

is constructed with 2 removable sides (a) and (b), held in place by heavy clips. The two fixed sides are raised by a 0.5-mm edging so that the original record sheet can be slipped freely under the sides and aligned with its lower edge parallel to the bottom of the frame. It is held in position by the lower removable batten (b) and the frame is filled with 80 glass rods (3-mm diameter) cut so as to be ca. 1 mm longer than the frame. These are held in place by clipping on the upper batten (a) which is lined with a 1-cm thickness of foam rubber. The upper ends of the rods are securely held by being embedded in the rubber.

Method. Sheets of tracing cloth or transparent plastic are prepared for the final corrected spectra. They are cut to fit in the rectangular opening defined by the sides of the frame and the calibration lines are traced onto them before use.

The chart carrying the spectrum is now clipped in place with the rods laid over it. The zero line of the chart is marked on the rods with a spirit-based fiber-tipped pen (Staedtler "Lumocolor", Stage a, Figure 2) after which the removable sides are unclipped. A heavy glass rod cut to fit the breadth of the tray is useful for gently easing the inked zero line so that it exactly falls on the recorded spectral blank scan. The rods are then clamped in this position using the upper side (a) of the frame, (Stage b, Figure 2).

The batten (a) had to be strengthened as shown in order to provide an even pressure at the center as well as the edges of the tray.

The spectral scan required is now marked on the rods (Stage

b, Figure 2). This is made easy by the focusing effect of the round glass rods which breaks the scan into a series of almost straight sections. The spectrum is effectively divided optically into a record using ca. 80 channels. The transcription of, for instance, sharper spectra would require smaller diameter rods or the use of an expanded wavelength record.

If a composite figure is required, second and further charts are slipped under the chart originally in the frame before the latter is withdrawn from the bottom. Unless this is done it is difficult to get the new chart in place without disordering the glass rods in the tray. After aligning the new chart with the lower edge of the frame and adjusting the rods to match the zero scan as before, the new scan may be marked on the rods. Varying ink colors are used if any possibility of confusion should arise in this or subsequent scan transcriptions.

Finally, the frame is reassembled and the rods returned to their initial arrangement, (Stage c, Figure 2). This action mechanically corrects all the observations to a common true zero. The transparent tracing cloth or plastic sheet can now be dropped into the tray over the rods and the spectra copied (Stage d, Figure 2).

The ink marks on the rods readily dissolve if they are stood vertically in a tall beaker containing methyl alcohol and they require only drying before re-use.

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Modified La Mer-Generator for the Production of Small Amounts of Sulfuric Acid Aerosol

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With the growing interest in the determination of atmospheric sulfuric acid (1, 2), there is also a need for a reliable and easily operatable sulfuric acid aerosol generator. Sulfuric acid aerosol generation methods which are currently used include the atomizer-burner combination as described by Thomas et al. (3), the Berglund-Liu generator (4), the conversion of sulfur dioxide to sulfur trioxide (5), or the reaction between SO_3 and H_2O (6, 7). The above mentioned aerosol generation methods possess one or more of the following disadvantages.

(1) The emission of only particles which are chemically identical is not necessarily assured. (2) The aerosol particles might not be balanced with respect to electrical charge. (3) Stability in the low-output mode is not satisfactory. (4) Difficulties are encountered in generating H_2SO_4 droplets of less than $0.1\text{-}\mu\text{m}$ diameter. (5) Construction of these devices may be expensive.

To avoid such disadvantages, it was preferable to use a condensation type generator as described by La Mer et al. (8) or by Spurný and Hampl (9). This generation method possesses the following advantages.

(1) Only chemically identical particles are emitted. (2) A homogeneous aerosol with a narrow size range can be produced. (3) Droplets with diameters less than $0.1\text{ }\mu\text{m}$ carrying a maximum of one unit charge (10) can be generated. (4) The generator can easily be constructed and adjusted to different

Table I. Working Parameters of the Modified La Mer-Generator

boiler temp.	temp. of heating section	Q_{boiler}^a	Q_{dil}^a	surface of pool
353-373 K	421 K	80 L/h	> 40 L/h	~ 10 cm^2

^a Q = flow rate.

modes of operation with respect to output and size range.

For our investigations of artifacts in filter sampling of sulfuric acid aerosol (11) the La Mer-generator in its original construction could not be used because of its high acid output. We have modified the generator with the practical considerations of simplicity, low output, and output stability in mind. The construction details are shown in Figure 1.

A pre-thermostated nitrogen stream flows over the surface of a thermostated sulfuric acid pool of the same temperature. To obtain an aerosol with low humidity, 99% sulfuric acid is used. In addition the nitrogen is pre-dried by flowing through silica gel. A small amount of sulfuric acid vapor is swept into the nitrogen stream, breaks down to molecules in the heating section (421 K) and then has the possibility to recondense to small droplets in the following cooling section. The result is homogeneously grown particles. The emitted

Table II. Particle Diameters and Particle Concentrations as a Function of the Boiler Temperature^a

	temperature, K					
	341.2	346.2	351.5	357.2	362.1	368.6
droplet count	0.018	0.020	0.022	0.024	0.026	0.027
median diameter \bar{d}_p , μm						
geometric standard deviation σ_g	1.39	1.39	1.43	1.46	1.46	1.29
particle concentration, cm^{-3}	1.12×10^7	1.17×10^7	1.29×10^7	1.48×10^7	1.5×10^7	1.56×10^7

^a Flow conditions: Q_{boiler} 86 L/h; Q_{dil} 286 L/h (~10% relative humidity).

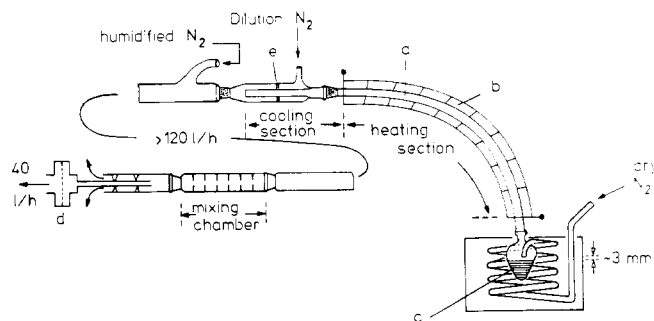


Figure 1. Modified La Mer-generator with sampling equipment. (a) Borosilicate glass tube, length ~40 cm, i.d. ~1 cm; (b) Resistance heating tape; (c) boiler with 25-mL flask and ~15 mL H_2SO_4 (approx. 99%). Surface of the pool ~10 cm^2 ; (d) filter holder; (e) glass frit

aerosol can then be diluted and humidified at a definite level.

The parameters which affect the output and the size of the acid droplets are the temperature of the sulfuric acid pool, the surface area of the acid pool, the flow rate through the boiler, and the temperature of the heating section.

The routinely used experimental conditions are listed in Table I. With these settings and a sampling flow rate of 40 L/h (37-mm diameter standard filter holder; see Figure 1), an amount of acid corresponding to about 100 ng H^+ can be collected in 10 min. An increase in the flow rate, Q_{dil} , of the dilution gas causes a decrease in particle concentration of the generated aerosol and consequently a decrease in the amount of acid collected per time unit. A warm-up time of 1.5 h is necessary before taking the first sample.

It was observed that the precision of the sulfuric acid output depends only on the flow and the temperature stability.

To investigate the stability of the aerosol generator, samples were taken repeatedly for different lengths of time. Nuclepore membrane filters (0.4- μm pore size) were used for aerosol collection. After extraction of the filters with deionized-distilled water, the extracts were analyzed by a radio-thermo-diffusion technique (12) for protons. The results are presented in Figure 2. As can be seen, the aerosol generator has good stability in the time range that was examined. The output stability was confirmed through an independent experiment employing X-ray fluorescence measurement of the sulfur content of the loaded filters.

To obtain information on the size distribution and the particle concentration of the generated aerosol, an electrical aerosol size analyzer (Thermo Systems Inc., Model 3030) was connected to the generator. Excess aerosol (6.2 L/min) from the generator was passed through a glass tank, and a fraction of it (4 L/min) was drawn in by the aerosol size analyzer from the tank. The parameters of the aerosol number distribution at different temperatures of the boiler are shown in Table II. They were obtained by fitting a log-normal distribution to the measured data taking into account the nonideal instrument response characteristic (13).

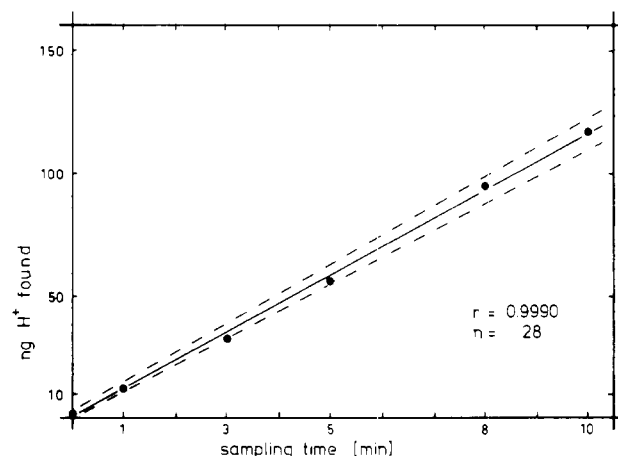


Figure 2. Amount of acid collected on a filter as a function of time. Dotted lines: Confidence limits ($p = 0.95$) of the regression line $[\text{ng H}^+] = (11.64 \pm 0.43) \times \text{min} - (0.30 \pm 2.32)$. Boiler temperature 365 K; Q_{dil} 40 L/h; sampling flow rate 40 L/h

The generator described is also well suited to produce a homogeneous submicron ammonium sulfate aerosol by mixing the H_2SO_4 aerosol with ammonia gas.

For this purpose the dilution gas is mixed with an appropriate concentration of ammonia escaping from a permeation device (14).

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