Scand J Work Environ Health 1978;4(2):176-178

<https://doi.org/10.5271/sjweh.2711>

Issue date: Jun 1978

**Hazards in the work environment--cyanide.
Spectrophotometric determination of volatile cyanide.**

by [Waernbaum G](#), [Wallin I](#)

Key terms: [air determination](#); [chemical analysis](#); [cyanide](#); [factory](#); [hazards](#); [spectrophotometric determination](#); [volatile cyanide](#); [work environment](#)

This article in PubMed: www.ncbi.nlm.nih.gov/pubmed/684391

This work is licensed under a [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/).

Hazards in the work environment — Cyanide

Spectrophotometric determination of volatile cyanide

by GÖSTA WAERNBAUM, M.D., and INGA WALLIN¹

WAERNBAUM, G. and WALLIN, I. Hazards in the work environment — Cyanide: Spectrophotometric determination of volatile cyanide. *Scand. j. work environ. & health* 4 (1978) 176—178.

Key words: air determination, chemical analyses, factories, volatile cyanide.

In the present study, cyanide in different forms, i.e., volatile cyanide, cyanide dust, and oxidized thiocyanate, was analyzed by a technique which is a modification of the one described by Amus and Garschagen (1). The air samples were collected from electroplating factories, a fumigation station, and a welding industry. The amounts of cyanide from these workplaces were compared with those in the air of places where no particular exposure to cyanide should occur, such as our laboratory and heavily trafficked urban areas.

Based on a rough estimation of the content of cyanide in the air, 50—100 l, was considered a proper volume to collect. The samples were taken during the work-day as the workers carried out their typical tasks. The samples were meant to give information on the total amount of cyanide which these workers inhaled per day.

Furthermore, no more than one impinger flask was needed because of the complete absorption in one flask, which was checked by experiments. Two impinger flasks were connected and no cyanide could be detected in the second one.

So far, we have not been able to study concentrations of cyanide in biological media, i.e., blood and urine, from workers. One problem is that most of the cyanide originally present in the specimens disappears rapidly. Formation of bound cyanide occurs. Moreover, smoking seems to affect the concentration of cyanide, although it is not known exactly to what extent (2). Because of these problems, it is obvious that for the time being one must use air concentrations of cyanide to assess the inhaled amounts.

METHODS AND MATERIAL

Apparatus

An MSA portable pump, model "G", from the Mine Safety Appliances Company and a Hilger Spectrophotometer Impinger Flask with a glass filter of type G 1 were used.

¹ National Board of Occupational Safety and Health, Department of Occupational Health, Division of Chemistry, Stockholm, Sweden.

Reprint requests to: Mr. G. Waernbaum, National Board of Occupational Safety and Health, Department of Occupational Health, Division of Chemistry, Pock, S-100 26 Stockholm, Sweden.

Reagents

The following reagents were used: (a) sodium hydroxide 0.5 N as the absorption solution (analytical grade), (b) sulfuric acid (1:1) for acidifying the sample (analytical grade), and (c) chloramine solution, 1 % (w/v). The last-mentioned solution had to be made anew every day.

The color reagent was prepared by suspending 1.5 g of barbituric acid of analytical grade in a 25-ml volumetric flask with 3 ml of distilled water. Pyridine (7.5 ml) was then added from a pipette. Water was added until the barbituric acid was dissolved, 1.5 ml of concentrated hydrochloric acid was added from a pipette, and the solution was allowed to cool. After being mixed, it should amount to 25 ml with water. The solution is stable for only one day. The assay is based on the formation of cyanogen chloride (CNCL) which is formed due to the action of chloramine (p-toluene sulfonic acid chloramide) and to the reaction with pyridine and barbituric acid. The result is a stable blue-violet polymethine dye. Compounds such as H_3BO_3 , HNO_3 , acetic acid, or phenols (1) will not interfere, at least as long as the concentrations are below about 1 g/l.

Potassium cyanide (KCN), analytical grade.

Air sampling

The impinger flask was filled with 15 ml of sodium hydroxide. The air pump was calibrated against a flowmeter before and after the sampling procedure. An air flow of about 0.5 to 1 l per minute, based on the surmized amount of cyanide, was selected, but lower air flows were possible to maintain. This air flow had proved to be the most convenient for the sake of preventing foaming tendencies in the impinger flask. Again with the estimated cyanide content in the air taken into consideration, air volumes between 50 and 100 l were chosen for collection. Smoking was not allowed in the vicinity of the air sampling vessel.

Procedure for the assay of total cyanide

The alkaline absorption solution was quantitatively transferred to a 20-ml volumetric flask. The impinger flask was washed thoroughly with distilled water, and the desired volume was obtained by the addition of water. Ten milliliters of this solution was transferred to a 50-ml flask with a glass-stopper and acidified with diluted sulfuric acid, just a few drops, until a pH value of 3—4 was obtained. After a fast adding of 0.4 ml of chloramine solution, the contents were mixed carefully. One minute later (exact), 1.2 ml of the color reagent solution was added, the solution was mixed and was left standing for 8 min. After this period of time, 9 min altogether, the absorbance was read at 580 m μ against a blank which had been prepared in the same way as the sample. The alkaline absorption volume was replaced by 10 ml of distilled water. In order to maintain the proper order in regard to the time schedule, one sample ought to be analyzed at a time.

Calibration curve

The calibration curve was made up through dissolving 250 mg of fresh KCN in distilled water in a volumetric flask of 1 l. One milliliter was transferred to a 100-ml volumetric flask, and the volume was brought up to 100 ml with distilled water. The concentration of CN^- per ml was 1 μ g. From this stock solution, samples of 1, 5, 10, and 20 ml were taken and transferred to 100-ml volumetric flasks. Again, water was added to achieve the proper volume. Samples of 10 ml were taken, and the assay procedure was carried out as previously described. According to the calibration curve, the limit of detection was determined to be 1 μ g cyanide/m³.

RESULTS AND DISCUSSION

Table 1 lists the cyanide concentrations in the air from the three factories where cyanide was used in various work pro-

Table 1. Concentrations of cyanide in the air of electroplating factories, a fumigation station, a welding industry, city air and a chemical laboratory.

Source of air sample	Collected air volume (l) measured at 25°C	Cyanide concentration ^a (mg/m ³)
Electroplating industry "F"	77.70	0.438
	56.08	0.197
	48.70	0.606
Electroplating industry "P"	106.09	0.193
	52.87	0.180
	48.48	0.253
Electroplating industry "C"	65.00	0.256
	65.00	0.637
	65.00	0.137
	65.00	0.159
Fumigation station		
Inside	108.50	0.069
Outside	89.70	0.119
Air polluted by exhaust gases from motor vehicles	14.10	0.037
	18.38	0.023
Welding industry "S-V"	15.38	1.6 · 10 ⁻³
	14.34	—
Laboratory	23.40	—

^a Given as an average value of two chemical analyses.

cesses. The temperature inside the factories was 20°C (the measurements were made during the autumn) and the air circulation was similar in all three places;

in addition the air was rather humid. Collection was carried out during various parts of the workday. The differences in cyanide levels seen in the table can be attributed to different work maneuvers. For example, the highest concentrations were measured when the workers had to lift a number of objects out of the cyanide baths. In general, however, there was a fairly good agreement from one factory to another, perhaps depending on the similarity in work procedure, as putting the objects into the cyanide baths, lifting the objects out of the baths and the drying process.

No cyanide could be detected in the air of our laboratory, whereas 30 µg/m³ was found in air polluted by motor vehicles. The concentration of cyanide in the air of our laboratory was estimated to be less than 1.0 · 10⁻³ mg per m³. Rather high concentrations of cyanide were found outside, as well as inside, the fumigation station (Stockholm), although the Swedish threshold limit value for cyanide (5 mg/m³) is much higher.

REFERENCES

1. ASMUS, E. and GARSCHAGEN, H. Z. Über die Verwendung der Barbitursäure für die photometrische Bestimmung von Cyanid und Rhodanid. *Anal. Chem.* 138 (1953) 414.
2. MAEHLY, A. C. and SWENSSON, Å. Cyanide and thiocyanide levels in blood and urine of workers with low-grade exposure to cyanide. *Int. Arch. Arbeitsmed.* 27 (1970) 195—209.

Received for publication: 12 December 1977