NICNAS Existing Chemicals Information Sheet

Sodium Cyanide 11 September 2009

Introduction

The National Industrial Chemicals Notification and Assessment Scheme (NICNAS) has assessed the environmental risks of sodium cyanide and made recommendations for minimising the environmental risks from its transport and use in mining. The report is available for public comment from 11 September to 9 October 2009. This information sheet is designed to assist in this process.

The assessment findings indicate that for a number of steps in the supply chain, implementation and monitoring of compliance with existing Commonwealth and state/territory legislation and voluntary measures results in low risks to the environment. The voluntary measures detailed in the International Cyanide Management Code for the Manufacture, Transport and Use of Cyanide in the production of gold and for manufacturers are aimed at minimising risks during use and manufacture of sodium cyanide.

The NICNAS assessment found that transfer of wastes containing sodium cyanide to tailings storage facilities occurs during use in mining and that this results in a risk to the environment when wildlife consume water at these facilities.

A proposed wildlife protection risk management framework takes into account the varying geological conditions at mines in Australia and recognises that a single concentration for mitigating the risk to wildlife may not be applicable at all mines. The framework proposes a flexible approach to protect wildlife by using controls on concentration and/or prevention of wildlife access to tailings storage facilities.

The assessment also recommends measures to avoid serious impacts on downstream aquatic areas or wildlife when sodium cyanide is transported by rail and road between the manufacturing sites and mines.

What is sodium cyanide?

Sodium cyanide (NaCN – CAS No 143-33-9) is a highly soluble, white deliquescent[1] crystalline powder. In Australia, sodium cyanide is mainly used in the mining industry to recover gold from ore.

For gold mining use in Australia, it is manufactured as solid briquettes, or provided in a liquid form containing approximately 30% NaCN.

Why was sodium cyanide assessed by NICNAS?

Sodium cyanide was declared a Priority Existing Chemical (PEC) by NICNAS in May 2002 in response to environmental concerns. These concerns included reports of mass bird poisonings as a result of consumption of cyanide-contaminated water at tailings dams, the potential release of toxic and flammable hydrogen cyanide gas when sodium cyanide comes in contact with water, the high acute toxicity to aquatic life, birds and animals, and high chronic toxicity to aquatic life.

[1] Deliquescent materials are substances (mostly salts) that have a strong affinity for moisture and will absorb relatively large amounts of water from the atmosphere if exposed to it, forming a liquid solution.

The assessment did not address the human health effects of sodium cyanide.

The report aims to:

- identify the potential for environmental exposure in Australia
- identify the environmental hazards of sodium cyanide making use of any international assessments
- determine the risk of adverse effects to the environment in Australia, during manufacture, transport and use
- assess current controls for sodium cyanide and identify whether these are adequate, and
- make recommendations on control measures for the management of environmental risks, where appropriate.

The assessment drew on international assessments, information provided by applicants, and both published and unpublished data obtained from various sources. Current controls by industry were also assessed to identify whether they are adequate to protect the environment.

Where is sodium cyanide used in Australia?

Australia is a major global manufacturer and exporter of sodium cyanide, with manufacturing facilities in Western Australia and Queensland. About 100 000 tonnes of sodium cyanide are manufactured each year, of which about 40-60% is exported. There are several companies that also import sodium cyanide and/or reformulate small quantities.

Approximately 40 000-60 000 tonnes each year is used in Australia, with the amounts used in each state and territory related to the relative sizes of the gold mining industries.

Bulk quantities of sodium cyanide in solid or liquid form (~30% solution) are transported by road and rail from the manufacturing sites to gold mines. Lesser amounts of sodium cyanide are used for ore flotation of base metals (eg. copper, lead, zinc) and in the electroplating and metal (case) hardening industries. A small quantity of sodium cyanide is used for analytical laboratory testing purposes.

Gold cyanide complexes are soluble in water, and consequently cyanide enables low levels of gold to be extracted from ore and the gold is then recovered by further processes. The treatment of the ore with cyanide (known as gold ore beneficiation) may occur in two basic ways after the ore is extracted from the ground, referred to as tank leaching and heap leaching.

With tank leaching (the main method used in Australia), the ore is milled and mixed with the cyanide solution in large tanks, and the used cyanide solution and exhausted ore are disposed of to tailings storage facilities.

With heap leaching, the cyanide solution is applied to the tops of large heaps of crushed ore, the solution containing dissolved gold is collected at the bottom, and the solution recirculated after the gold is removed, or treated to destroy the cyanide residues before disposal.

How does sodium cyanide affect the environment?

Exposure of wild animals and birds and aquatic organisms to human activity using sodium cyanide, or cyanide forms arising from it, could potentially occur at various stages in the life cycle of sodium cyanide – from manufacture, to transport, use and ultimate release to the environment.

The overall fate of sodium cyanide and its products in the environment is complex and depends on a wide range of site-specific and operational factors.

These include:

- in solution, the amount of HCN present increases with decreasing pH and an important form of release at the pH range in the normal environment is volatilisation (vapourisation) of gaseous HCN.
- forms of cyanide available at the low pH in the stomachs of birds and mammals are commonly measured as Weak Acid Dissociable cyanide (WAD CN).
- in tailings storage facilities (TSFs) and heap leach piles, cyanide may be lost by volatilisation of HCN, degraded by various abiotic and biotic processes, fixed within the site by precipitation and adsorption of metallocyanides, and may potentially migrate in seepage to underlying strata and groundwater.

Most sodium cyanide-derived waste from non-mining uses is expected to be treated to destroy free cyanide before delivery to landfill, where dissipation, degradation and fixation processes are expected to occur.

Cyanide-resistant micro-organisms capable of biodegrading cyanide have been identified in sewerage treatment systems that require air – and the small amounts of cyanide arising from industrial discharge into sewers are likely to be destroyed during secondary treatment.

Effects of Sodium Cyanide

Cyanide has been found to have very high acute (eg. single dose) toxicity to aquatic and land animals and is also toxic to plants and certain micro-organisms. It also can produce chronic toxicity following long-term or repeat-dose exposure, such as adverse impacts on egg production and spawning in fish.

Once in the bloodstream, cyanide rapidly forms a stable complex with enzymes involved in cellular respiration, resulting in cellular asphyxiation. The lack of available oxygen leads to lactate accumulating in the blood. The combined effect is depression of the central nervous system (CNS) that can result in respiratory arrest and death. A range of other enzymes and biological systems, other than the CNS, are also affected by cyanide.

In general, the effects of small non-lethal doses of cyanide tend to be reversible over time due to metabolic processes leading to cyanide degradation.

The report reviews the toxicity of cyanide to birds, as there have been incidents in Australia in the past where hundreds or thousands of birds have been killed within a relatively short period at a single gold ore processing site through exposure to cyanide residues in a TSF or associated facilities. Observations indicate smaller numbers of birds have died on an intermittent, ongoing basis at gold ore processing site TSFs and heap leach facilities in Australia and the USA.

Key Findings

Risks to the environment during manufacture and storage of sodium cyanide and during use in processes such as base metal flotation, electroplating and metallurgical processes are low. Risks to the aquatic environment, groundwater and vegetation can be maintained at or below acceptable levels if existing Commonwealth and state/territory legislation and voluntary measures are properly implemented and compliance with these measures monitored.

Despite current controls the risk to wildlife through consumption of water containing sodium cyanide at mine tailings storage facilities maybe high and additional risk mitigation measures are needed. Therefore it is critical to maintain sodium cyanide levels at the lowest feasible level in the TSFs and/or minimise access to TSFs by wildlife. The framework proposed minimises these risks while providing flexibility to industry and takes into account the varying geological conditions across Australia.

National Industrial Chemicals Notification and Assessment Scheme
GPO Box 58 Sydney NSW 2001 Australia, T +61 2 8577 8800, F +61 2 8577 8888 www.nicnas.gov.au

Large quantities of sodium cyanide are transported by rail and road between the manufacturing sites and mines. There is a potential for incidents to occur and for serious impacts on downstream aquatic areas or wildlife. Additional control measures are necessary to prevent such incidents

Recommendations

The recommendations arising from the NICNAS assessment address the various stages of distribution and use of sodium cyanide.

Industry should continue to comply with existing Commonwealth and state/territory legislation and voluntary control measures that apply to manufacture and storage of sodium cyanide and to use in processes such as base metal flotation, electroplating and metallurgical processes and State/Territory governments should continue to monitor compliance.

Transport

Adherence to transport best practice principles, including compliance with transport regulations, careful selection of route and optimal load size, driver training and prompt emergency response by appropriately trained and equipped emergency responders, will collectively reduce the likelihood of, or lessen the impacts of accidents leading to sodium cyanide release to the environment. Implementation of these measures should be monitored by the relevant state and territory authorities.

Protection of wildlife during gold ore beneficiation use

Regulators and operators should adopt a framework strategy (provided in the NICNAS Report) combining concentration limits with other measures appropriate to the environmental risks at the individual site. This framework can also be applied at heap leach operations.

Industry, in agreement with the relevant state/territory government agencies, should ensure that suitable habitat, wildlife and cyanide concentration monitoring and response programs are in place and operating satisfactorily at sites using sodium cyanide for extracting gold from ore.

Industry should use the monitoring data obtained to report to the relevant government agencies, according to an agreed process to allow significant incidents to be brought to the attention of the agencies promptly so that government agencies can confirm the adequacy of ongoing cyanide management procedures at each site.

For more information

Contact NICNAS on phone 1800 638 528 or email info@nicnas.gov.au

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