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## Abstract

Two pieces of equipment have been designed for the laboratory in which large amounts of carbon-14 are handled. One of these, a vented housing for a vacuum manifold, protects the chemist against ingestion of large amounts of radioactivity. The other, a hooded cleaning area, makes possible a safe, thorough and reproducible decontamination procedure.

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Although the health hazards due to ingestion of carbon-14 have been shown in the last several years to be far less than was first anticipated,[1-6] there is nonetheless need for great care in handling this radioactive element to avoid unnecessary ingestion and contamination. The probability of ingesting appreciable quantities of solid radioactive organic compounds, such as amino acids, fatty acid salts and drugs has not proved a serious problem in practice. Checks of the personnel of the Bio-Organic Chemistry Group, Radiation Laboratory, University of California, Berkeley, have shown no detectable carbon-14 in blood samples within the sensitivity of the assay techniques, ± 0.01 dis./min./mg. $BaCO_3$.[7,8]

The chances for ingestion are much greater in the case of the volatile organic compounds, such as lower molecular weight halides, alcohols and hydrocarbons. These compounds are usually handled in a glass vacuum system[9] and there is a fairly high probability that a system may be broken at a critical moment, or that gaseous pressure can unseat a stopcock or joint due to unforeseen reactions or wrong manipulations.

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(1) Summary of Conference on the Toxicity of Carbon-14. By A. M. Brues and D. L. Buchanan, Argonne National Laboratory, Chicago, January 15-16, 1952. Report ANL-4787 (1952).

(2) N. I. Berlin, B. M. Tolbert & J. H. Lawrence, J. Clin. Invest., 30, 73 (1951).

(3) N. I. Berlin, B. M. Tolbert & C. Lotz, J. Clin. Invest., 31, 335 (1952).

(4) G. L. Nardi, Science, 111, 362 (1950).

(5) H. E. Skipper, L. White, Jr., & C. E. Bryan, J. Biol. Chem., 180, 187 (1949).

(6) D. L. Buchanan, J. Gen. Physiol., 34, 737 (1951).

(7) B. M. Tolbert. To be published.

(8) C. D. Janney & B. T. Moyer, Rev. Sci. Instruments, 19, 667 (1948).

(9) M. Calvin, et al., "Isotopic Carbon," John Wiley & Sons, Inc., New York, New York (1949), Page 127 ff.

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To provide more adequate protection for the chemist in such cases, a movable box, large enough for a standard vacuum line[9] has been designed and is shown in Figure 1. This unit consists of a wooden box five feet wide, four feet high and two feet deep, which is mounted on a base frame and four large (five inch) casters. Three safety glass doors are hung on two tracks by small bearings. The two doors on the front track may be removed, after releasing a safety catch, by rolling the door off the end of the track. This provides easy access to the box for construction of equipment.

Outlets are provided in the side of the box for standard utilities such as gas, water, vacuum, etc. On the right hand side of the box is a small control panel containing switches for lights, fan, accessories and a stirrer motor rheostat. A master switch controls all accessories except the fan switch, which is put on a separate circuit. The mechanical vacuum pump is placed on the floor beneath the box to reduce noise and vibration, but it is vented inside the enclosed area.

The floor of the box is completely covered by a steel tray, coated with a plastic paint.[10] The tray may be removed for decontamination through the piano-hinge panel on the lower front of the box. This panel, which holds one-half inch mat of Owens-Corning Aircraft Insulating fiberglass type PF105 also acts as a filtered air inlet for the box.

In operation, the sliding doors remain closed between the operator and the glass equipment except for small slits opened for the manipulation of dewar flasks, stopcocks, etc. A fan, mounted on top of the box, exhausts filtered air through three openings in the upper back wall at a rate of 85 cu.ft./min. The air dis-

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(10) Drum lining laquer Plastic Paint 4A, Interchemical Corp., San Francisco, California. The material is a phenol-formaldehyde resin cured by baking at 375-400°F. It is very resistant to acid and organic solvents.

charge may be made into a hood duct system or outside of the building proper through a window. The filters are specially constructed units which provide four boxes, one square foot each, of PF 705 filter medium, with a low pressure drop.

Three vacuum thermocouple gauge power packs are mounted at the top front of the box in Figure 1.

This type of portable vacuum line box has proved very useful in service and is certainly recommended for any high level activities with volatile radioactive compounds of carbon ($C^{14}$), hydrogen ($H^3$( and sulfur ($S^{35}$). If the unit is extensively contaminated it may be easily removed from the laboratory for cleaning.

## Cleaning of Laboratory Glassware

High level activity carbon-14 synthesis presents a problem when carried out in the same general area as biological and chemical studies which may use only tracer amounts of activity. Cross contamination can completely mask the results of experiments in which some samples should be free from activity and can lead to erratic results in radioactivity balances. Although complete separation of glassware and work areas would be desirable, this is often not possible because of lack of space and equipment.

One of the most important causes of severe cross contamination in a carbon-14 radiochemical laboratory is incompletely cleaned glassware. Unless a hot cleaning solution is used one cannot be sure that all organic material is removed from the glassware. However, it is necessary to make sure that vapors from the cleaning pots, hot water in the sink, etc. do not offer opportunities for ingestion of volatile radioactive residues or carbon dioxide. The use of carbon tetrachloride in degreasing stopcocks is also hazardous and provision for removal of vapors should be made.

To solve these several problems, a dishwashing area has been constructed and is shown in Figure 2. The unit consists of a large lead-lined sink (36 inches by 20 inches by 10 inches deep), a stainless steel detergent bath and a silicon-bearing iron[11] cleaning solution bath, all covered by a double canopy hood with sides but no front doors. The table and splash back are covered with 1/8 inch lead sheeting, which gives good resistance to the corrosive action of the cleaning solution, and the slightly resilient surface decreases glass breakage. The upper sides of the hood area are covered with white plastic material[12] mounted on plywood.

Both the stainless steel pot and the silicon-iron pot are heated by steam jacket as shown in Figure 3. Low pressure steam is used so the maximum temperature is not more than 100°C. The stainless steel pot is soldered directly to the lead sink top so no leakage can occur. The silicon-iron pot, however, merely has a cover of lead sheeting folded over the edge. The down spout in the bottom of this sink is sealed in with acid-proof cement.[13]

The glassware drying cabinet, which is located to the right of the hood and serves as the right side partition, vents into the hood area. Two small steam radiators, placed on their side, serve as a source of warm air. This all-metal unit is painted with the plastic paint 4A.[10]

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(11) Corrosiron sink with drain plug and standard down pipe. Pacific Foundry Company, San Francisco, California.

(12) Panelyte. St. Regis Paper Company, 230 Park Avenue, New York, New York.

(13) Penchor acid-proof cement. Pennsylvania Salt Manufacturing Company, Philadelphia, Pennsylvania.

The hood system draws a total of 1150 cu./ft./min. of air across the opening of the sink (3 feet by 8-1/2 feet). This gives sufficient air velocity to allow the worker to handle noxious chemicals or to stand directly in front of the hot cleaning solution bath without hazard or discomfort.

In operation, glassware is rinsed in running water and allowed to stand in the hot sodium phosphate-detergent solution for an hour. The glassware is then rinsed again, allowed to drain, and placed in the sulfuric acid-sodium dichromate cleaning solution (approximately 80°C.) for two to three hours. The cleaning solution is freshly prepared every three to four weeks and is periodically strengthened by addition of about nine pounds 30% fuming sulfuric acid per week.

After thorough rinsing with tap and distilled water, the glassware is dried. It has been found that glass equipment used in a one hundred millicurie carbon-14 synthesis retained no activity detectable with a thin-window Geiger-Mueller tube ($\lesssim 2$ mg.cm.$^2$) after routine decontamination in this system.

The authors wish to acknowledge the extensive work on these projects and thank the members of the Health Chemistry Group, Radiation Laboratory, University of California, Berkeley.

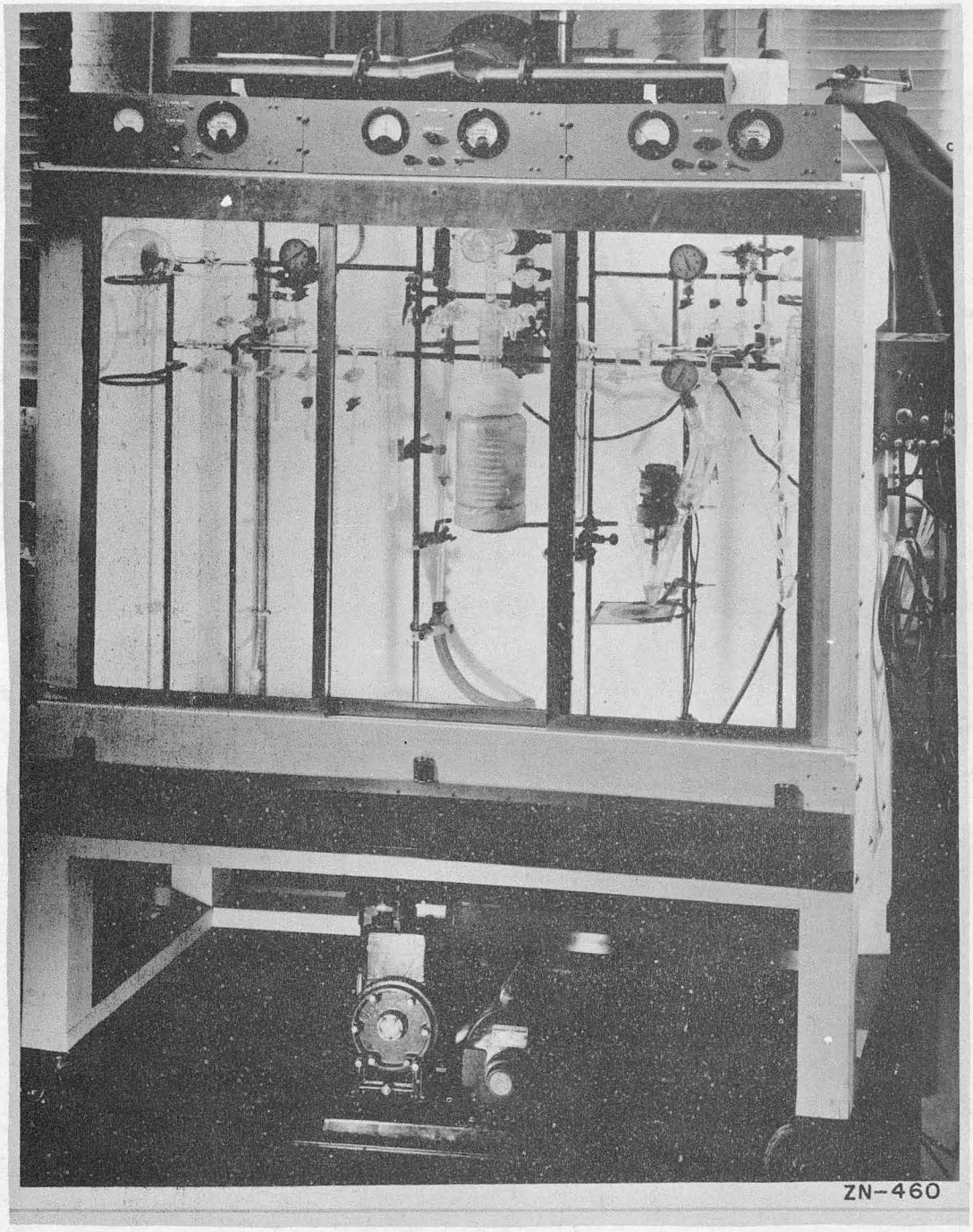



Fig. 1

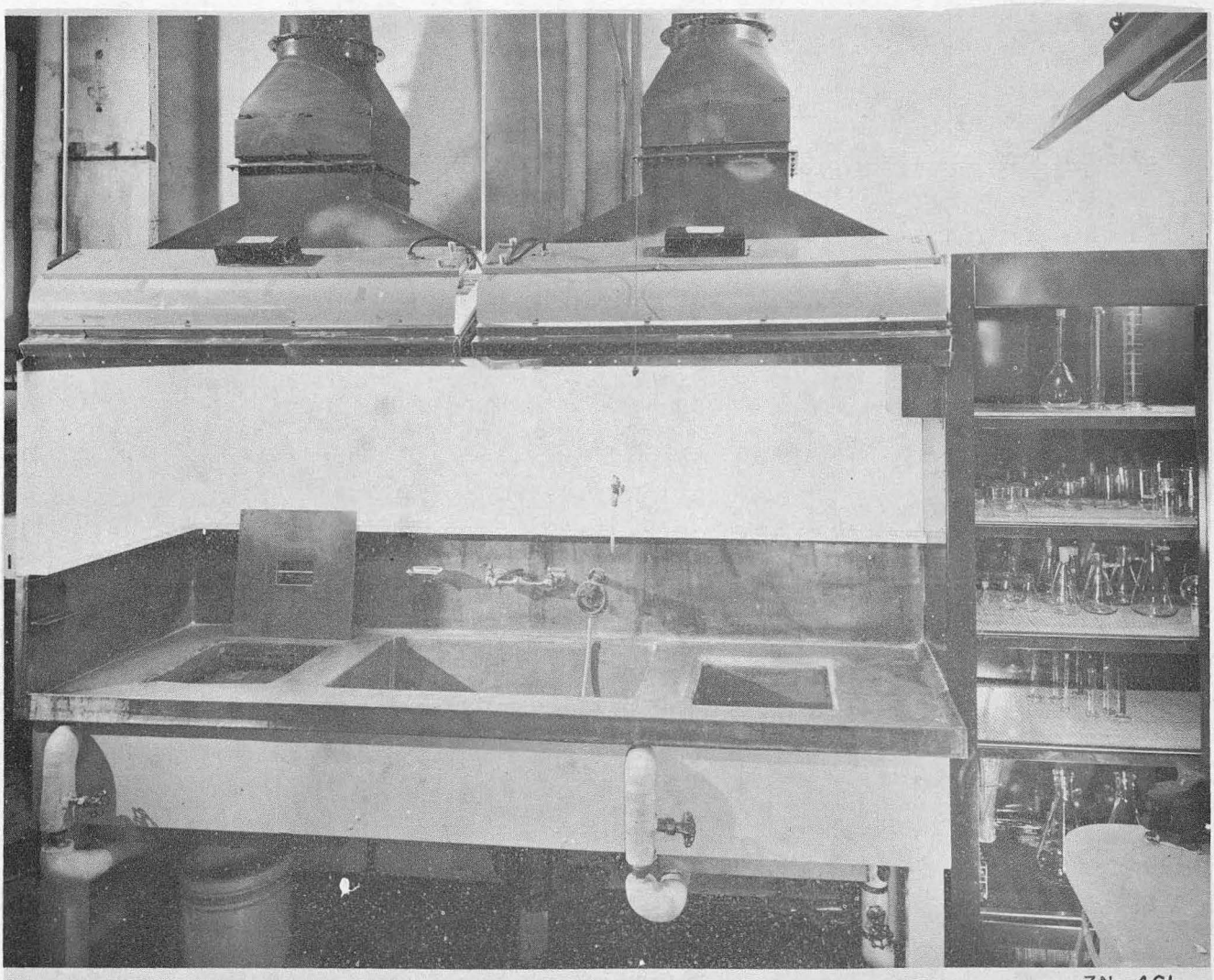
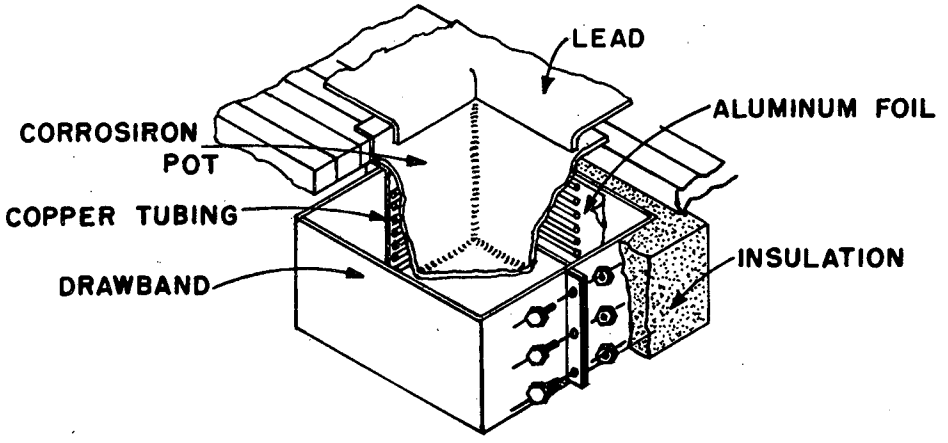



Fig.2

FIG 3

CLEANING-SOLUTION POT

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