Unit 20 metallurgical environment engineering

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New words and expressions

precipitation [prɪˌsɪpɪ'teɪʃn] n. 沉淀;沉淀物

accumulate [ə'kjuːmjəleɪt] v.累积；积聚

ingest [ɪn'dʒest] v.摄取；咽下；吸收

effluent /ˈefluənt/ n.（注入河里等的）污水，工业废水

adsorption [æd'sɔːpʃən] n. 吸附

adsorbent [əd'zɔːrbənt] n. 吸附剂; adj. 吸附的

electrodialysis [ɪˌlektroʊdaɪ'æləsɪs] n. 电渗析

intensify [ɪn'tensɪfaɪ] v.增强；强化；加剧

zeolite ['ziːəˌlaɪt] n. 沸石

accommodate [ə'kɑːmədeɪt] v. 适应；调解

Outweigh [ˌaʊt'weɪ] v. 胜过，在重要性超过，超过

- autoimmunity [ɔːtə'ʊɪmjuːnɪtɪ] n. 自身免疫
- rheumatoid arthritis/' ruːmətɔɪd ɑːr'θraɪtɪs / n. 风湿性关节炎
- manifestation/,mænɪfe'steɪʃ(ə)n/ n. 病变
- visceral/ 'vɪsərəl / adj.内脏的
- vascular/ 'væskjələ(r) / adj.血管的
- carcinogen/ kɑːr'sɪnədʒən / n.致癌物
- diarrhea/ ˌdaɪə'riːə / n. 腹泻；痢疾
- nausea/ ‘nɔːziə / n.恶心；反胃；作呕
- vomiting/ 'vɒmɪtɪŋ/ adj. 呕吐的
- insomnia/ ɪn'sɒmniə/ n. 失眠；失眠症
- dermatitis/ ˌdɜːmə'taɪtɪs / n. 皮肤炎
- lethargy/ 'leθərdʒi/ n. 昏睡；倦怠；无精打采
- neurological [ˌnʊrə'lɑːdʒɪkl] adj. 神经病学的
- etch/etʃ/ v. 蚀刻

New words and expressions

- metal-contaminated wastewater重金属废水
- conventional treatment processes传统处理方法
- chemical precipitation化学沉淀
- ion exchange离子交换
- electrochemical removal电化学脱除
- metal-binding capacity金属结合能力
- polymeric material[ˌpɑlɪ'mɛrɪk]**聚合材料；聚合物材料**
- membrane separation膜分离
- membrane filtration膜过滤
- ultrafiltration (UF)超滤[ˌʌltrəfɪl'treʃən]
- nanofiltration (NF) 纳滤
- physico-chemical treatments物理化学处理法
- removal performance脱除性能
- electroless depositions化学镀

outline

Heavy metals

- introduction
- **Heavy metal in industrial wastewater**
  - Definition of heavy metal
  - Industrial wastewater sources
  - Conventional processes for removal
- Evaluation of heavy metals removal processes

- Describe advantages and drawbacks
- a large amount of chemicals； a large amount of solids
  注意amount的用法，用number？
- and的用法， chemical costs (such as utilizing of low-cost adsorbents) and feasible sludge disposal

A and B, A, B应同时为单数或者复数吗？

Industrial wastewater sources

- Water is commonly used in various steps of metallurgical processes, such as mining, flotation, sintering, coking, flue gas cleaning, steel making, steel rolling, pickling and electroplating. The amount of wastewater produced from the metallurgical sector contributes significantly to the total industrial wastewater.

- In rare earth metallurgy, about 60-100 tons of wastewater are generated in the production of every ton of rare earth oxide or other purified compounds.

- The classification and characteristics of wastewaters from the iron and steel industries and non-ferrous metallurgy are briefly summarized in Table 20-1.

Industrial wastewater sources

Table 20-1 Classification of wastewaters from the metallurgical industry

(A) Iron and steel industrial wastewater		(B) Non-ferrous metallurgical wastewater	
Process wastewater	Raw material system	Types of wastewater	
	Coking	Classification one	Heavy non-ferrous metallurgical wastewater; light non-ferrous metallurgical wastewater; rare earth metallurgical wastewater
	Sintering and pelletizing		
	Iron smelting		
	Steel making and continuous casting	Classification two	Acidic wastewater; alkali wastewater; heavy metal wastewater; fluoride wastewater; cyanide wastewater; oil-containing wastewater; radioactive wastewater
	Hot rolling		
	Cold rolling		

heavy metal in wastewater

Due to the discharge of large amounts of metal-contaminated wastewater, industries bearing heavy metals, such as Cd, Cr, Cu, Ni, As, Pb, and Zn, are the most hazardous among the chemical-intensive industries.

Damage to health

Because of their high solubility in the aquatic environments, heavy metals can be absorbed by living organisms. If the metals are ingested beyond the permitted concentration, they can cause serious health disorders.

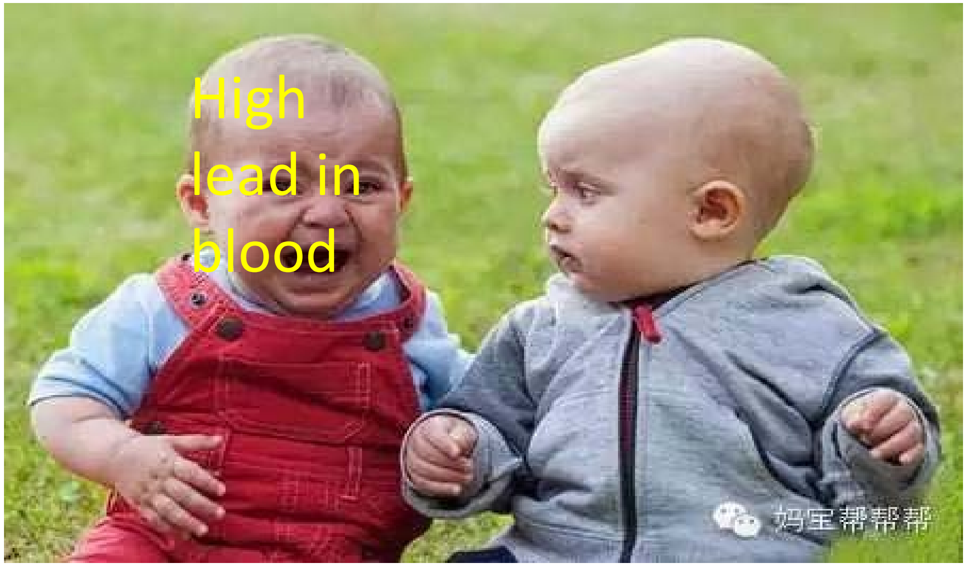
Introd-uction

Removal method

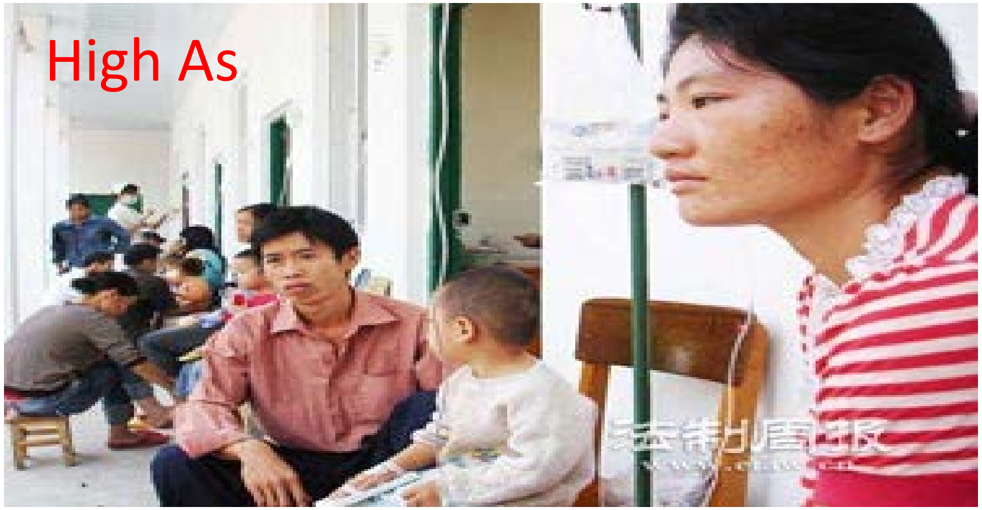
Heavy metal removal from inorganic effluent can be achieved by conventional treatment processes such as chemical precipitation, ion exchange, and electrochemical removal.

Disadvantage of current technolo

These processes have significant disadvantages, which are, for instance, incomplete removal, high-energy requirements, and production of toxic sludge.


High
lead in
blood
妈宝帮帮帮


Cr Poisoning


High As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Definition and toxicity

- Heavy metals are generally considered to be those whose density exceeds 5 g per cubic centimeter. A large number of elements fall into this category.
- Heavy metals cause serious health effects, including reduced growth and development, cancer, organ damage, nervous system damage, and in extreme cases, death.
- Exposure to some metals, such as mercury and lead, may also cause development of autoimmunity, in which a person’s immune system attacks its own cells.
- At higher doses, heavy metals can cause irreversible brain damage. Children may receive higher doses of metals from food than adults since they consume more food for their body weight than adults.

- Wastewater regulations were established to minimize human and environmental exposure to hazardous chemicals. This includes limits on the type and concentration of heavy metals that may be present in the discharged wastewater.

Table 20-2 The MCL standards for the most hazardous heavy metals

Heavy metal	Toxicities	MCL/(mg · L^{-1})
Arsenic	Skin manifestations, visceral cancers, vascular disease	0.05
Cadmium	Kidney damage, renal disorder, human carcinogen	0.01
Chromium	Headache, diarrhea, nausea, vomiting, carcinogenic	0.05
Copper	Liver damage, Wilson disease, insomnia	0.25
Nickel	Dermatitis, nausea, chronic asthma, coughing, human carcinogen	0.20
Zinc	Depression, lethargy, neurological signs and increased thirst	0.80
Lead	Damage the fetal brain, diseases of the kidneys, circulatory system, and nervous system	0.006
Mercury	Rheumatoid arthritis, and disease of the kidneys, circulatory system, and nervous system	0.00003

- The conventional processes for removing heavy metals from wastewater include many processes such as chemical precipitation, floatation, adsorption, ion exchange, and electrochemical deposition. Chemical precipitation is the most widely used for heavy metal removal from inorganic effluent.

- Lime and limestone are the most commonly employed precipitant agents due to their availability and low cost in most countries. Lime precipitation can be employed to effectively treat inorganic effluent with a metal concentration of higher than 1000mg/L.

Advantages and drawbacks of lime precipitation

- Other advantages of using lime precipitation include the simplicity of the process, inexpensive equipment requirement, and convenient and safe operations.
- However, chemical precipitation requires a large amount of chemicals to reduce metals to an acceptable level for discharge. Other drawbacks are its excessive sludge production that requires further treatment, slow metal precipitation, poor settling, the aggregation of metal precipitates, and the long-term environmental impacts of sludge disposal.

Ion exchange

- Ion exchange is another method used successfully in the industry for the removal of heavy metals from effluent. An ion exchanger is a solid capable of exchanging either cations or anions from the surrounding materials.

- The disadvantage of this method is that it cannot handle concentrated metal solution as the matrix gets easily fouled by organics and other solids in the wastewater.
- Moreover ion exchange is nonselective and is highly sensitive to the pH of the solution.

Electrolytic recovery

- Electrolytic recovery or electrowinning is one of the many technologies used to remove metals from process water streams. This process uses electricity to pass a current through an aqueous metal-bearing solution containing a cathode plate and an insoluble anode.

- Positively charged metallic ions cling to the negatively charged cathodes leaving behind a metal deposit that is strippable and recoverable. A noticeable disadvantage was that corrosion could become a significant limiting factor, where electrodes would frequently have to be replaced.

Evaluation of heavy metals removal processes

- In general, physico-chemical treatments offer various advantages such as their rapid process, ease of operation and control, flexibility to change of temperature.

- Unlike in biological system, physico-chemical treatment can accommodate variable input loads and flow such as seasonal flows and complex discharge. Whenever it is required, chemical plants can be modified. In addition, the treatment system requires a lower space and installation cost.

Evaluation of heavy metals removal processes

- Their benefits, however, are outweighed by a number of drawbacks such as their high operational costs due to the chemicals used, high-energy consumption and handling costs for sludge disposal.
- However, with reduced chemical costs (such as utilizing of low-cost adsorbents) and feasible sludge disposal, physico-chemical treatments have been found as one of the most suitable treatments for inorganic effluent.

Evaluation of heavy metals removal processes

- However, the most challenging aspect for industrial wastewater treatment in the future will be process integration, which can bring out intelligent combinations of different physico-chemical processes as well as physico-chemical processes coupled with biological processes. The application of physico-chemical methods is not just relevant from the point of view of industrial wastewater treatment for meeting pollution control norms, but also relevant from the point of view of water recycling and reuse. This is especially important in view of the scarcity of water resources in several parts of the world that would demand water conservation, quite apart from environmental pollution control.

THANKS

End

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