

Experimental Foundation for Environmental Monitoring (1)

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环境监测实验基础（1）

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思考问题的男人.JPG



Preface

Reliable statistics showed that main reason for failed case in authentication of environmental monitoring lab, is not due to bad instrument quality, but others, for example, problems in reagents and experimental water inspection, inaccurate working standard & preparation of “blind sample” solution, etc, all can lead to incorrect analytical results.



思考问题的男人.JPG



序言

可靠的统计资料表明，在环境监测实验室认证考核中大多数的分析项目结果不合格者，主要不是因为其使用的仪器质量不够好，而是因为其他一些问题。例如，疏忽所用试剂的实际质量和实验用水达标鉴别，不够精细的标准系列配制和“盲样”分析液制备，最终就导致分析结果超差。



Therefore, solid foundation and skill in analytical chemistry experiment is necessary for improving the quality of environmental monitoring, which refer to the knowledge of lab safety; lab's water, reagent specification and preservation; analytical balance; weight & titration analysis; calibrations, etc. **Lab safety** is one of the most important issue.





因此，具备扎实的分析化学实验基础知识与操作技能是提高环境监测工作质量的必备条件。该基础知识和技能包括：实验用水、试剂的规格及试剂的使用和保存、**实验室安全知识**、分析天平及其称量方法、化学滴定法基本操作、重量分析基本操作以及量具的校正等。其中，**实验室安全**是最重要的。





1 Experiment water for environmental monitoring

Pure water, distilled water or deionized water would be used. Redistilled water or higher specifications are for electronic anachem, HPLC etc. Pure water is not absolutely pure , but impurity lower in certain micro-lever.





1 环境监测实验用水

分析化学实验应使用纯水，一般是蒸馏水或去离子水。有的实验要求用二次蒸馏水或更高规格的纯水（如：电分析化学、液相色谱等的实验）。纯水并非绝对不含杂质，只是杂质含量极微而已。分析化学实验用水的级别及主要技术指标，见表1。





The level and technical indices are listed in following.

Table 1 water level and technical index (fr. GB6682-92)

name	level1	level 2	level 3
• PH	no rule (nr)	nr	5.0 ~ 7.5
• Conductivity (25°C), mS/ m, (\leq),	0.01	0.1	0.50
• Combustible subs (in (O)), mg/L, ($<$),	nr	0.08	0.4
• Evaporites (105 \pm 2 °C), mg/L, (\leq),	nr	1.0	2.0
• Absorbancy (254nm, 1cm optical path), (\leq),	0.001	0.01	nr
• Soluble silicon (in (SiO ₂)), mg/L, (\leq),	0.01	0.02	nr



环境监测实验用水的级别及主要技术指标，如表1所示。



表1 分析化学实验室用水的级别及主要技术指标（载自GB6682—92）

指标名称	一级	二级	三级
pH值范（25°C）	—	—	5.0~7.5
电导率（25°C）/mS·m ⁻¹ （≤）	0.01	0.10	0.50
可氧化物质（以（O）计）/mg·L ⁻¹ （<）	—	0.08	0.4
蒸发残渣（105±2°C）/mg·L ⁻¹ （≤）	—	1.0	2.0
吸光度（254nm，1cm光程）（≤）	0.001	0.01	—
可溶性硅（以（SiO ₂ ）计）/mg·L ⁻¹ （≤）	0.01	0.02	—

注：在一级、二级纯度的水中，难于测定真实的pH值，因此对其pH值的范围不作规定；在一级水中，难于测定其可氧化物质和蒸发残渣，故也不作规定。





1.1 Distilled water:

- Distilled water is made by distillation to remove non-volatile impurities. The impurities varieties and contents are different with different set. Glass distillation water may contain Na^+ and SiO_2^- , and Cu^+ with copper distillation. Stainless steel set is popular for better quality.





1.1 蒸馏水:

通过蒸馏方法、除去水中非挥发性杂质而得到的纯水称为蒸馏水。同是蒸馏所得纯水，其中含有的杂质种类和含量也不同。用玻璃蒸馏器蒸馏所得的水含有 Na^+ 和 SiO_2^- 等离子；而用铜蒸馏器所制得的纯水则可能含有 Cu^+ 离子。用纯不锈钢蒸馏器，所制得的纯水质量较好。





采用阴床，阳床，混床
去离子超纯水处理设备

1.2 Deionized water:

- Using ion-exchange agent to remove cations and anions, deionized water is produced. Pls note that old deionized water may contain microorganisms and organic impurities.



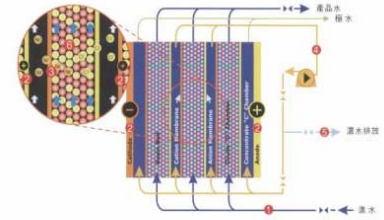


采用阴床，阳床，混床
去离子超纯水处理设备

1.2 去离子水：

利用离子交换剂去除水中的阳离子和阴离子杂质所得的纯水，称之为离子交换水或“去离子水”。未进行处理的去离子水可能含有微生物和有机物杂质，使用时应注意。

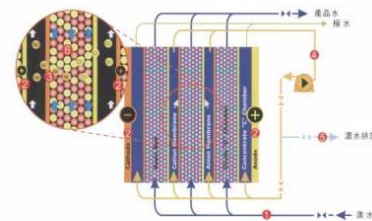




技术特点:

- 可连续生产超纯水, 产水水质稳定;

Electrodeionization (EDI) is a combination technology of ion exchange and ion electric migration for pure water. By using mixed ion exchange resins to adsorb ions in supply water, and these adsorbed ions are removed by the action of going through anion exchange membrane and cation exchange membrane respectively under DC voltage. Ion exchange resin is electric continuous renewable without traditional acid and alkali operation.



技术特点:

- 可连续生产超纯水, 产水水质稳定;

电去离子 (Electrodeionization) 简称 EDI, 是离子交换技术和离子电迁移技术相结合的新的纯水制造技术。利用混合离子交换树脂吸附水中的阴离子和阳离子, 同时这些被吸附的离子又在直流电压的作用下, 分别透过阴与阳离子交换膜而被去除。这一过程中离子交换树脂是被电连续再生的, 不需要传统费时费力的酸与碱再生过程。



- 1.3 Pure water quality inspection

The index include water resistivity, acidity, calcium & magnesium ions, chloride ion, etc.

(1) The resistivity: conductivity (min range 0.02 mS /cm) (see table 1.1).

(2) PH index: 6 ~ 7 pH value. Test way are as follows:





1.3 纯水质量的检验

纯水的质量检验指标很多，分析化学实验室要对实验用水的电阻率、酸碱度、钙镁离子、氯离子的含量等进行检测。

(1) 电阻率：选用适合测定纯水的电导率仪（最小量程为 $0.02 \mu\text{S}\cdot\text{cm}^{-1}$ ）测定（见表1.1）。

(2) 酸碱度：要求pH值为6~7。检验方法如下：





- ① simple method: water 10 mL in each test-tube;
- 1) add 2 drops of methyl red indicator, no red colour appeared.
 - 2) add 5 drops of 0.1% bromine thyme phenol blue, no blue colour observed.
- ② instrument method : with acidity meter, under atmospheric balance, water pH is at 6 ~ 7 .





① 简易法:

取2支试管，各加待测水样10 ml，其中一支加入2滴甲基红指示剂应不显红色；另一支试管加5滴0.1% 溴麝香草酚蓝（溴百里酚蓝）不显蓝色为合要求。

② 仪器法:

用酸度计测量与大气相平衡的纯水的pH值，在6~7为合格。





- ③ Ca^{2+} Mg^{2+} : 50 ml water , add 1 ml of ammonia – chloride (pH = 10) , a bit of chromium black T (EBT), no red showed (be pure blue !).
- ④ Cl^- : 10 ml water, add 2 drops of 1 mol / L HNO_3 , 2 drops of 10 g / L AgNO_3 , no turbidity appeared.





③钙镁离子：取50 ml待测水样，加入pH=10的氨水-氯化铵缓冲液1 ml和少许铬黑T (EBT) 指示剂，不显红色（应显纯蓝色）。

④氯离子：取10 ml待测水样，用2滴1 mol·L⁻¹ HNO₃酸化，然后加入2滴10 g·L⁻¹ AgNO₃溶液，摇匀后不浑浊为合要求。





In chemical analysis, deionized water for complex- titration, distilled water for other methods. pure water must keep without pollution. Usually they are made of polyethylene material.





化学分析法中，除络合滴定必须用去离子水外，其它方法均可采用蒸馏水。分析实验用的纯水必须注意保持纯净、避免污染。通常采用以聚乙烯为材料制成的容器盛载实验用纯水。



1.4 Reagent specification, use and preservation



- Specification & use: for accuracy of anal results, pay attention to experiment circumstances, the content and object, sensitivity and selectivity, etc, use an appropriate grade to avoid waste.
- Preservation: without contamination and metamorphism.





1.4 常用试剂的规格及试剂的使用和保存

分析化学实验中所用试剂的质量，直接影响分析结果的准确性，因此应根据所做试验的具体情况，如分析方法的灵敏度与选择性，分析对象的含量及对分析结果准确度的要求等，合理选择相应级别的试剂，在既能保证实验正常进行的同时，又可避免不必要的浪费。试剂应合理保存，避免沾污和变质。





1.4.1 Reagent classification

- Thousands kinds of reagents produced, new reagents emerge with science development. No unified classification indicated. Only briefly introduce the standard reagent, general reagent and specific reagent as following:



1.4.1 化学试剂的分类



化学试剂产品已有数千种，而且随着科学技术和生产的发展，新的试剂种类还将不断产生，现在还没有统一的分类标准，这里只简要地介绍标准试剂、一般试剂、高纯试剂和专用试剂。





杭州化学试剂, 标准

(1) The standard reagents

Standard reagent, standard reference materials, is used to measure chemical amount in other materials. Its characteristic is high main contents, reliable to use.

Our country stipulates that main content are from 100 (+-) 0.02% to 100 (+-) 0.05% for titration analysis.

domestic standard reagents are listed in 1.4(1)
(see table 1)





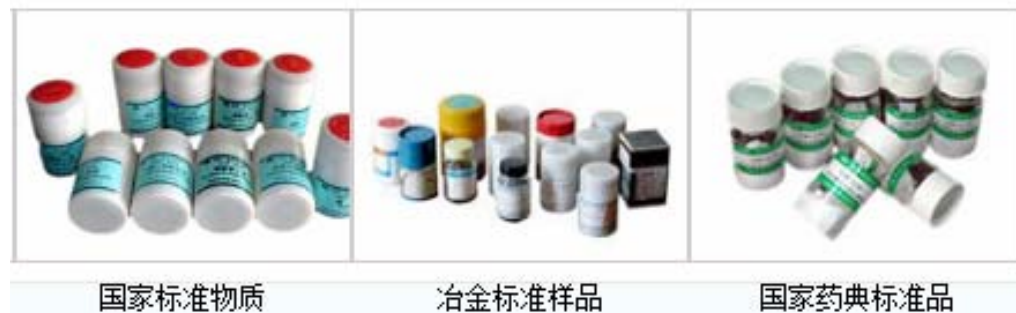
杭州化学试剂, 标准

(1) 标准试剂

标准试剂是用于衡量其它（欲测）物质化学量的标准物质，习惯称之为基准试剂，其特点是主体含量高，使用可靠。我国规定滴定分析第一基准和滴定分析工作基准的其主体含量分别为 $100\pm 0.02\%$ 和 $100\pm 0.05\%$ 。主要国产标准试剂的种类及用途见表1.4(1)。



Table 1.4 (1) China standard reagent specifications & usage



Class

Use

Titration analysis First Primary Standard; for setting value of working standard reagents

Titration analysis working standard reagent; for fixing value of titration analysis standard solution

Titration analysis standard solution; for determination of material content with titration method

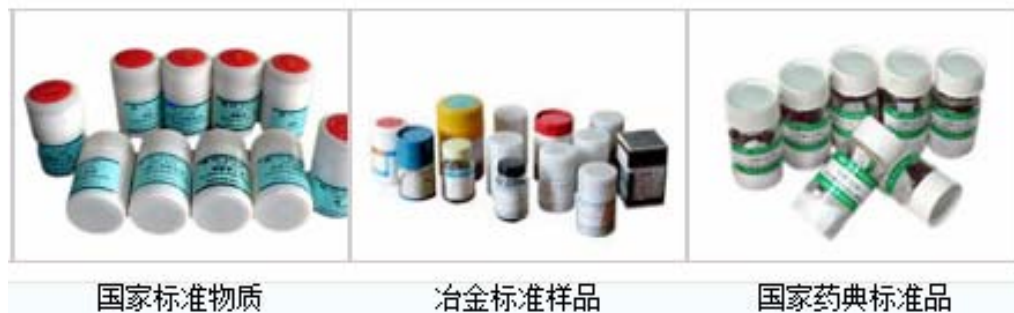
standard solution for Impurities analysis; for trace impurities analysis in instrumental and chemical analysis

Level 1 pH benchmark reagent; for setting value of pH benchmark reagents, and calibration of pH meter;

PH benchmark reagent, for calibration of pH meter;



表1.4(1) 主要国产标准试剂的规格与用途



类别	主要用途
滴定分析第一基准试剂	工作基准试剂的定值
滴定分析工作基准试剂	滴定分析标准溶液的定值
滴定分析标准溶液	滴定分析法测定物质的含量
杂质分析标准溶液	仪器及化学分析中作为微量杂质分析的标准
一级pH基准试剂	pH基准试剂的定值和高精密度pH计的校准
pH基准试剂	pH计的校准（定位）
热值分析试剂	热值分析仪的标定
气相色谱分析标准试剂	气相色谱法进行定性和定量分析的标准
临床分析标准溶液	临床化验
农药分析标准试剂	农药分析
有机元素分析标准试剂	有机物元素分析





国家标准物质

冶金标准样品

国家药典标准品

Class // Use

Calorific value analysis reagent; for calibration of calorific value analyzer;

Standard reagent of Gas chromatographic analysis; standard in the analysis of gas chromatography (quantitative and qualitative);

Clinical analysis standard solution; for clinical laboratory testing;

Pesticide analysis standard reagent; for pesticide analysis

Organic element analysis standard: for organic materials analysis;





级别 // 使用

热值分析试剂; 对校准热量分析仪;

气相色谱分析标准试剂; 气相色谱法(定量和定性的)标准;

临床分析标准溶液; 临床实验室测试;

农药分析标准试剂; 农药和农药残留分析;

有机元素分析标准; 有机材料分析;



(2) General reagents

The most common reagents in lab, On their impurity differences, classified as grade one, two, three, four and biochemical reagents etc. The details are listed in table 1.4.(2).





(2) 一般试剂

一般试剂是实验室最普遍使用的试剂，其规格是以其中所含杂质的多少来划分，包括通用的一、二、三、四级试剂和生化试剂等。一般试剂的分级、标志、标签颜色和主要用途列于表—1.4. (2)。



Table 1.4.(2) – general chemical reagents



level	specification	symbol	scope	labeling color
1	grade pure (guarantee reagent)	G R	precision analysis	green
2	analysis pure (analysis reagent)	AR	general analysis	red
3	chemical pure	C P	general experiment	blue
4	experimental reagent	L R	general experiment auxiliary reagent	brown or other colors
Biochem reagents	bio & biomedic colorings	B R	biochem and medicinal experiment	brown or rose



表1.4. (2) —— 一般化学试剂的规格及选用



级别	中文名称	英文符号	适用范围	标签颜
一级	优级纯 (保证试剂)	G R	精密分析实验	绿色
二级	分析纯 (分析试剂)	A R	一般分析实验	红色
三级	化学纯	C P	一般化学实验	蓝色
四级	实验试剂	L R	一般化学实验辅助试剂	棕色或 其它颜色
生化试剂	生化试剂 生物染色剂	B R	生物化学及医用化学实验	咖啡色 玫瑰色





(3) High pure reagents

Impurity content: less than GR; use in trace analysis; minimize the interference fr. blank, improve the reliability of anal results. In the technical indexes, its main ingredient is quite same as GR, but marked impurity items are more than 1 ~ 2 times.

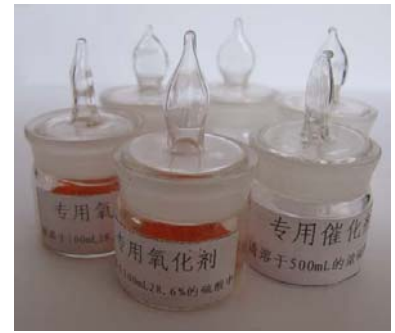




(3) 高纯试剂

高纯试剂其最大的特点是其杂质含量比优级或基准试剂都低，用于微量或痕量分析中试样的分解和试液的制备，可最大限度地减少空白值带来的干扰，提高测定结果的可靠性。同时，高纯试剂的技术指标中，其主体成分与优级或基准试剂相当，但标明杂质含量的项目则多1~2倍。

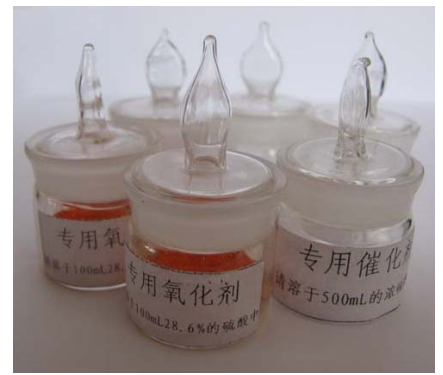




(4) special reagents

It refers to the special purpose reagents, for example, chromatographic pure reagent for chromatography & thin layer analysis as carrier, fillers & fixatives. Spectrum pure one for optical analysis; ext. It is important that the impurity do not generate obvious interferences in specific application .





For COD

(4) 专用试剂

专用试剂顾名思义是指专门用途的试剂。例如在色谱分析法中用的色谱纯试剂、色谱分析专用载体、填料、固定液和薄层分析试剂；光学分析法中使用的光谱纯试剂和其它分析法中的专用试剂。专用试剂除了符合高纯试剂的要求外，更重要的是在特定的用途中、其干扰的杂质成分不产生明显干扰的限度之下。





- 1.4.2 Attention items
- (1) Cap (plug) in time to prevent reagent hygroscopic, stains and metamorphism after opening .
- (2) Put cap (plug) in right place avoiding contamination .
- (3) Do not reverse the reagent back after taking from original bottles .

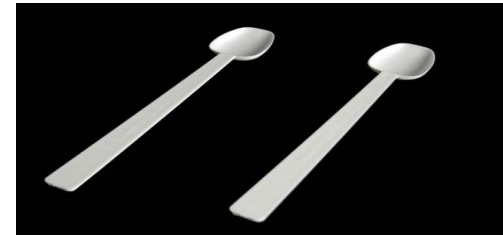




1.4.2 使用试剂注意事项

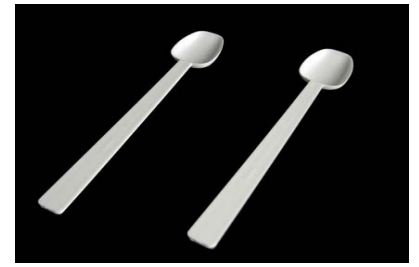
- (1) 打开瓶盖（塞）取出试剂后，应立即将瓶（塞）盖好，以免试剂吸潮、沾污和变质。
- (2) 瓶盖（塞）不许随意放置，以免被其它物质沾污，影响原瓶试剂质量。
- (3) 试剂应直接从原试剂瓶取用，多取试剂不允许倒回原试剂瓶。





- (4) Use clean dry small spoon to get solid reagents . Wash spoon immediately to lest corrosion after access strong alkaline reagents .
- (5) Never allow same straws for transferring two liquid reagents.
- (6) Certify marked label, reagent name, specifications and the date on tags before use.
Do not use illegible reagent.





(4) 固体试剂应用洁净干燥的小勺取用。取用强碱性试剂后的小勺应立即洗净，以免腐蚀。

(5) 用吸管取用液态试剂时，决不许用同一吸管同时吸取二种试剂。

(6) 盛装试剂的瓶上，应贴有标明试剂名称、规格及出厂日期的标签，没有标签或标签字迹难以辨认的试剂，在未确定其成份前，不能随便使用。





- 1.4.3 Reagent preservation

Undeserved place may cause quality and component change. Reagents should be kept in ventilation & clean house, avoid moisture & contamination of dust and other substances, and select corresponding preservation methods according to the reagent nature.





1.4.3 试剂的保存

试剂放置不当可能引起质量和组分的变化，因此，正确保存试剂非常重要。一般化学试剂应保存在通风良好、干净的房子，避免水分，灰尘及其它物质的沾污，并根据试剂的性质采取相应的保存方法和措施。





- (1) Reagent with corrosion to glass shall be kept on plastic bottle. Such as: HF, fluoride (NaF, KF, (NH₄)F), KOH, NaOH, etc.
- (2) Reagent with character decomposed by light, or oxidized by air, such as H₂O₂, HNO₃, AgNO₃, Gallic acid, KMnO₄, H₂CO₄, Na₂BiO₄, SnCl₂, FeSO₄, Na₂SO₃, etc; and volatile Br, NH₄OH and volatile organic solvents, should be kept in brown glass bottle, stored in the cold & dark place.





- (1) 容易腐蚀玻璃影响试剂纯度的试剂，应保存在塑料瓶中。如：氢氟酸、氟化物（氟化钠、氟化钾、氟化铵）、苛性碱（氢氧化钾、氢氧化钠等。
- (2) 见光易分解，遇空气易被氧化和易挥发的试剂应保存在棕色瓶里，放置在冷暗处。如过氧化氢（双氧水）、硝酸银、焦性没食子酸、高锰酸钾、草酸、铋酸钠等属见光易分解物质；氯化亚锡，硫酸亚铁，亚硫酸钠等属易被空气逐渐氧化的物质；溴、氨水及大多有机溶剂属易挥发的物质。





- (3) Reagents with feature of water imbibition (Na_2CO_3 , NaOH , etc) should be strictly sealed & stored.
- (4) Regents: acid & ammonia, oxidant & reductant, could easy interact; organic solvent are inflammable; HClO_4 , H_2O_2 , nitro-compound are explosive; should be separately stored in a cool ventilated place.





(3) 吸水性强的试剂应严格密封保存。如：
无水碳酸钠，苛性钠，过氧化物等。

(4) 易相互作用、易燃、易爆炸的试剂，应
分开贮存在阴凉通风的地方。如：酸与氨
水、氧化剂与还原剂属易相互作用物质；有
机溶剂属易燃试剂；氯酸、过氧化氢、硝基
化合物属易爆炸试剂等。



Tea break.





Dangerous liquid reagent should be placed in lab low position to prevent rupturing from shaking. Larger amount of flammable or poisonous liquid should be store in safe underground chemical warehouse with high duct ventilation. Std of high hiradioactive sources should be stored in a special underground hole.





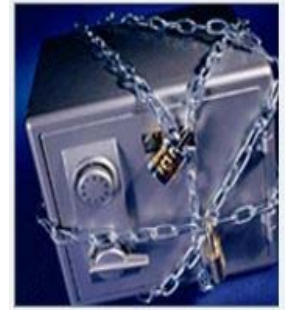
危险液体样品应该放在较低的安全位置，要考虑到因为震动导致破裂所带来的危害。特别对易燃的有机液体，易挥发的有毒无机液体，如数量较大，应储存在安全的有高位的通风管道地下化学品仓库。放射源标准样品要存放在专门的地下井里。





- (5) Reagents, such as cyanide (KCN , NaCN), HF , HgCl_2 , As_2O_3 (arsenic) should specially safekeeping, strictly carry out use formality to avoid poisoning accidents.





(5) 剧毒试剂应专门保管，严格取用手续，以免发生中毒事故。如：氰化物（氰化钾、氰化钠）、氢氟酸、二氯化汞、三氧化二砷（砒霜）等属剧毒试剂。





1.5 laboratory security

It includes “ water, electricity, door, window, gas, waste and reagent”. The seven words covers issues of laboratory work. They are discussed as following:





1.5 实验室安全常识

实验室工作安全包括：“水、电、门、窗、气、废、药”。它涵盖了实验室工作中使用水、电、气体、试剂、实验过程产生的废物处理和安全防范的基本问题。





- 1.5.1 Lab water safety

Tap shall be timely closed after using, especially in case of “water stopping” .

Before leaving lab, please check whether the taps are fully closed (it is easily to forget closing condenser cooling water).





1.5.1. 实验室用水安全

使用自来水后要及时关闭阀门，尤其遇突然停水时，要立即关闭阀门，以防来水后跑水。离开实验室之前应再检查自来水阀门是否完全关闭（使用冷凝器时较容易忘记关闭冷却水）。





当心触电

1.5.2 lab electricity safety

Very strict requirements are as following:

- (1) electric set must be professionally installed.
- (2) No wiring electricity at random.
- (3) Carefully read the instructions at first, and be in accordance with the rule to use instrument.





当心触电

1.5.2 实验室用电安全

实验室用电有十分严格的要求，不能随意。必须注意以下几点：

- (1) 所有电器必须由专业人员安装；
- (2) 不得任意另拉、另接电线用电；
- (3) 在使用电器时，先详细阅读有关的说明书及资料，并按照规定去做；





请·不·要·超·负·荷·用·电·!

- (4) Power matching should be qualified between power supply volumes and consumptions. Never overload running to reduce accident. Remember: **immediately turn off the power in accident!**
- (5) Emergency treatment in electric shock accidents: turn the power off, or with insulating objects to pull down the power cord, or unplug (note: never unarmed to pull electrocuted person, avoid more shock accidents).
- Then carry the electrocuted to fresh air ASAP ,





(4) 所有电器的用电量应与实验室的供电及用电端口匹配，决不可超负荷运行，以免发生事故。谨记：任何情况下发现用电问题（事故）时，首先先关电源！

(5) 发生触电事故的应急处理：如若遇触电事故，应立即使触电者脱离电源——拉下电源或用绝缘物将电源线拨开（注意千万不可徒手去拉触电者，以免抢救者也被电流击倒）。同时，应立即将触电者抬至空气新鲜处，



电击伤的急救



Light electric shock can regain consciousness within short time. To serious electrocuted without breathing, get the electrocuted unbutton and timely perform artificial respiration and oxygen. The rescue must have patience (sometimes hours). **No injection of strong heart stimulant!**





如电击伤害较轻则触电者短时间内可恢复知觉；若电击伤害严重或已停止呼吸，则应立即为触电者解开上衣并及时做人工呼吸和给氧。对触电者的抢救必须要有耐心（有时要连续数小时），同时忌注射强心兴奋剂。





1.5.3 lab fire (heat) security

Heat source: electricity or gas. No matter what form to use, worker must pay great attention to fire (heat) rules and requirements:

(1) For gas source device, should often detect pipe (gas) leak, avoid fire accident.





1.5.3 实验室用火（热源）安全

目前，实验过程使用的热源大多用电，但也有少数直接用明火（如用煤气灯）。首先，不管采用什么形式获得热源都必须十分注意用火（热源）的规定及要求：

(1) 使用燃气热源装置，应经常对管道或气罐进行检漏，避免发生泄漏引起火警。





可调电热套

- (2) For inflammable reagent, use water bath, electric oil bath. No naked fire absolutely.
- (3) Use zeolite (or porcelain fragment) for boiling point heating. No riot boiling hurt. No leaving experiment site.
- (4) Use standard heating device (no simple substitution).





可调电热套

- (2) 加热易燃试剂时，必须使用水浴、油浴或电热套，绝对不可使用明火。
- (3) 若加热温度有可能达到被加热物质的沸点，则必须加入沸石（或碎瓷片），以防暴沸伤人，实验人员不应离开实验现场。
- (4) 用于加热的装置，必须是规范厂家的产品，不可随意使用简便的器具代用。





In fire accident, the first thing is to turn off power or gas connection. Fire extinguisher is for small accident extinguishing. If the fire has spread trend, immediately report to the police. Fire extinguishers and the applicable scope, see table 1.5.3 (1).





如果在实验过程发生火灾，第一时间要做的是：**将电源和热源（或煤气等）断开**。起火范围小可以立即用合适的灭火器材进行灭火，但若火势有蔓延趋势，必须同时立即报警。常用的灭火器及其适用范围 见表1.5.3（1）



Table 1.5.3 (1) Fire extinguishers and the application scope:



- Type solution components application scope
- Acid-base: NaHCO_3 H_2SO_4 ; general fire, no oil and electrical fire;
- Bubble: $\text{Al}_2(\text{SO}_4)_3$ NaHCO_3 ; oil fire
- Carbon dioxide: liquid CO_2 ; electrical fire
- *Carbon tetrachloride liquid: CCl_4 ; electrical fire (X)*
- Dry powder: Na_2CO_3 etc with lubricants, moisture-resistant agent: combustible gas & oils, electrical equipment, document, articles burned in water, or the beginning of fire
- *1211: CF_2ClBr ; oil, organic solvents, high volt electrical equipment, instruments (X)*
- ABC: $(\text{NH}_4)_3\text{PO}_4$; oil, organic solvents, electrical equipment, instruments





表1.5.3 (1) 常用的灭火器及其适用范围

类型	药液成分	适用范围(备注)
酸碱式	H_2SO_4 , $NaHCO_3$	非油类及电器失火的一般火灾
泡沫式	$Al_2(SO_4)_3$ $NaHCO_3$	油类失火
二氧化碳	液体 CO_2	电器失火
四氯化碳	液体 CCl_4	电器失火 (公安部禁用)
干粉灭火	Na_2CO_3 等盐类物质, 加入适量润滑剂、防潮剂	油类、可燃气体、电器设备、 文件和遇水燃烧等物品的起火
1121	CF_2ClBr	油类、有机溶剂、高压电器设 备、精密仪器等失火(公安部禁用)
ABC	磷酸铵盐类	油类、有机溶剂、高压电器, 仪器





Water is common extinguishing material, but be caution when using in chem. lab. Most inflammable organic solvents are lighter than water, floating on the surface of water, leading fire spread. Violent reaction takes place when certain solvent meet water, generating large quantity of heat to aggravate burning or explosion.

According to material properties, fire disasters are divided into categories of A, B, C, D. Corresponding fire extinguisher is selected accordingly.





水虽是人所共知的常用灭火材料，但在化学实验室的灭火中要慎用。因为大部分易燃的有机溶剂都比水轻，会浮在水面上流动，此时用水灭火，非但不能灭火反而使火势扩大蔓延；还有的溶剂与水发生剧烈的反应产生大量的热能引起燃烧加剧甚至爆炸。根据燃烧物质的性质，国际上统一将火灾分为A、B、C、D四类，必须根据不同的火灾原因，选择相应的灭火器材。





上海3 kgABC干粉灭火器...

- Fire category and fire extinguisher (FE)
- Table 1.5.3 (2) - Fire category and FE
- Fire type / burning material / fire extinguisher
 - **Class A:** Wood, paper, cloth, etc; Acid-base type extinguisher; It ejects H_2O & CO_2 ; Bubble fire one: H_2O , CO_2 , plus tiny bubbles (from bubbling agent), forming tiny bubbles on wood surface, prevent oxygen invading for combustion.



上海灭火器批发 - 二氧化碳灭火...

火灾类别及其灭火器材的选用

表1.5.3 (2) 火灾类别及其灭火器材的选用



上海3 kgABC干粉灭火器...

火灾类型	燃烧物质	A	注意事项（灭火效果）
A	木材、纸张、棉布等为一类	酸碱式、泡沫式、水；	酸碱式灭火器喷出的主要是水和二氧化碳气体，而泡沫式灭火除了有水 and 二氧化碳气体外，同时喷出发泡剂，与水、二氧化碳混合在一起，形成被液体包围的细小气泡群，在燃烧物表面形成抗热性好的泡沫层，阻止燃烧气化和外界氧气的侵入。



上海灭火器批发 - 二氧化碳灭火...



- **Fire type / Burning material / Fire extinguisher**
Class B / Burnable liquid (liquid petroleum products, edible oils and paint thinner, etc.) / Bubble FE (Remember: no water and Acid-base extinguisher)
- Note: for bubbling FE, the function as aforesaid; also CO₂ FE and carbon tetrachloride FE are OK. Note:
 - 1, CO₂ FE: must stand in the windward, prevent CO poisoning, and hands and body don't close to spray pipe and sleeve, avoid low temperature (about - 70 °C) frostbite! The effective distance is only 1.5 to 2 m.
 - 2, CCl₄ FE: CCl₄ may be transformed into toxic phosgene at high temperatures, so should keep a distance!





火灾类型	燃烧物质	灭火器材	注意事项 (灭火效果)
B类	可燃烧液体 (液态石油化工产品, 食用油脂和涂料稀释剂等)	泡沫式灭火器 切记: 不能用水和酸碱式灭火器	可用泡沫式灭火器, 其作用如前述。B类火灾还可以用二氧化碳灭火器和四氯化碳灭火器, 注意: 1、使用CO ₂ 灭火器时, 人要站在上风处, 以免二氧化碳中毒, 手和身体不要靠近喷射管和套筒, 以防低温(约-70°C)冻伤。另外, 二氧化碳灭火器的有效喷射距离仅为1.5~2 m。 2、四氯化碳灭火器: 由于四氯化碳在高温下可能会转化为剧毒的光气, 所以使用时应保持一定的距离(✗)。





Fire type / burning material / fire extinguisher / note

- Class C / combustible gas (natural gas, coal gas, methane, etc) / powder fire extinguisher / time is short and strong ability to extinguish fire, but working time is short.

Don't use water type, acid-base type and bubble type.

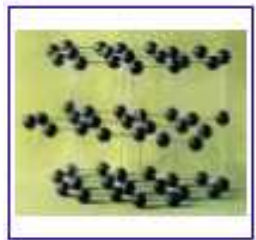
- D class / Combustible metal (potassium, sodium, calcium, magnesium, lead, titanium, etc.)





火灾类型	燃烧物质	灭火器材	注意事项（灭火效果）
C类	可燃性气体（天然气、城市生活用煤气、沼气等）	干粉灭火器	干粉灭火器灭火时间短、灭火能力强。 禁用水、酸碱式和泡沫式灭火器。
D类	可燃性金属（钾、钠、钙、镁、铅、钛等）	砂土	严禁用水、酸碱式、泡沫式和二氧化碳灭火器灭火。扑灭D类火灾最经济有效的材料是砂土（注意消防用砂土应该应该清洗干净且放置在固定位置）。另外：偏硼酸三甲酯（TMB）灭火剂，因其受热分解，吸收大量的热量，并在可燃性金属表面生成氧化硼保护薄膜、隔绝空气。原位石墨灭火剂：由于它受热迅速膨胀，生成较厚的海绵状保护层，使燃烧区温度骤降，并隔绝空气，迅速灭火。



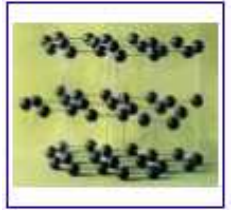


Sand only (note: should be clean and placed in a fixed position) ; Acid or alkali type, bubble type & carbon dioxide are prohibited.

Boric acid methyl- 3 ester (TMB) extinguisher, because of its decomposition, absorb a lot of heat, generate protection film on the metal surface, oxidation boron isolate air.

In situ graphite extinguisher: with turgor ability when heated, generate a thick spongiform cover, make burning zone temperature down, isolate air and extinguish fire.



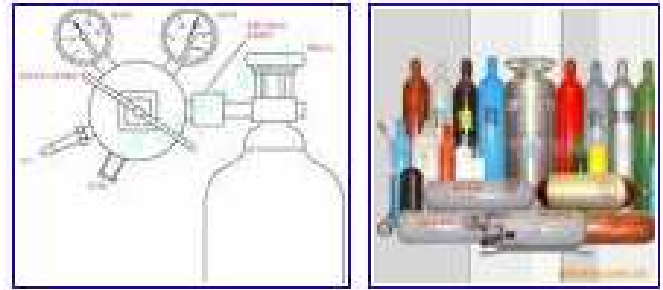


砂子(注:必须是清洁的,放置在一个固定位置): 当酸或碱的类型、泡沫型及二氧化碳类型被禁用时。

甲基-3硼酸酯(TMB)灭火剂: 因其分解、吸收了很多热量,产生金属表面保护膜、氧化硼隔绝空气。

原位石墨灭火器: 具有受热时膨胀特性,产生一种海绵状盖状物,使燃烧区温度的下降,隔绝空气,扑灭火灾。





1.5.4 Safety on compressed gas in lab

Note for compressed air (cylinders):

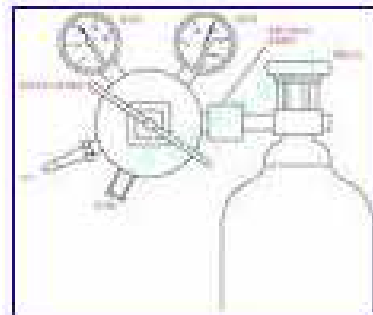
- 1). Need: clear external landmarks (see the appendix 1.3.4); consistent for gas and landmarks. .
- 2). Handling and storage: fix helmet tightly with spanner.
- 3). Moving: with special stretcher or cars;
Don't put hand on the valve to prevent opening.
Horizontally placed, fixed with chains.

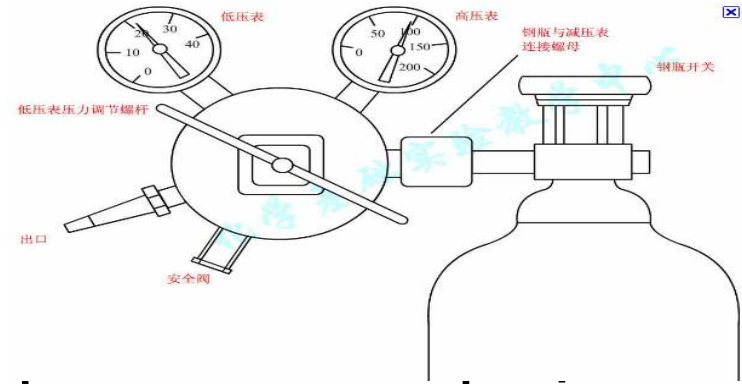


1.5.4 实验室使用压缩气的安全

使用压缩气（钢瓶）时应注意：

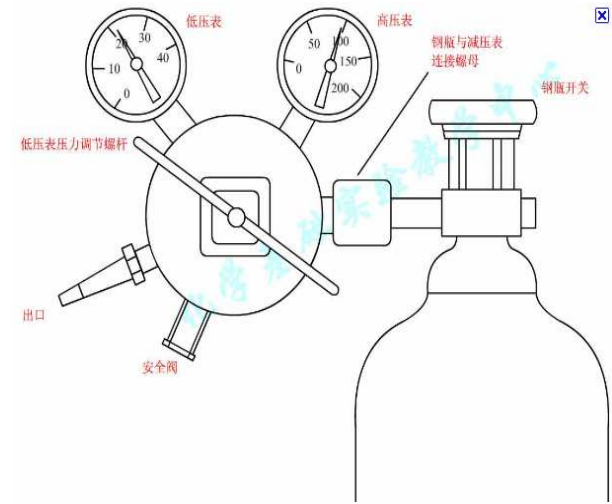
- 1) 压缩气体钢瓶有明确的外部标志（见附表1.3.4），内容气体与外部标志一致。
- 2) 搬运及存放压缩气体钢瓶时，一定要将钢瓶上的安全帽旋紧。
- 3) 搬运气瓶时，要用特殊的担架或小车，不得将手扶在气门上，以防气门被打开。气瓶直立放置时，要用铁链等进行固定。





- 4). When opening the valve of compressed gas cylinders and pressure reducing valve, screwing speed not too fast, reduce over flow risk.
- 5). Gas shall not be exhausted and residual pressure should generally more than number several hundreds of KPa; otherwise air or other gases will get into the cylinder, which affects next inflatable gas purity, and prevent dangerous.





4). 开启压缩气体钢瓶的气门开关

及减压阀时，旋开速度不能太快，而应逐渐打开，以免气流过急流出，发生危险。

5). 瓶内气体不得用尽，剩余残压一般不应小于数百千帕，否则将导致空气或其他气体进入钢瓶，再次充气时将影响气体的纯度，甚至发生危险。





1.5.5 Safe disposal of chemical experimental waste (CEW)

CEW are various for different reaction reagents and wastes. Some poison materials (cyanide, etc) are not permitted to fall in sinks. If cyanide waste meet acid, virulent HCN will produce immediately. Treating cyanide wastewater with alkaline ferrous sulfate to form ferrous cyanide salts for further waste liquid processing.





1.5.5 化学实验废物的安全处理

由于化学实验室的实验项目繁多，所使用的试剂与反应后的废物也大不相同。一些毒害物质不能随手倒在水槽中。例如：**氰化物**的废液，若倒入强酸的介质中将立即产生**剧毒的HCN**。一般将含有氰化物的废液倒入碱性亚铁盐溶液中，使转化为亚铁氰化物盐类，再作废液集中处理。





Dichromate potassium ($K_2Cr_2O_7$)

The $K_2Cr_2O_7$ STD is often used in lab. Its residue should be transformed into Cr^{+3} , untreated pouring is never allowed. According to the national standards GB8978 - 1996 "integrated standard for wastewater discharge ", the first type of pollutants (refer to pollutants, can deposit in environment or animal body and produce long-term impact to the human body). Strict rules for discharge concentrations, as shown in table 1.5.5:





又如**重铬酸钾**标准溶液是常用标准溶液之一, 剩的重铬酸钾溶液应将其转化为三价铬再作废液处理, 决不允许未经处理就倒入下水道。根据国家标准GB8978—1996《污水综合排放标准》, 第一类污染物(指能在环境或动物体内蓄积, 对人体产生长远影响的污染物), 它们允许排放的浓度作了严格的规定, 如表1.5.5所示:





Table 1.5.5 The maximum permission
of first type of pollutant

Pollutant / maximum permission (mg /L)

Total Hg / 0.05

Alkyl Hg / not detectable

Total cadmium / 0.1

Total chromium / 1.5

Hexavalent chromium ($\text{Cr}_2\text{O}_7^{2-}$) / 0.5

Total arsenic / 0.5

T lead / 1.0

Total nickel / 1.0

Benzopyrene (alpha) / 0.00003

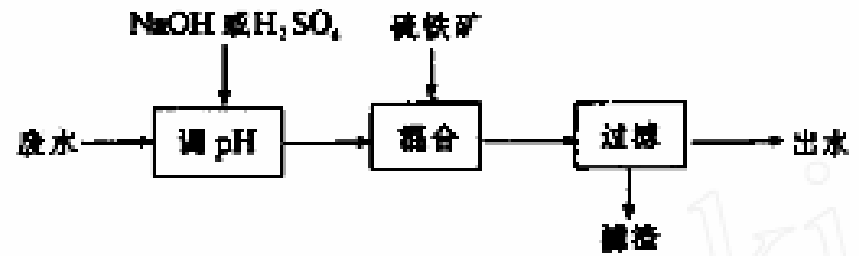


表1.5.5 —— 第一类污染物的最高允许排放浓度



污染物	最高允许排放浓度 (mg/L)	污染物	最高允许排放浓度 (mg/L)
总汞	0.05	铬六价	0.5
烷基汞	不得检出	总砷	0.5
		总铅	1.0
总镉	0.1	总镍	1.0
总铬	1.5	苯并芘	0.00003



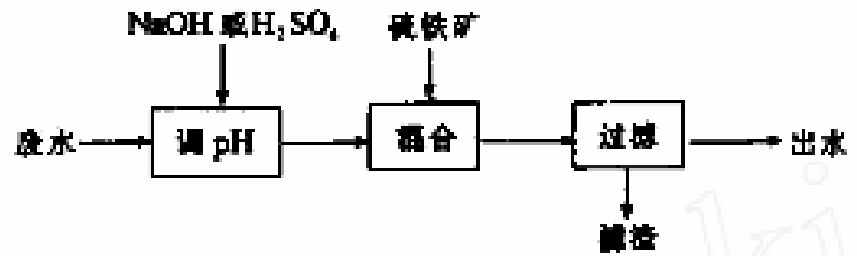


硫铁矿处理含汞废水试验流程图

1. Mercury salt wastewater treatment

Make waste liquid pH 8 ~ 10, generate sulfide precipitation, add ferrous sulfate, and produce iron sulfides precipitation to absorb suspension of sulfide mercury particles & form co-precipitation. Get rid of clear liquid, to calcinate residue for recycling mercury, then make mercury salt.





黄铁矿处理含汞废水试验流程图

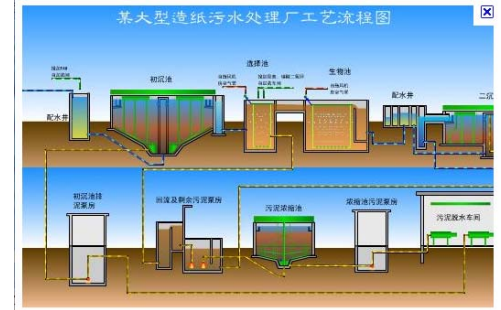
1. 含汞盐废液的处理

将废液调至pH 8~10，加入过量的硫化钠，使其生成硫化汞沉淀，再加入共沉淀剂硫酸亚铁，生成的硫化铁吸附溶液中悬浮的硫化汞微粒而生成共沉淀。弃去清液，残渣用焙烧法回收汞，或再制成汞盐。



* 2. Arsenic wastewater treatment

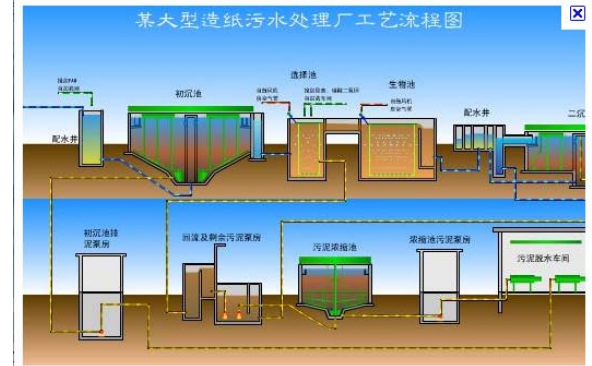
(1) Add CaO, adjust pH to 8 for generating CaAs_2O_4 & CaAsO_2 precipitates. (2) adjust $\text{pH} > 10$, form the undissolved low-toxic sulfides precipitation.



* 3. Lead, cadmium waste liquid

Add hydrated lime, pH to 8 ~ 10, to form $\text{Pb}(\text{OH})_2$ & $\text{Cd}(\text{OH})_2$ precipitation; add ferrous as co-precipitation agent.





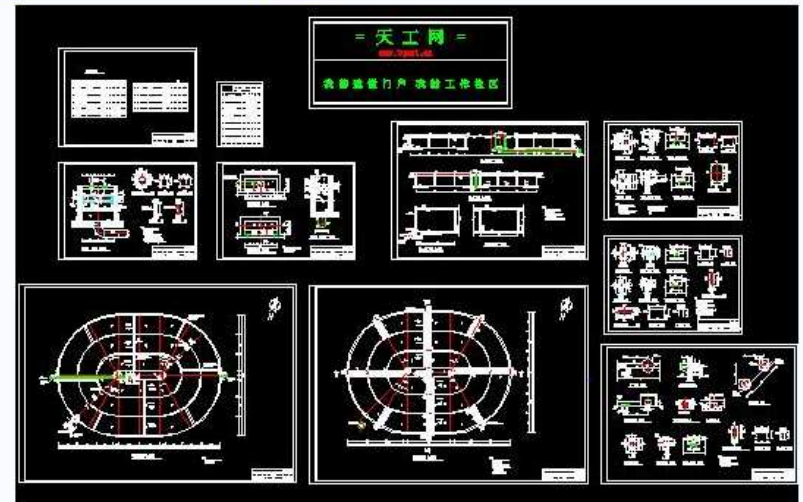
* 2. 含砷废液的处理

加入氧化钙，调节pH为8，生成砷酸钙和亚砷酸钙沉淀。或调节pH为10以上，加入硫化钠与砷反应，生成难溶低毒的硫化物沉淀。

* 3. 含铅、镉废液

用消石灰将pH调节至8~10，使 Pb^{2+} 、 Cd^{2+} 生成 $Pb(OH)_2$ 和 $Cd(OH)_2$ 沉淀，加入硫化亚铁作为共沉淀剂，使之沉淀





* 4. Cyanide wastewater

Adjust pH > 10 With NaOH , add excessive amounts of KMnO_4 (3%) , **oxidize & decompose CN^-** . For high content CN^- , add CaClO_3 and NaOH solution.

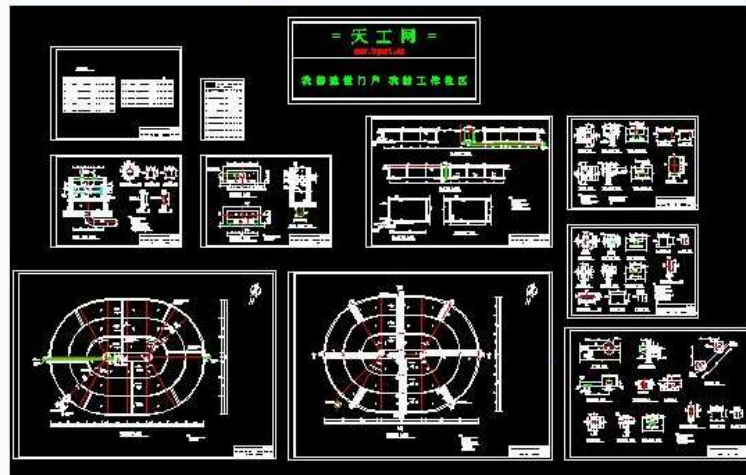
* 5. For fluoride: Add lime to form CaF precipitation.

* 6. $\text{Cr}_2\text{O}_7^{2-}$ wastewater treatment:

According to EPC role, 0.5 mg/L as the maximum permission

0.05 mg /L for some advanced country.





* 4. 含氰废液

用氢氧化钠调节pH值为10以上

加入过过量的高锰酸钾（3%）溶液，使CN— 氧化分解。

如CN—含量高，可加入过量的次氯酸钙和氢氧化钠溶液。

* 5. 含氟废液：加入石灰生成氟化钙沉淀。

* 6. 含Cr⁶⁺ 废液的处理：

我国环境保护有关规定，Cr⁶⁺最高允许排放浓度为0.5 mg·L⁻¹，而有些国家往往限制到0.05 mg·L⁻¹。



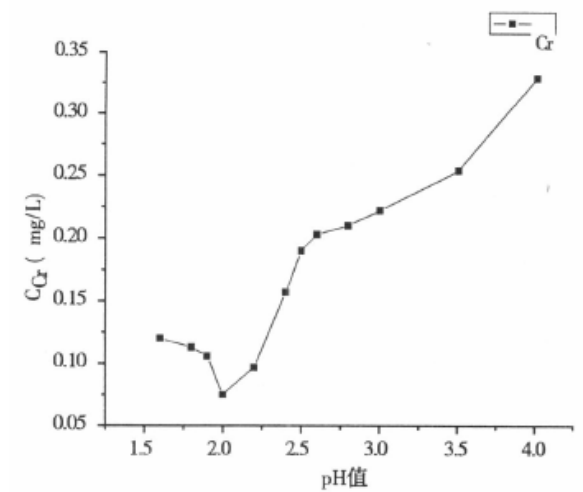
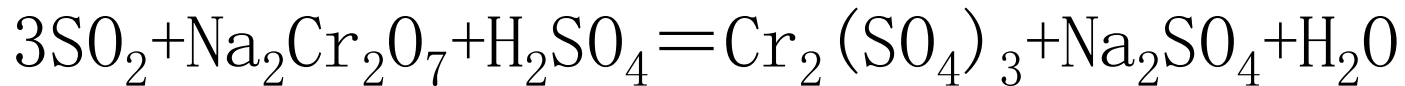


图 1 pH 值对 Cr(VI)还原反应的影响

Chemical reduction for $\text{Cr}_2\text{O}_7^{2-}$:

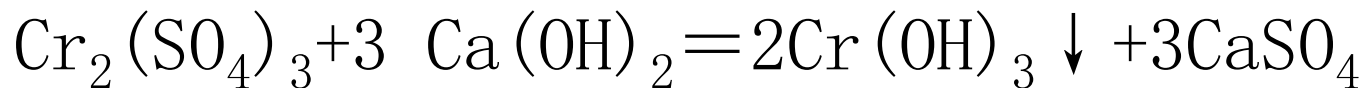
Use reductants: SO_2 , FeSO_4 , NaHSO_3 , etc.

Example:



Use lime or NaOH to treat

chromate salt & convert it into $\text{Cr}(\text{OH})_3 \downarrow$ from water for further processing.



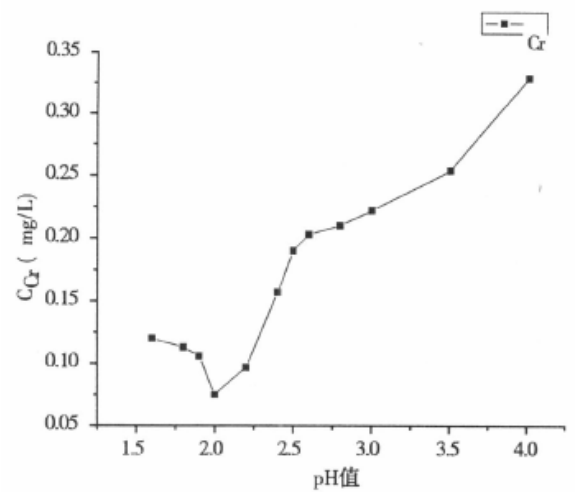
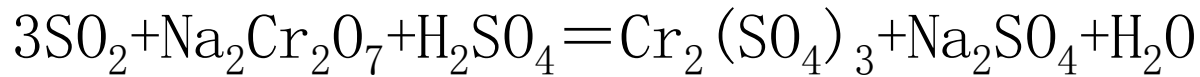
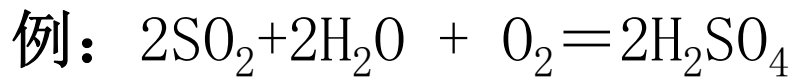
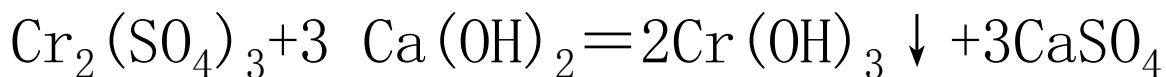


图 1 pH 值对 Cr(VI)还原反应的影响

Cr⁶⁺处理方法，一般常用化学还原法，还原剂可用SO₂等（二氧化硫、硫酸亚铁、亚硫酸氢钠等）。



铬酸盐被还原后，应使用石灰或氢氧化钠将铬酸盐转化成氢氧化铬从水中沉淀下来再另作处理。



1.5.6 chemistry lab safety

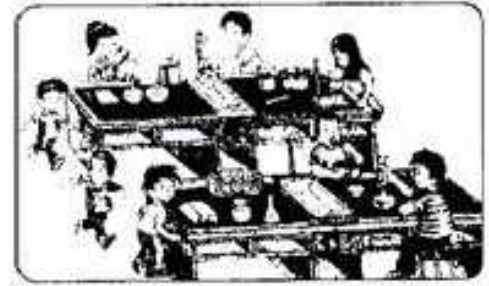
Because there are chemical reagents, inflammable and explosive gas, organic solvents in chem lab, lab safety is great important . For all staffs & students in lab, safety education must be carried out.



1.5.6 化学实验室的安全防范

因为化学实验室一般都存放有化学试剂、易燃易爆的气体、有机溶剂等，因此，必须十分重视实验室的安全防范工作。对所有在实验室工作的人员和上实验课的学生，都必须进行安全教育。

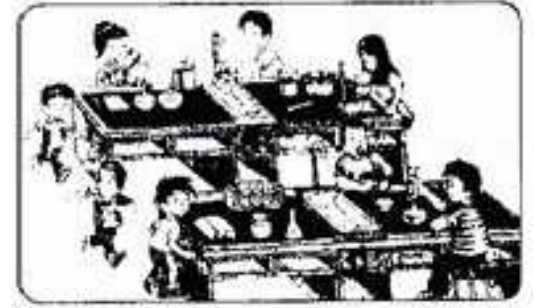




Every one should know how to work and study safely in lab, should know how to take emergency measure in accident.

To sum up, the lab security is most important ! All people must abide by the rules of lab, which make a safe environment for **better work**, study and for your **life security** !





每位人员都应知道如何安全地进行工作和学习，更应该知道当事故发生时，应如何面对和采取怎样的应急措施。

综上所述，实验室的安全十分重要，所有人员必须遵守实验室的规则，使大家都有一个安全的生存，工作和学习环境。



感谢 指 导！



Thank you for your direction !

向华南理工大学 蔡明招 等各位 致谢。

Special thanks to Mr. Cai Ming zhao, etc. SCUT.

