### Zinc chromate

| Property                          | Value         |
|----------------------------------|---------------|
| MAK value                        | –             |
| Peak limitation                  | –             |
| Absorption through the skin      | –             |
| Sensitization (1997)             | Sh            |
| Carcinogenicity (1978)           | Category 1    |
| Prenatal toxicity                | –             |
| Germ cell mutagenicity           | –             |
| BAT value                        | –             |

Zinc chromate or zinc yellow (further synonyms in Table 1) is used widely, for example, in the metal and printing industries. The Danish product register (PROBAS) lists, among 47400 entries, 110 products containing zinc chromate, e.g. paints, floor coverings, colourants and corrosion inhibitors (Flyvholm 1991).

The sparingly soluble zinc chromate (ZnCrO$_4$, CAS No. 13530-65-9) and the readily soluble, dermally corrosive zinc dichromate (ZnCr$_2$O$_7$, CAS No. 14018-95-2) are now mainly used only as laboratory chemicals. In addition, the formation of zinc chromate is to be expected in the passivation of zinc-plated metal components using alkali chromates or alkali dichromates (Fregert et al. 1970).

The term zinc chromate is used for several substances and mixtures (Table 1) which, however, are rarely defined exactly in publications. In addition to the considerable differences in the composition of the group of products described as zinc chromate, especially the differing solubility in water of the various products and thus the differences in the amounts of chromate ions (CrO$_4^{2-}$) and dichromate ions (Cr$_2$O$_7^{2-}$) released must be taken into consideration (Adams et al. 1976). This apparently also plays a role in the use of the products; simple paints contain mainly products which are less dissociated into ions (types II and III in Table 1), the corrosion inhibiting primer paints (chromate primer) (Burrows 1984) are made, however, of potassium dichromate-containing zinc yellow types which are much more dissociated into ions (IV and V in Table 1).
Table 1. Products described in the literature as zinc chromate or zinc yellow

| Type | CAS No.       | Molecular formula | Chemical name                     | Solubility in water (20°)       |
|------|---------------|-------------------|-----------------------------------|---------------------------------|
| I    | 13530-65-9    | ZnCrO₄        | chromic acid, zinc salt          | insoluble₆ sparingly soluble₆    |
|      |               |                  |                                   |                                 |
| II   | 49663-84-5    | ZnCrO₄·4Zn(OH)₂ | zinc chromate hydroxide           | readily soluble₆                 |
|      | 15930-94-6    | Cr₂O₇·H₂O₂·Zn₂·H₂O | chromic acid, zinc hydroxide hydrate (1:2:2:1) | c 0.04 g/l₆                     |
|      | 50922-29-7    | Cr₂O₇·H₂O₂Zn₆   | chromic acid, zinc salt, basic    |                                 |
|      |               |                  | basic zinc chromate              |                                 |
| III  | 37300-23-5    | CrO₄·Zn·H₄O₂·Zn₂·CrO₃ | chromic acid, zinc salt, compound with zinc hydroxide and chromium oxide (9:1) | 2.5–5 g/l₆                     |
|      |               |                  | zinc yellow 1007                 |                                 |
|      |               |                  | C.I. pigment yellow 36           |                                 |
| IV   | 11103-86-9    | Cr₂O₇Zn₂·K₆     | hydroxyoctaoxidizincaledichromate(1-) potassium | sparingly soluble₆             |
|      |               |                  | buttcup yellow                    |                                 |
|      |               |                  | chromic acid, potassium zinc salt (2:2:1) |                                 |
|      |               |                  | citron yellow                     |                                 |
|      |               |                  | potassium zinc chromate           |                                 |
|      |               |                  | zinc chromate                     |                                 |
|      |               |                  | zinc yellow                       |                                 |
| V    | 37224-57-0    | unknown         | chromium potassium zinc oxide     |                                 |
|      |               |                  | potassium zinc chromate           |                                 |
|      |               |                  | zinc potassium chromate           |                                 |

₆ Howard PH, Neal M (Eds) (1992) *Dictionary of chemical names and synonyms*, Lewis Publishers, Chelsea, Michigan  
₇ National Library of Medicine (1997) *Chemline databank*, Chemical Abstract Service, quoted from 05.04.1997  
₈ Elvers B, Hawkins S, Schulz G (Eds) (1992) *Chromate pigments. Ullmann’s encyclopedia of industrial chemistry*, Vol A 20, VCH-Verlagsgesellschaft, Weinheim, 341–342  
₉ Falbe J, Regitz M (Eds) (1992) *Römpp Chemie-Lexikon*, 9. Auflage, Georg Thieme-Verlag, Stuttgart New York, 5141  
₁₀ Soc Dyers & Colourists (1971) *Colour-Index*, 3rd ed, Bradford (GB), 3276
1 Allergenic Effects

Apart from the fact that many different products are covered by the term zinc chromate or zinc yellow, the exact evaluation of the sensitizing effects of these products is not possible for another reason as well. Even in those cases in which contact dermatitis occurred after handling exclusively zinc chromate, the levels of potassium chromate or potassium dichromate in the zinc chromate types used were almost never given, and, above all, the tests were mainly not carried out with the chromate with which the persons had been in contact or with metal components treated with it, but as standard tests with 0.5 % potassium dichromate in petrolatum.

With these limitations in mind, the observations listed below suggest that zinc chromate has sensitizing effects.

Eight patients with oil dermatitis, who as shipyard workers came into contact with heavy oils and sometimes also with rust inhibitors containing chromates, reacted in the patch test to 0.1 % potassium dichromate (Anderson 1960).

Sixty-five of 250 workers of an automobile factory who rubbed down the primer on car chassis by hand using the wet procedure developed contact dermatitis. The dry paint contained 6.3 % zinc chromate. Of 58 persons tested, 53 reacted to 0.5 % potassium dichromate (Engel and Calnan 1963).

A female worker who was employed in the production of upholstered furniture and had contact with 20 % zinc chromate powder, produced a reaction in the “standard chromium test”; after the work process had been changed to one using titanium dioxide she became free of symptoms (Fregert and Gruvberger 1976).

Among 45000 employees of two aircraft construction firms, 755 had dermatitis. 202 of these persons whose skin condition was shown to be work-related were further investigated. In 132 workers (65.3 %) the zinc chromate primer was the cause of the dermatitis, and these persons, with 4 exceptions, all reacted to pieces of metal treated with the substance. The reactions occurred at the earliest in the first month after taking up the work and on average in the seventh month (Hall 1944).

In 9 of 150 workers who assembled engine parts painted with chromate primer with their bare hands, contact dermatitis with evidence of allergy to dichromate was observed (Hjerpe 1986). As the author explicitly refers to corresponding observations of other authors (Fregert et al. 1970) who assume zinc chromate to be the cause of dermatitis, also in these cases sensitization from such surface treatment is probable.

Toxic dermatitis was observed in 24 of 41 persons who assembled computer components painted with chromate primer. Although attention was drawn to the presence of zinc yellow (Zn₂CrO₄(OH)₂H₂O) and other soluble and insoluble zinc chromate compounds, the clinical findings and the negative results in the dichromate test (in only one of the persons) indicated there was no sensitization (Bruynzeel et al. 1988). As known for cement dermatitis, chromate allergy occurs mainly in persons working with damp materials in the building trade, but not as a result of exposure to the dust from cement factories (Engelbrigtsen 1952). The same should apply for the very clean and dry atmosphere during the assembly of computer components painted with chromate primer.
| Activity/workplace         | Agent                                      | Number of cases | Author                        |
|---------------------------|--------------------------------------------|-----------------|-------------------------------|
| shoe maker                | primer paint on a prosthesis               | 1 patient       | Bang Pedersen and Fregert 1970|
| pharmaceutical industry   | printing inks for plastic sacks           | 1 patient       | Brun 1965                     |
| repair of machines        | metal paint containing lead chromate       | 1 patient       | Bruze et al. 1996             |
| aircraft factory          | hardener                                   | 2/92 patients   | Ellis 1946                    |
| electronics factory       | not specified                              | 2/19 persons    | Chee-Ching et al. 1995        |
| printing works            | primer                                     | 1/19 persons    | Halbert et al. 1992           |
| aircraft factory          | primer                                     | 20 patients     | Hjorth 1967                   |
| labelling of cans         | rust inhibitor                              | 2 patients      | Malten 1975, Spruit and Malten 1975 |
| offset printing           | not specified                              | 3 patients      | Pirilä and Kilpiö 1949       |
| automobile industry       | primed automobile parts                    | 1 patient       | Mathur et al. 1991            |
| painter, polisher         | primers                                    | 7 patients      | Moura et al. 1994             |
| automobile factory        | chromate passivated zinc-plated parts      | 47/56 persons   | Newhouse 1963                 |
| pigment factory           | not specified                              | 12/26 patients  | Omer and Al-Tawil 1994        |
| paint production          | chromium pigments                          | 7/43 persons    | Pirilä 1947                   |
| radio factory             | not specified                              | 7 patients      | Pirilä and Kilpiö 1949       |
| metal processing          | metal parts                                | 4 patients      | Rycroft and Calnan 1977       |
| painter, polisher         | probably mainly $K_2Cr_2O_7$ as noxious   | 40/120 patients | Wilkinson and Beck 1993       |
| printing industry         | catalysts with lead and chromium components ($PbCrO_4$) | 3/6 patients | Wilkinson and Beck 1993       |
| metal processing          | metal parts                                | 1 patient       | Wilkinson and Beck 1993       |
A series of other publications (Table 2) supports the theory that the release of chromate or dichromate ions from zinc yellow (Schwartz et al. 1957, Spier and Natzel 1952, Zelger 1964) and from surfaces treated with the substance is sufficient to cause sensitization or at least to provoke chromate dermatitis in persons already sensitized. As a result of the frequency of such occurrences it has even been suggested that these corrosion inhibitors be completely replaced by zinc molybdate or calcium molybdate (Fregert 1967). Eczematous reactions were apparently observed not only during the application of the products, but in many cases also during the processing of metal components treated with the substance.

There are no data available from animal experiments.

2 Manifesto (sensitization)

The data from the literature do not allow any conclusive answer to be given to the question of whether one of the products described as zinc chromate or zinc yellow has sensitizing effects on the skin. However, with some of these products the occurrence of chromate or dichromate ions must be expected in a much higher concentration than in cement. In view of the inadequate characterization of the various types of zinc chromate, all products included under this name are designated with “Sh”. To date there is no evidence of sensitization of the airways.

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completed 05.05.1997