

Working with Aqua Regia Guideline

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Responsible Executive: Director, Health, Safety & Environment

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جامعة الملك عبد الله
للعلوم والتقنية
King Abdullah University of
Science and Technology



1 Introduction

This document is an addendum to “HSE-RST-Chem001G_working with Corrosives” and is offered to provide a short and concise overview of a widely used and unique hazardous corrosive material. Understanding of the parent document is a crucial prerequisite in understanding basic safety fundamentals such as 1) hazard awareness, 2) engineering controls, 3) work practices, 4) PPE and 5) emergency response for working with corrosive materials.

2 Scope

The guideline applies to lab personnel, and it has been developed to assist them in the preparation of lab specific SOPs.

3 Procedure

3.1 Introduction to Aqua Regia



Ideal PPE:
Neoprene gloves

Aqua regia is prepared by slow mixing of one volume of concentrated Nitric Acid (HNO_3) with three volumes of concentrated Hydrochloric acid (HCl) to form nitrosyl chloride (NOCl), chlorine (Cl_2), and water; both chlorine and nitrosyl chloride are yellow-colored and volatile.

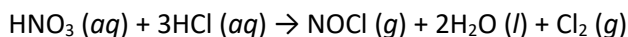
Aqua regia solutions are extremely corrosive and oxidizing and may result in explosion or skin burns if not handled with extreme caution. It causes destruction of living tissue at site of contact. Corrosive effects can occur not only on the skin and eyes, but also in the respiratory tract. They are used to dissolve metals such as gold, palladium, platinum, silver, etc. It is commonly used as a cleaning agent to remove trace amounts of organic compounds, and due to its highly corrosive nature, should be handled with extreme caution.

Do NOT use aqua regia unless it is necessary. Please consult with your PI or senior researchers before you use aqua regia for the first time.

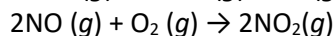
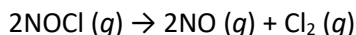
It is a corrosive and oxidizing fuming liquid therefore not only will one need to follow the basic precautions of working with corrosive materials but one will need to follow basic guidelines of working with oxidizers as well.

For best results mix the nitric acid into the hydrochloric acid mixture. Because Aqua Regia is a very powerful oxidizer, never let Aqua Regia come into contact with organic materials. See past Aqua Regia incident here:

https://hse.kaust.edu.sa/docs/default-source/research-safety/lfp-safety-bulletins/waste_bottle_explosion.pdf?sfvrsn=e8914db4_2



Over time generated nitrosyl chloride (NOCl) further decomposes producing chlorine gas and nitric oxide (NO) which auto-oxidizes to nitrogen dioxide (NO₂), a poisonous reddish-brown gas.



Be aware that fresh mixtures of aqua regia evolve oxidizing and toxic gases (chlorine, nitric oxide, nitrogen dioxide), therefore making aqua regia should only be done under good exhaust ventilation (i.e. chemical fume hood). Additionally this evolved gas can cause explosions if containers of aqua regia are capped. Therefore containers should be loosely capped. Ideally Aqua Regia solutions should be made fresh (for best results), then used and destroyed/quenched/neutralized shortly after use. Batches should also be created in the smallest size needed; avoid making large batches. If quenching or neutralizing Aqua Regia, pour it into a large volume of ice and then start the neutralization process with an appropriate base such as sodium or potassium hydroxide.



Key take away points for Aqua Regia (in addition to the already stated for Corrosive Materials)

- Ensure that a Standard Operating Procedure is available.
- Review safety data sheets prior to use.
- Identify the location of the nearest eyewash and shower and verify that they are accessible.
- Locate and verify that appropriate corrosive spill cleanup materials are available. Never clean up spills of Aqua Regia with spill pads or paper towels. Neutralize it first.
- Prepare only the minimum amount necessary.
- Never mix Aqua Regia with organic materials: perform all work in a secondary container that is clean and free of organic matter.
- Be aware of the oxidizing and toxic gases (chlorine, nitric oxide, nitrogen dioxide) evolved from Aqua Regia.
- Never store mixtures of Aqua Regia, it can build up pressure! Make it fresh and in small batches for immediate usage. Once done using, neutralize/quench it.
- Never submit Aqua Regia for disposal as closing the container can cause pressure issues from the evolved gases.

3.2 During work

- Avoid inhalation. Perform all operations in a chemical fume hood.
- All handling of aqua regia must be done with glassware inside a fume hood.
- Avoid contact. Wear appropriate PPE including, lab coat, closed toed shoes, double gloves or acid resistant gloves and safety glasses.
- When handling large amounts (>500mL), or when splashing is more likely, in addition to working in a fume hood, wear acid resistant gloves, acid-resistant apron, and face shield.
- Wash hands thoroughly each time gloves are removed.
- Use materials and containers appropriate for aqua regia (e.g. glass) and remain aware of potential incompatibilities.
- Always use glass (preferably Pyrex) containers. It is also very likely to become hot - more than 100°C. Handle with care.
- Aqua regia will melt some plastics and corrode most metals.
- Never put aqua regia in a closed vessel; evolved gases will cause a pressure build-up and possible over pressurization of your container.

3.3 After completing work

- Used aqua regia should be allowed to cool and cease gas generation, and then should be handled as hazardous waste.
- To quench aqua regia, pour onto ice and carefully neutralize the solution by adding small portions of sodium or potassium carbonate with stirring. When the solution no longer foams upon addition of carbonate, it can be disposed.
- Dispose of aqua regia waste following hazardous waste procedures.
- Use glass bottles, ensure that the waste container you are using is clean, dry, and does not have residual solvent or other organic materials in it.
- Aqua regia should be the sole waste constituent in the waste bottle.

3.4 Emergency procedures

3.4.1 Skin contact

- Flush skin with tepid water for 15 minutes using the closest available sink, portable drench hose or safety shower. Remove any exposed clothing as well as any jewelry that may be trapping aqua regia.
- Call **911** on a landline phone for medical assistance or **012-808-0911** from a mobile phone.

3.4.2 Eye contact

- Using eyewash, flush eyes while holding eyelid open and away from exposed eye.
- Call **911** on a landline phone for medical assistance or **012-808-0911** from a mobile phone.
- Continue flushing with water until emergency medical personnel arrive.

3.4.3 Inhalation

- If aqua regia mist or vapors are inhaled, immediately move to get fresh air.
- Call **911** on a landline phone for medical assistance or **012-808-0911** from a mobile phone.

3.4.4 Ingestion

- Do not induce vomiting.
- Call **911** on a landline phone for medical assistance or **012-808-0911** from a mobile phone.

3.5 Spill Response

- Alert others and evacuate to a safe distance
- Prevent entry to the laboratory.
- If trained and confident, wearing PPE apply acid neutralizer.
- Collect residue, place in container, label and dispose of as hazardous waste.
- Otherwise close fume hood and await support by calling **911** on a landline for assistance or **012-808- 0911** from a mobile phone

4 References

- OSHA 3404-11R (2011) – Laboratory Safety Guidance
- [KAUST Laboratory Safety Manual](#)
- HSE-RST-Chem001M – Chemical Safety Program

5 Help

Questions about this guideline? Contact: hse@kaust.edu.sa