

Standard Operating Procedure for Coating and Extracting Annular Denuders with Sodium Carbonate

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Contents

Section	Page
1.0 Purpose and Applicability.....	3
2.0 Safety Precautions.....	3
3.0 Equipment and Materials	3
4.0 Preparation of Sodium Carbonate Solution	4
5.0 Coating of IMPROVE Annular Denuders	4
6.0 Extraction of IMPROVE Annular Denuders	4
7.0 Coating of URG Annular Denuders.....	5
8.0 Extraction of URG Annular Denuders.....	6

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1.0 Purpose and Applicability

This document outlines the general procedures for coating and extracting annular denuders with sodium carbonate for the collection and quantitation of gas phase acidic species in the ambient air. This standard operating procedure (SOP) is applicable for coating and extracting aluminum annular denuders used with the IMPROVE sampler. Procedures are also outlined for coating and extracting the glass annular denuders used with other PM_{2.5} speciation samplers, such as the URG MASS 400 sampler.

2.0 Safety Precautions

- 2.1 Always wear clean, dry neoprene gloves when handling any component involved in these procedures.
- 2.2 Always wear protective eyewear when conducting laboratory procedures specified in this SOP.
- 2.3 Read, understand, and follow the Material Safety Data Sheets (MSDS) for all chemicals involved in this procedure.
- 2.3 Always keep open chemical containers in properly operating fume hoods and wear adequate protective clothing according to the MSDS sheets for that chemical.
- 2.5 Always label secondary containers used in this procedure.
- 2.6 Disposal of waste materials should be in accordance with the appropriate MSDS.

3.0 Equipment and Materials

- 3.1 Chem Master neoprene gloves, medium (VWR Brand Catalog Number 32892-058)
- 3.2 Sodium carbonate, reagent grade. 500 g (VWR Brand Catalog Number EM-SX0400-1)
- 3.3 Glycerol, reagent grade. 500 mL (VWR Brand Catalog Number EM-GX0185-5)
- 3.4 Methanol, reagent grade. 4 L (VWR Brand Catalog Number VW4300-3)
- 3.5 1,000 mL volumetric flask, Pyrex Class A (VWR Brand Catalog Number 29610-182)
- 3.6 PVC pipe, 1 1/4" x 28" (required for IMPROVE denuders only)
- 3.7 1,000 mL polyethylene storage bottles (VWR Brand Catalog Number 16155-050)
- 3.8 Distilled laboratory-grade water
- 3.9 Source of nitrogen gas or clean air

- 3.10 Storage bottles, high-density polyethylene, 60 mL capacity (VWR Brand Catalog Number 16058-043 [required for IMPROVE denuders only])
- 3.11 Storage bottles, high-density polyethylene, 30 mL capacity (VWR Brand Catalog Number 16058-021 [required for URG denuders only])
- 3.12 Graduated cylinder, 50 mL capacity (VWR Brand Catalog Number 24711-295).

4.0 Preparation of Sodium Carbonate Solution

- 4.1 Place 500 mL of deionized water in a pre-labeled, 1,000 mL volumetric flask.
- 4.2 Add 10 g of sodium carbonate and 10 g of glycerol to the flask. Mix thoroughly.
- 4.3 Add methanol to the flask until the total volume reaches 1,000 mL. Mix thoroughly.
- 4.4 Transfer the prepared coating solution to a pre-labeled, 1,000 mL polyethylene storage bottle.

5.0 Coating of IMPROVE Annular Denuders

- 5.1 Cap one end of the PVC pipe with a rubber stopper.
- 5.2 While holding the PVC pipe in the horizontal position, carefully slide a clean annular denuder into the PVC pipe.
- 5.3 While holding the PVC pipe in the vertical position, pour the coating solution into the pipe until the denuder is totally immersed.
- 5.4 After approximately 5 minutes, drain and discard the excess coating solution from the PVC pipe.
- 5.5 Remove the denuder from the PVC pipe. Shake the denuder to remove excess solution droplets and to facilitate its subsequent drying.
- 5.6 To dry the coated denuder, connect it to a URG glass drying manifold or equivalent apparatus. Plug any unused ports of the manifold and turn the connecting valve clockwise to activate the source of nitrogen gas. Following a 1-hour drying time, turn off the nitrogen source and remove the denuder from the drying column. Wrap the dry, coated denuder in aluminum foil and label the foil with the proper field sampling code.

Note: If a source of nitrogen is not readily available, clean air may be used to facilitate drying of the coated denuders. Alternatively, the denuders may be allowed to dry in an available laboratory fume hood.

6.0 Extraction of IMPROVE Annular Denuders

- 6.1 Cap one end of the PVC pipe with a rubber stopper.
- 6.2 While holding the PVC pipe in the horizontal position, carefully slide a clean annular denuder into the PVC pipe.

- 6.3 Add 50 mL of deionized water to the denuder, cap the other end, and then repeatedly invert the denuder (approximately 20 times) to ensure that all internal surfaces are thoroughly rinsed.
- 6.4 Uncap one end of the denuder, and empty the solution into a pre-labeled, 60 mL capacity bottle.
- 6.5 Store the bottled extract at temperatures below 5°C until the time of the solution's subsequent analysis by ion chromatography.
- 6.6 If the denuder is required for additional field use, repeat the coating procedure outlined in Section 5.0 of this SOP.

7.0 Coating of URG or Similar Annular Denuders

- 7.1 Cap one end of the URG denuder with a plastic CaPlug® or similar cap.
- 7.2 Add 20 mL of deionized water to the denuder. Cap the other end, and then repeatedly invert the denuder (approximately 20 times) to ensure that all internal surfaces are thoroughly rinsed.
- 7.3 Uncap the denuder then empty and discard the excess solution. This rinsing procedure may be repeated once.
- 7.4 Pour 20 mL of the previously prepared sodium carbonate coating solution (see Section 4.0 of this SOP) into the denuder and cap the denuder's other end.
- 7.5 Repeatedly invert the denuder (approximately 20 times) to ensure that all internal surfaces are properly coated.
- 7.6 Uncap one end of the denuder and then empty and discard the excess solution. Rotate the denuder as the solution leaves so uniformity of deposit on the interior walls is maintained.
- 7.7 To dry the coated denuder, connect the denuder to a URG glass-drying manifold or an equivalent apparatus. Plug any unused ports of the manifold and turn the connecting valve clockwise to activate the source of nitrogen gas. Following a 1-hour drying time, turn off the nitrogen source and remove the denuder from the drying column. Cap the end of the denuder and label it with its proper field sampling code.
- 7.8 If there are O-rings at either end of the denuder assembly, use a water-moistened laboratory wipe to wipe their surfaces and remove any sodium carbonate. It may be necessary to apply (with fingers) a very thin coating of silicone grease to the O-ring surface so it can be attached to a sampler with ease.

Note: If a source of nitrogen is not readily available, clean air may be used to facilitate drying of the coated denuders. Alternatively, the denuders may be allowed to dry in an available fume hood.

8.0 Extraction of URG or Similar Annular Denuders

- 8.1 Cap one end of the URG denuder.
- 8.2 Add 20 mL of deionized water to the denuder, cap the other end, and then repeatedly invert the denuder (approximately 20 times) to ensure that all internal surfaces are thoroughly rinsed.
- 8.3 Uncap one end of the denuder and empty the solution into a pre-labeled, 30-mL-capacity bottle.
- 8.4 Store the bottle at temperatures below 5°C until the time of the solution's subsequent analysis by ion chromatography.
- 8.5 If the denuder is required for additional field use, then repeat the coating procedure outlined in Section 7.0 of this SOP.