

## Standard Operating Procedure

**Task:** Aqua Regia

**Date:** 5/15/14

**Revision Date:** 02/14/2019

### Background:

- Aqua regia is a strongly acidic solution formed from three parts hydrochloric acid and one part nitric acid. The orange, fuming solution inherited its namesake for its ability to dissolve metals, such as gold. It easily oxidizes organics and metals, and is used for removing metal and other residues from glassware.
- The hydrochloric and nitric acids engage in several equilibria:
$$\text{HNO}_{3(aq)} + 3\text{HCl}_{(aq)} \rightleftharpoons \text{NOCl}_{(g)} + 2\text{H}_2\text{O}_{(l)} + \text{Cl}_{2(g)}$$
$$2\text{NOCl}_{(g)} \rightleftharpoons 2\text{NO}_{(g)} + \text{Cl}_{2(g)}$$
$$2\text{NO}_{(g)} + \text{O}_{2(g)} \rightleftharpoons 2\text{NO}_{2(g)}$$
- These equilibria are responsible for the color and strongly oxidizing nature of aqua regia.

### Training Requirements:

- Lab safety training required before using any chemicals.

### Potential Hazards:

- Storage warning: only the minimum amount of aqua regia required should be prepared; do not store aqua regia for more than 24 hours, as it will evolve corrosive gases and lose its effectiveness.
- Corrosive and toxic liquids and gases: aqua regia is composed of strong acids that can lead to acid burns on skin or mucus membrane contact. The nitrogen oxides and chlorine gases that are continuously released from aqua regia are toxic and can corrode metallic surfaces.
- Aqua regia can dissolve some plastics—only use glass when handling aqua regia.
- Explosion hazard: Aqua regia violently reacts with organic chemicals and may cause an explosion. All glassware and frits should be thoroughly rinsed with water before cleaning with aqua regia. After treatment with aqua regia, all glassware should be thoroughly rinsed with water again.
- Explosion hazard: nitrogen oxides and chlorine gases are released continuously from aqua regia, which can lead to pressure buildup in a closed system. Never tightly cover aqua regia.

### Materials Needed:

- Hydrochloric Acid
- Nitric Acid
- A clean, glass secondary container or tray

**Procedure:***Preparation*

1. Aqua regia composition: 3 parts hydrochloric acid to 1 part nitric acid, by volume.
2. Only prepare aqua regia in a fume hood. Remove all organic solvents from the vicinity of aqua regia preparation.
3. Carefully and slowly pour the desired amount of hydrochloric acid into a glass beaker or flask.
4. Carefully and slowly add the nitric acid to the hydrochloric acid.
5. For best results, wait a few minutes before use. The colorless solution will deepen to red-orange and bubbles will form.

*Cleaning*

1. Always keep your glassware in a secondary container when cleaning with aqua regia. The bubbles formed in aqua regia often lead to acid spilling over the sides of glassware.
2. Soak frits or other glassware in the aqua regia as needed. A convenient way to clean frits involves placing the frit "upside down" so that the drain spout is sticking up. Aqua regia can be added to the bottom side of the frit until it almost fills the spout. Gravity will draw the aqua regia through the frit.
3. Clearly label the fumehood with a sign noting the presence of glassware soaking in aqua-regia.

*Cleanup and Disposal*

1. Rinse glassware and holding container thoroughly with water.
2. Collect rinses in a clean glass beaker or flask.
3. Dilute aqua regia 3-5 times its volume with water and use a separate aqua regia-only waste stream.

**Common Applications:**

1. Often used to clean cuvettes, NMR tubes, and frits
2. Do not use aqua-regia on non-glass material (steel, plastic, etc.)

**Related SOPs:**

- Cleaning Glassware
- Aqua regia videos: <https://www.ipmi.org/videos/index.cfm?page=4>