

CYANIDE WASTE DECOMPOSITION IN WATER AND AIR

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The photoelectrocatalytic degradation of wastewater, using TiO_2 and WO_3 is a well investigated topic in our workgroup. The treatment experiments with this method for the oxidation of cyanides in alkaline solutions showed that the optimisation of the experimental conditions can result in a new method for the degradation of cyanides. The extraction of gold from low-grade ores is one of the main application areas of sodium cyanide. In this work the utilisation of cyanides in the cyanidation process of gold ores is followed to find out the pros and cons of the existing treatment methods and to point out the usability of photoelectrocatalytic treatment for the oxidation of cyanides.

The analysis of cyanide was done with standard methods (AgNO_3 /dimethylaminobenzalrhodanine). Cyanide volatilisation in different buffered sodium cyanide solutions (pH 10 – 14) was followed by purging with air and collecting the HCN gas by passing it through a NaOH solution (pH14) in an absorption flask. The light source for the irradiation experiments was a fluorescent UVA lamp array (3 x 9 W).

About 2700 t of gold were recovered worldwide in 2011. The global production of NaCN for use in beneficiation of gold ores is cited in different sources between 120000 t and 450000 t [1-3]. For the recovery of one kilo of gold, 0.5 kg of NaCN is needed - based on the molecular ratio. This means that most of the cyanide, utilised for gold mining, is either volatilised or can not be recovered after the cyanidation of the ore and has to be treated after the extraction process.

The estimation that cyanide, when exposed to air and sunlight, is converted to cyanate and subsequently to carbonate can be found in various publications (see e.g. [4]). However the evidence should be proved in analysing the cyanide content in the atmosphere as a result of volatilisation. Cyanide leaching is typically done in solutions with pH ranging between 10 and 11. At the pH value of 9.3 (equal to the pKa) the concentration of HCN and CN^- ion are equal (Fig. 1).

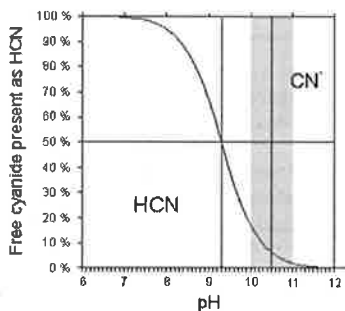


Fig. 1: Relative Percentage of HCN and CN^- as a function of pH (25 °C) (in solution in equilibrium with the vapour phase)

With an increase in pH to 10.5, approximately 7 % would be in the form of HCN. Molecular HCN has a relatively high vapour pressure, and therefore is readily volatilised. In Fig. 2 the volatilisation of different sodium cyanide solutions (CN^- concentration: 400 mg/l) is illustrated. Experiments with UV as well as tests with and without magnetic stirring showed a high degree of volatilisation. At pH 10.5 approximately 30 % of cyanide had disappeared from the solution after 48 h (the different amounts can be explained by the different gas flow due to the experimental set-up). The amount of cyanide in the absorption flask correlates to the loss in the reaction flask, including the experiments with permanent UV-irradiation.

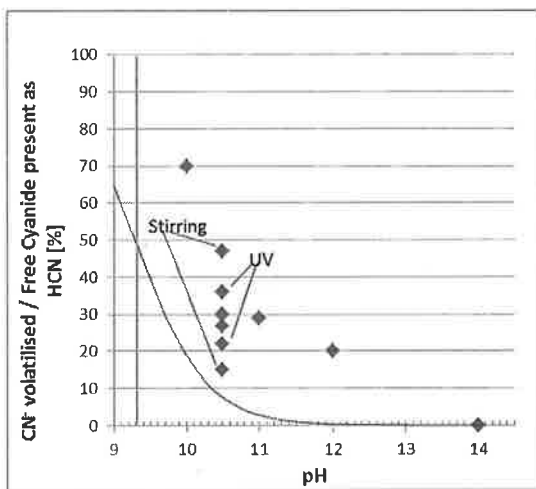


Fig. 2: Cyanide volatilisation in different buffered solutions after 48h aeration. Red line: Relative percentage of HCN and CN^- as a function of pH (in solution in equilibrium with the vapour phase)

With the results of these experiments it can be outlined that a major part of applied sodium cyanide will be distributed into the atmosphere in the gold cyanidation. Following experiments should follow the distribution in air and time of possible destruction of HCN in the atmosphere. There could be some potential in the reduction of sodium cyanide consumption for the gold production (heap leaching, cyanide recovery).

Nevertheless an additional treatment of cyanide wastes after recovery is required. In common treatment methods the mining industry has to deal with the problems of high cost, lowering the pH before treatment (volatilisation) or toxic byproducts [5]. The photoelectrocatalytic pathway could be an advantageous alternative.

References

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