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ACOUSTIC AND TURBULENT AGGLOMERATION OF SODIUM AEROSOLS

Progress Report
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William C. Hinds

Harvard School of Public Health
Boston, Massachusetts 02115

APPROVED:

William C. Hinds, Assistant Professor of Environmental Health Engineering

Howard J. Levy, Assistant Dean for Financial Affairs

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ABSTRACT

Freshly formed and aged sodium aerosols generated by burning metallic sodium in air were decontaminated in wet cell washers of experimental design. Two wetted cells in series packed with curly glass fibers 35 μm in diameter gave removal efficiencies in excess of 90%. More efficient cell packings and a larger number of cells in series can be used to raise collection efficiency above 99%.

ANNUAL PROGRESS REPORT

Experimental Apparatus

Figure 1 is a diagram of the experimental wet cell washer being used to clean high concentration sodium aerosols. The apparatus consists of three cells of which the first two are wetted cells and the third cell is a dry cell being used as a mist eliminator. Each cell has a four inch thick fiber packing in a holding unit which is sealed at an angle (for increased filter surface area) to the scrubber frame. The wet cells each have one Spraying Systems nozzle (type 3/8 HH27W) which produces a wide angle round spray that washes aerosol deposits from the face of the filter. A wash water outlet is at the bottom of each cell. The apparatus can be used with water recirculation or as a once through unit. The mist eliminator removes entrained water droplets, permitting a dry downstream sample to be taken for analytical purposes.

The aerosol is prehumidified by two nozzles (Spraying Systems 1/4J) located sufficiently upstream of the wet cells to provide one second prehumidification time. An upstream sampling probe is located between the 3,200 ft^3 chamber where the test aerosol is generated and the prehumidification nozzles. A centrifugal blower pulls the aerosol from the chamber through the scrubber unit. A Venturi meter is used to measure gas flow and U-tube manometers to measure pressure drop across the two wet cells.

In the aerosol generation chamber, sodium is burned continuously in an electrically heated pot to produce a dense sodium aerosol for test purposes. Several two-in. diameter ports in the chamber wall provide cross ventilation to mix the aerosol before it is drawn out through a ten inch port to the scrubber unit at a rate of 320 ft^3/min. Another two-in. port is used to sample the chamber aerosol concentration.

From previous work done with wet cell washers,[1] wet cell performance is dependent upon fiber pad thickness, the type of fiber used, and the fiber's physical characteristics. In the initial tests with this wet cell washer, a Buffalo Forge Co. Dynel fiber pad (fiber diameter = 76 μm) was used as the collecting medium.

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[1] First, M.W., et al., "Performance of Wet Cell Washers for Aerosols", Ind. and Eng. Chem., Vol. 43, p. 1363, June 1951.

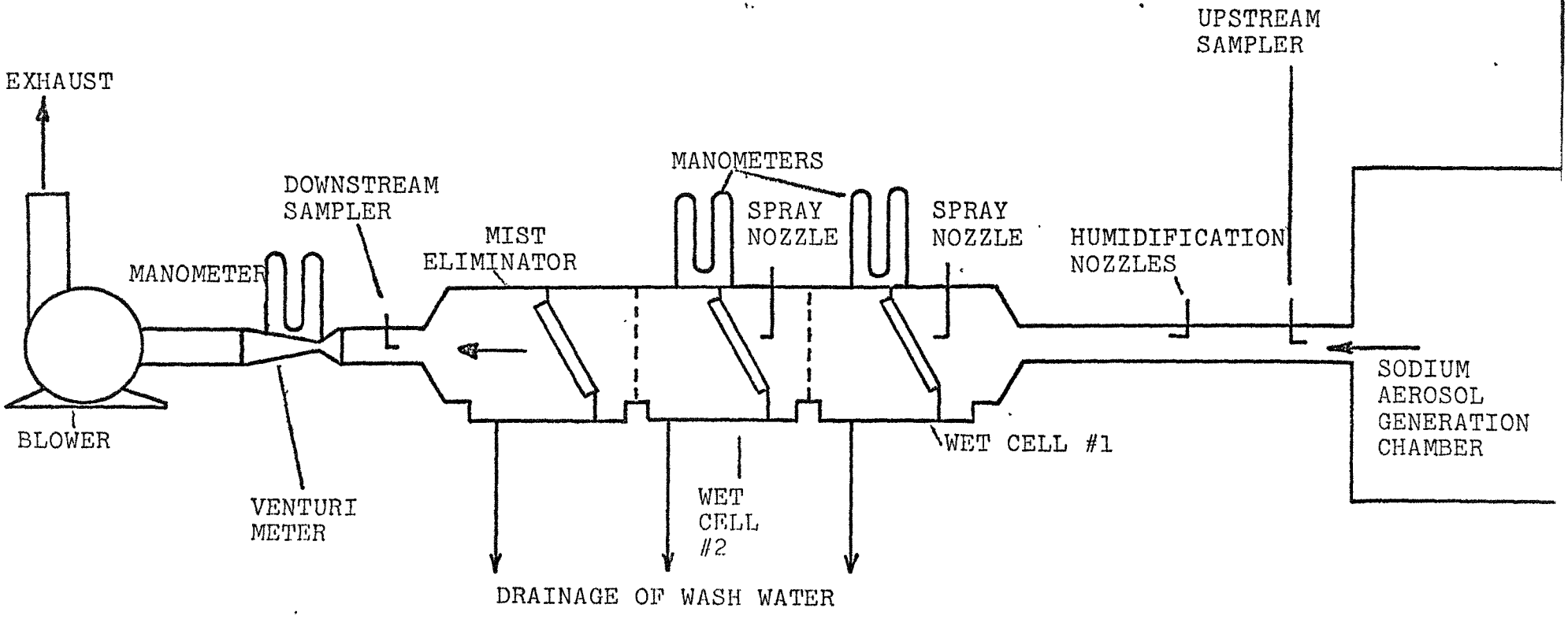


FIGURE 1. WET CELL WASHER

With a cell thickness of 4-in. this material provided efficiencies of about 80%. Another cell filling being tested is a curly glass fiber bed having the physical characteristics shown in Table 1. It gave sodium collection efficiencies in the 90% range.

To use a pool fire effectively for running several scrubber tests and to simulate a prolonged sodium fume evolution in a reactor containment vessel, constant aerosol concentrations over 1 g/m^3 are needed for an hour or more. Therefore, the sodium fire in the aerosol generation chamber was extended by adding metallic sodium to the initial pool fire at frequent intervals. The steadiest aerosol concentrations were obtained by adding approximately 28 g of metallic sodium to the top of the pool fire through a chute at one minute intervals. This produced a sodium concentration of 1.10 $g/m^3 \pm 0.15$ g/m^3 over a 64 minute period (Figure 2).

Higher aerosol concentrations were obtained by directing air onto the surface of the pool fire to enhance burning rate. This produced aerosols in the 2.0 g/m^3 range.

Simultaneous samples were collected isokinetically up- and downstream of the washer unit on all-glass absolute filter paper (MSA 1106-B) and scrubber mass efficiency determined by atomic absorption spectrophotometry.

Because this filter paper contains some leachable sodium content, a sodium blank was determined and subtracted from the samples. This had the effect of increasing efficiency of the scrubber unit 2%. Lower sodium background can be obtained by prewashing the filters.

After two scrubber runs the curly-glass fiber cells were removed from their casings for inspection. The upstream filter had noticable sodium deposits on the edges of the downstream side of the filter. In the middle of the fiber packing there were heavy deposits; this was observed by pulling back a thin layer of the filter front surface. The downstream wet cell had similar deposits but not as heavy. Water flow through the washing nozzles was increased from 2.7 gpm to 4.0 gpm but this did not entirely eliminate the problem, uneven cell packing and inadaquate nozzle coverage of the filter surface are suspected as the causes.

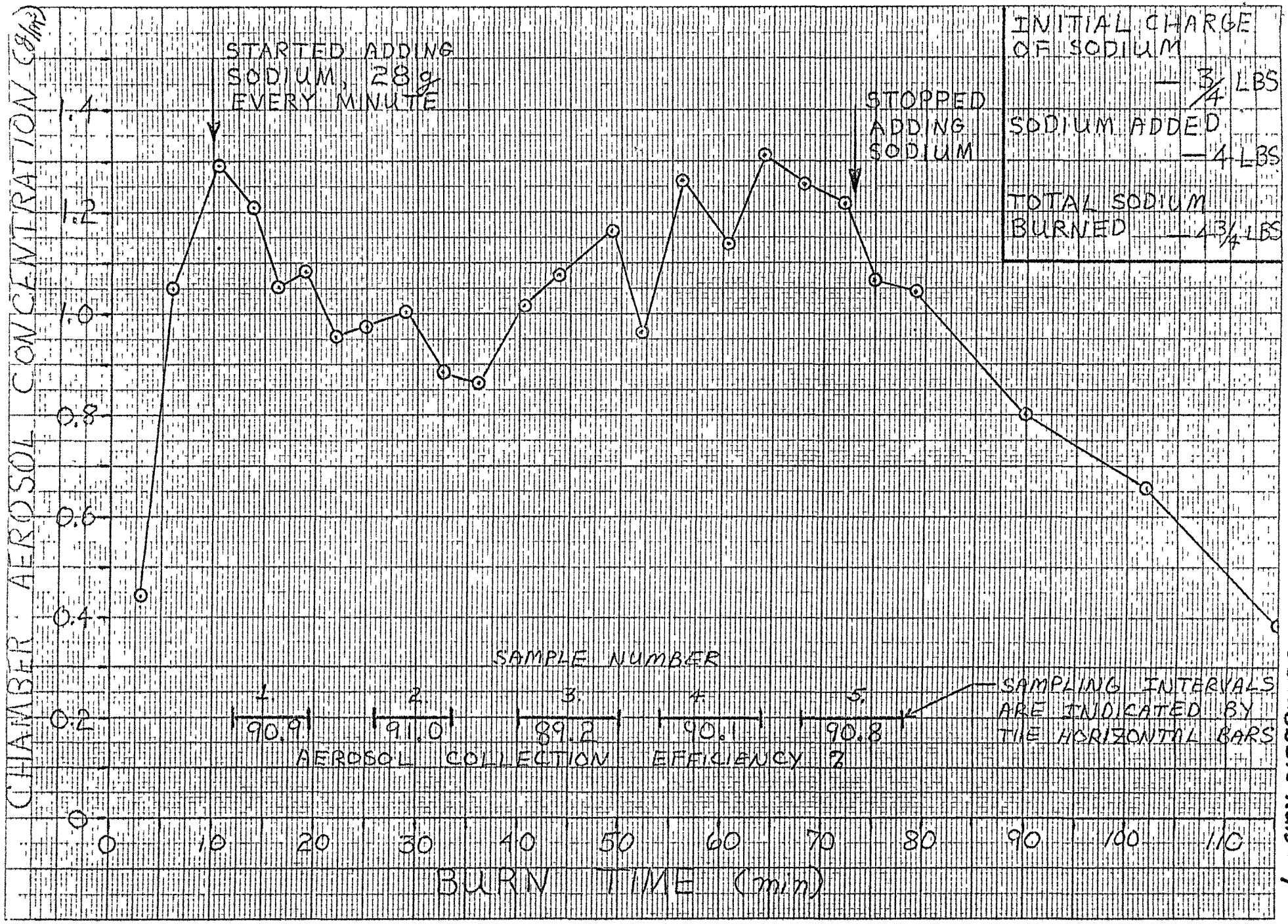
Pressure drop across the curly-glass fiber cells increased with increasing water flow and permanent increase in pressure drop was observed over the course of the tests. During scrubber run #9, cell resistance increased from 1.60 to 1.80 in. w.g. for wet cell #2 and wet cell #1 showed a higher resistance whereas clean fiber pads had a resistance of 1.25 in. w.g. for 320 $ft^3/min.$ gas flow and 25 psi nozzle pressure.

In scrubber run #8 (Table 2), tests were run with and without prehumidification. Collection efficiency was between 83.6 and 87.6% at an entering relative humidity of 54%. After prehumidification to a relative humidity 96%, efficiency rose to 89.1% and 91.6%.

TABLE 1.

Curly Glass Fiber Material

Fiber Diameter	35 microns
Cell Thickness	4 inches
Packing Density	1 lb/ft^3
Fiber Orientation	Random
Cell Size	12"x15"x4"



SCRUBBER RUN #9

TABLE 2.

Scrubber Run #8 Results

Test #	Upstream Sample Conc. g/m3	Scrubber Efficiency	
		No Prehumidification %	One Second Prehumidification %
1	0.26	83.6	--
2	0.31	86.3	--
3	0.31	87.6	--
4	0.25	--	89.1
5	0.14	--	91.6
		Average Efficiency 85.8%	Average Efficiency 90.4%