam turbines:**

- Assembly pastes
- Insulations
- Heat-conducting cement

**However, these conditions are by no means exclusive to turbines. The use of calcium-containing insulations and assembly pastes on chromium steels is widespread in the industry and reflects the state of the art.**

**Reflecting specifically on steam turbines, the following protective measures have been defined for handling Cr(VI):**

- In the case of work where I<contact with Cr(VI) is to be expected, a quick test must be used to check whether the risk of I<contact is actually present.
- When performing the rapid test and Cr(VI) is present, the following protective clothing must be worn: FFP3 respirator half mask according to EN 149:2001+A1:2009, Nitrile rubber gloves according to EC directive 89/686/EEC and EN ISO 374, protective goggles which are tightly sealed against dust as Eye protection according to DIN EN 166 and overgarments protecting against dust according to DIN EN ISO 13982.
- Dust must be collected by means of an industrial vacuum cleaner with filter according to EN ISO 14644.
- Contaminated materials must be disposed of in accordance with local legislation.