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GDCh-Advisory Committee
on Existing Chemicals of
Environmental Relevance (BUA)

Acrylic acid
(2-Propenoic acid)
BUA Report 160
(December 1994)



S. Hirzel

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GDCh Office:

Dr. H. Behret, GDCh, Frankfurt am Main

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Dr. H. Behret
Gesellschaft Deutscher Chemiker
Postfach 90 04 40
D-60444 Frankfurt am Main

Translated by R. Brown

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Foreword

The German Chemicals Act (Chemikaliengesetz - ChemG) of 1980 stipulates that certain existing chemicals must be reported to the competent authority, if they exhibit properties which indicate that they may be hazardous, either alone or in combination with other substances.

In the summer of 1982, an Advisory Committee on Existing Chemicals of Environmental Relevance (BUA) was set up by the German Chemical Society (Gesellschaft Deutscher Chemiker - GDCh). It brings together representatives from the scientific community, the chemical industry and the governmental authorities. This Advisory Committee is responsible for elaborating appropriate solutions for substances of relevance for health and the environment on the basis of voluntary measures. It selects and examines existing chemicals from the aforementioned angles. The testing and evaluation are based on scientific criteria alone.

It was, therefore, necessary to develop priority setting procedures. In a first phase reports were only prepared for priority chemicals. Within the framework of a first priority setting procedure, chemicals were compiled from several priority lists and 135 chemicals were selected for detailed substance reports.

In a second priority setting procedure the survey of the German Chemical Industry Association (VCI) on all substances with a production volume of more than 10 tons per year was used as a starting list. Since this survey covered 4,600 chemicals, BUA decided to process the corresponding list in several stages. The first stage included approx. 1,050 substances with a production volume of more than 1,000 tons per year.

Detailed reports are drawn up on chemicals suspected of having a hazard potential and abridged reports on those presenting only a minor hazard potential, according to the current state of knowledge.

The detailed BUA reports take in both the published literature and data from industry. If data for the evaluation of the chemicals are not available, additional studies are recommended and the results are published as updates to the reports. The reports serve as a basis for the instigation of administrative measures, when there are indications of risks to health or the environment.

Tübingen, May 1993

Ernst Bayer
Chairman of the Advisory Committee
on Existing Chemicals
of Environmental Relevance

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BUA Report on Acrylic acid (2-Propenoic acid)

Summary and conclusions

Acrylic acid is an industrial intermediate that is used to manufacture acrylates (ca. 2/3) and polymers (ca. 1/3). Homopolymers and copolymers of acrylic acid are primarily used as detergents, superabsorbers, flocculants and dispersants.

German production capacity in 1994 was ca. 405 000 t. World capacity was in excess of 2 million t and will increase in the next few years by ca. 500 000 t y⁻¹.

Discharge of acrylic acid into the atmosphere from manufacture and further processing at BASF AG, Hüls AG, Degussa AG and Hoechst AG amounted to ca. 9.3 t y⁻¹. Discharge of acrylic acid into the hydrosphere from the effluent of industrial wastewater-treatment plants (BASF AG, Hüls AG) cannot be quantified. On account of the ready biodegradability, a high degree of elimination in wastewater-treatment plants may be expected. Degussa AG and Hoechst AG do not discharge acrylic acid into the wastewater.

Acrylic acid has been found as a natural metabolic product in numerous marine algae and it is also present in organisms for which algae form part of the food chain. Acrylic acid is also known to be a metabolic intermediate in different anaerobic micro-organisms.

Acrylic acid is readily biodegradable in water in aerobic conditions. Biodegradation has been reported in anaerobic conditions in water, both with and without acclimation. The substance is only slightly or not at all volatile from water. Hence transfer into the air is expected to be slight. The estimated half-life in the atmosphere is 6.6 hours. Adsorption of acrylic acid onto soils and sediment is not likely in view of the K_{OC} values.

The toxicity of acrylic acid to bacteria lies between TTC 0.15 mg l⁻¹ (*Microcystis eruginosa*, 8 days) and TTC 41 mg l⁻¹ (*Pseudomonas putida*, 16 hours). Its acute toxicity to protozoa lies between TTC 0.9 mg l⁻¹ (*Chilomonas paramecium*, 48 hours) and TTC 20 mg l⁻¹ (*Entosiphon sulcatum*, 72 hours). As for toxicity to algae, a 96-h EC₅₀ of 0.17 mg l⁻¹ has been reported for *Selenastrum capricornutum* and a 72-h EC₅₀ of 0.04 mg l⁻¹ for *Scenedesmus subspicatus*; a TTC of 18 mg l⁻¹ (*Scenedesmus quadricauda*, 8 days) has also been reported.

The 24-h EC₀ (EC₅₀) values for *Daphnia magna* to unneutralized acrylic acid lie between 51 mg l⁻¹ (54 mg l⁻¹) and 175 mg l⁻¹ (270 mg l⁻¹), to neutralized acrylic acid, 156 mg l⁻¹ (765 mg l⁻¹). The 48-h NOEC is 23 mg l⁻¹; the 48-h EC₅₀ is 95 mg l⁻¹. Values for acute toxicity to fish lie between 27 mg l⁻¹ (LC₅₀ *Oncorhynchus mykiss*, 96 hours) and 420 mg l⁻¹ (LC₁₀₀ *Leuciscus idus*, 48 h).

Measured values of 0.38 and 0.46 for log P_{OW} and the calculated bioconcentration factor of 2.14 rule out appreciable bioaccumulation. A mean K_{OC} value of 43 (calculated from measured values) also suggests a low potential for geoaccumulation.

Acrylic acid is rapidly and completely metabolized (mainly by fatty acid β-oxidation). It has slight acute toxicity. The primary acute effects are local irritation or corrosion (skin, eyes, respiratory tract). Acrylic acid does not cause skin sensitization. Repeated application results mostly in local irritation (NOAEL rat, 12 months, drinking water: 40 - 66 mg kg⁻¹ d⁻¹; NOAEC rat, 3 months, inhalation: 74 mg m⁻³, LOAEC mouse, 3 months, inhalation: 15 mg m⁻³; NOAEC and LOAEC mouse 2 weeks - 21 months: 1 % dermal). Acrylic acid did not cause gene mutations *in vitro* in bacterial test systems. *In vitro* tests on mammalian cells produced non-uniform results: in the mouse lymphoma assay and in chromosome mutation tests on mammalian cells, cytotoxic concentrations of acrylic acid induced significantly higher rates of

gene and chromosome mutations. In the HPRT test on mammalian cells, however, no gene mutations were induced.

Further *in vitro* tests (micro-nuclei, UDS, cell transformation) also produced negative results. *In vivo* mutation tests in soma cells and germ cells of mammals proved negative and so were germ cell tests on *Drosophila*. The positive findings in clastogenicity tests in cytotoxic conditions are not suitable for evaluating a correlation between geno-toxicity and possible carcinogenic effect (Wangenheim, 1988; Scott et al., 1991). In well documented Guideline studies involving doses in drinking water extending up to the limits of palatability (MTD), no systemic carcinogenic effect exerted by acrylic acid was detected. Influences on fertility were not detectable (NOAEL 460 mg kg⁻¹ d⁻¹). Acrylic acid is non-teratogenic in the context of assessable studies. No embryotoxic/foetotoxic effects occurred in maternal-toxic doses.

Apart from the irritation, the toxicity data show that acrylic acid does not constitute a risk potential to humans.

When compiling its priority lists, the Advisory Committee on Existing Chemicals of Environmental Relevance (BUA) had classified acrylic acid as a compound for which no potential risk to humans or the environment has currently been identified. However, this report, which has brought additional data to light, has shown that there probably is a potential risk to the environment when the criteria of the BUA are applied. In contrast, the available toxicity data demonstrate no hazard potential to humans, apart from irritation.

The EU ordinance on existing chemicals assigned acrylic acid to the first priority list. A risk evaluation is currently in preparation.