UNIVERSITY OF VICTORIA
Occupational Health, Safety and Environment

Chemical Safety – Special Hazards

Safe Work Procedure (SWP – 003)

Aqua Regia

Last revised: ***January 28, 2022***

REVISION HISTORY

	Revision Date	*Author*	*Position*
1.	May 13, 2021	Vivian Lagaditis	OHSE consultant
2.	January 28, 2022	Paraskevi Lagaditis	OHSE consultant

DOCUMENT APPROVAL

Approved by: Laboratory Safety Committee

Jody Spence _____ *February 4, 2022*
Chair, Laboratory Safety Committee *Date Approved*

**This revision replaces all previous versions of this document. If a copy is printed, it is the users' responsibility to verify the copy is the most current version of the document.*

University of Victoria

PURPOSE

To provide guidance and instruction of the safe preparation and use of Aqua Regia in laboratories. In addition to this general Safe Work Procedure (SWP), each lab must develop a lab-specific work procedure unique to the experiments and activities being performed. The Lab SWP must be reviewed by OHSE (see Procedures, #7)

SCOPE

The SWP applies to preparation, handling, storage and disposal of Aqua Regia solution (also known as Royal Water), being both a strong acid and oxidizer. It a mixture of concentrated hydrochloric acid (HCl) with nitric acid (HNO_3) in a 3:1 ratio by volume, respectively. The acid combination reacts and produces gases most of which are harmful, such as nitric oxide and chlorine gas.

TRAINING

The following training is required to be completed prior to being permitted to prepare and work with Aqua Regia:

- WHMIS
- Lab Safety for Lab Workers
- Lab SWP with documented signoff by the individual and their supervisor.

Refresher training in the General and Lab SWP must be provided when:

- there has been an extended timeframe of inactivity, or
- there has been an incident or injury, or
- 2 years has elapsed since the original training

REGULATION AND POLICY

The University of Victoria will follow WorkSafeBC Occupational Health and Safety Regulation, specifically sections 30.20 (1-4) and the University of Victoria Occupational Health, Safety & Environment Department.

RESPONSIBILITY

It is the responsibility of personnel undertaking activities with special hazards to complete all required training and adhere to these safe work procedures, including any additional lab or job-specific procedures.

It is the PI's or supervisor's responsibility to ensure that individuals working with special hazards have been trained prior to commencing work and have demonstrated competency in safely performing all duties associated with the special hazard in accordance with these procedures.

DEFINITIONS

Circumvent® caps: A vented cap liner to relieve pressure in containers while maintaining integrity against liquid leaks/spills

MATERIALS

Acid waste container dedicated to concentrated acid waste equipped with a venting cap (such as Circumvent® caps which are available at Science Stores). For overnight use of Aqua Regia (e.g. soaking glassware), use Pyrex or glass container and label "Aqua Regia (hydrochloric acid & nitric acid) Extremely Corrosive"

Spill X-A or sodium bicarbonate ($NaHCO_3$) are commonly used acid neutralizers. When sodium bicarbonate is used to neutralize acids, carbon dioxide gas is released which is a non-toxic, non-flammable gas. Spill X-A is a proprietary product comprised of mainly (60-100%) magnesium oxide (MgO) blended with other chemical additives. Spill X-A has a reddish colour and minimal gas release is produced.

HAZARD

Aqua Regia is a fuming corrosive liquid that is red when freshly prepared but turns yellow upon time. It is commonly used as a cleaning agent to remove trace amounts of organic or metal compounds. Both liquid and vapour produced are corrosive to skin and respiratory tract. Aqua Regia can become hot, more than 100 °C. Explosion can occur when gas generated from Aqua Regia pressurizes closed containers or when Aqua Regia is in contact with organic compounds. Before you work with Aqua Regia, you should consider less hazardous alternatives to achieve the desired goal.

PROCEDURE

1. Handling

a. Ensure the area where Aqua Regia is prepared has an adequate amount of an acid-neutralizing spill kit (Spill X-A, sodium bicarbonate or equivalent) and is immediately accessible to neutralize accidental spills.
b. Prepare and use the minimum amount of Aqua Regia for the task in a fume hood. It is recommended to not exceed 500 mL.
c. Don PPE (safety glasses, lab coat and gloves).
d. If handling large amounts (>500mL) or when splashing is a potential, wear acid resistant gloves with extended cuffs, acid-resistant apron, and face shield.
e. Keep all organics and strong bases away from the area when preparing Aqua Regia.
f. Keep plastic and metals (e.g. spatulas) away from Aqua Regia.
g. Ensure glassware are rinsed with acetone then with water before coming into contact with Aqua Regia.
h. Add nitric acid to hydrochloric acid, never vice versa.
i. Prepared Aqua Regia may heat to hot temperatures. Heat insulated gloves may be necessary; allow Aqua Regia to cool before using.
j. Do not mix Aqua Regia with incompatible materials, meaning materials that react, such as organic acids, bases and organic solvents.
k. Do not seal containers containing Aqua Regia because toxic gases (i.e. nitrosyl chloride, nitrogen dioxide and chlorine) will pressurize the container; use venting caps (such as Circumvent® caps)

2. Storage

a. Do not store Aqua Regia; it quickly loses its effectiveness due to oxidation of its reactive components.

3. Spills

a. Follow OHSE's general spill response instructions
b. Do not attempt to clean up any spill if not trained. Seek assistance or call Campus Security (250-721-7599)
c. Specific steps for small Aqua Regia spills:
    i. Don personal protective equipment neoprene gloves, safety glasses, lab coat and closed toe shoes.

ii. Slowly neutralize using an acid spill kit (Spill X-A, sodium bicarbonate, or equivalent) from outside of the spill inward.
iii. Wait for 15 minutes
iv. Test with pH paper until the spilled material is within the neutral range of pH 6-8.
v. Scoop the absorbed neutralized material into an appropriately sized plastic (polyethylene or polypropylene) container.
vi. Wipe up any residue with a moist paper towel or rag
vii. Soak the area with detergent, then rinse with water.
viii. Collect and label all materials used in the clean-up for disposal through the hazardous waste system indicating the material is "Neutralized Aqua Regia spill absorbent and debris"

b. Complete a *Department Incident & Hazard Report Form* to document and review the spill incident.

4. Decontamination

a. Pre-rinse containers and lab ware with water to collect any residual Aqua Regia and collect pre-rinse washing for hazardous waste disposal (strongly acidic).
   i. Completely rinse with copious amounts of water in a sink after pre-rinse.

5. First Aid and Emergencies

a. Call 911 to summon an ambulance if there is a medical emergency.
b. Call Campus Security at 250-721-7599 for first aid.
c. If material has contacted the eyes, use emergency eyewash and flush for at least 15-20 minutes.
d. For skin contact, flush affected area with running water for at least 15-20 minutes.
e. For inhalation, move immediately to fresh air; seek medical attention in the event of respiratory irritation, cough or tightness in the chest.

6. Waste Disposal

a. Transfer used or unused Aqua Regia into a dedicated user supplied container with a venting cap in a fume hood for several hours (overnight) before disposal as waste.
b. Do not mix Aqua Regia waste with other waste.
c. If neutralizing Aqua Regia as neutral waste disposal, use a weak base (such as sodium bicarbonate).
   i. In a fume hood, dilute Aqua Regia by pouring into a beaker with water (use an ice bath or ice water)
   ii. Slowly add sodium bicarbonate while mixing and allow gas release to cease
   iii. Test the pH and repeat addition of sodium bicarbonate until solution is no longer acidic and there is an excess of sodium bicarbonate.
   iv. Allow the solution to sit for a prolonged time until gas release has overall ceased
   v. Collect the neutralized solution in a separate hazardous waste bottle since it will be contaminated with the metals; ensure bottle is no more than 75% full
   vi. Do not pour neutralized Aqua Regia down the sink.
   vii. Neutralized Aqua Regia must be return into a dedicated user supplied bottle. Do not pour neutralized Aqua Regia into the aqueous neutral waste container provided by OHSE.

d. Label container carefully
    i. If Aqua Regia is not neutralized label bottle with: “Caution Aqua Regia (hydrochloric acid & nitric acid). May explode in sealed container”
    ii. If Aqua Regia is neutralized label bottle with: “Neutralized Aqua Regia”
e. Do not use an airtight container for Aqua Regia waste. Store waste solutions in a glass bottle with a vented cap (such as Circumvent® caps) which can be obtained from Science Stores.
f. Affix a green hazardous waste sticker on the bottle.
g. Submit online request for hazardous waste pick-up from OHSE.
    i. Note of any heavy metals present in the waste for proper disposal stream by OHSE

7. Lab SWP

In additional to this general SWP, each lab that is using Aqua Regia requires a Lab SWP that includes specific procedures for:

a. Amount permitted to be prepare.
b. Personal protective equipment to wear.
c. How to decontaminate any surfaces or reusable lab ware
d. Spill containment and response.
e. Disposal procedure.
f. Emergency first aid response.

REFERENCES

1. WorkSafeBC *OHS Regulations Part 30.20 Explosive and highly reactive materials.* Retrieved from https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-30-laboratories
2. Yale University EH&S. *Standard operating procedure Aqua Regia*. Retrieved from https://ehs.yale.edu/sites/default/files/files/aqua-regia-sop.pdf
3. Harvard University EH&S. *Laboratory safety guideline Aqua Regia.* Retrieved from https://www.ehs.harvard.edu/sites/ehs.harvard.edu/files/lab_safety_guideline_aqua_regia.pdf.
4. Spill –X-A Acid Neutralizing/Solidifying Spill Treatment Agent Data/Specifications. Retrieved from: https://www.steelfire.com/UserFiles/Docs/ANS_AN76255_specsheet.pdf