Pressure Vessels and Materials

It is often possible to make instruments that do not need pressure-proof cases. A surprising number of commercial items, such as small photoflashbulbs, work well under pressure. Some subminiature vacuum tubes and electronic parts will stand depths of thousands of meters when they are housed in an oil-filled flexible container. Automobile and flashlight batteries operate satisfactorily at the bottom of the ocean if external insulation is provided. Smoked glass, waxed paper, or soft metal plates are water resistant and can be scribed with very light pressures.

Glass, bronze, stainless steel, aluminum, plastics, and ordinary steel have all been used successfully as pressure vessels, with the choice being dependent on weight, handling problems, availability, and cost. For the thicker instrument cases of cylindrical form, one can consider the ratio of the wall thickness to the radius of the tube to be the same as the ratio of the external pressure to the desired maximum working stress of the material. It is also possible to make pressure vessels of glass or aluminum that can go to a depth of several miles and still be light enough to be buoyant. Corrosion problems can be minimized by proper choice of materials, design clearances, and "elbow grease."

Oddly enough, oceanographers are seldom bothered more by leaks at great depth than they are at shallow depths. This is because, when designing for great depths, they usually take pains to design seals properly. Modern electronic equipment is amazingly trouble free if given reasonable care.

Conclusion

Many instrument problems, such as navigation, the collection of bottom samples, the measurement of gravity at sea, the design of unattended instruments, towed electric cables, marine meteorology, marine biology, and the study of radioactive waste disposal, are just as interesting and essential as those to which space has been devoted. Also, it has not been possible to discuss here the many oceanographic instruments in the shore laboratory that are needed to supplement seagoing work. This omission is only partly excusable on the grounds that they tend to be more like conventional instruments.

I hope that this article (*3*) gives some idea of the scope of oceanographic instruments. It should be apparent that most instrumentation should be simple, rugged, and reliable. However, for exploratory work, serious scientists use the best instruments available. In most cases, the designer has to be shipmates with his creation before it can be called an instrument. The designer and user must work as a team, because simple measurements and precise thinking usually result in a greater scientific product than precise measurements and simple thinking. Rather than dwell on the relative merits of theory versus measurement, I hope that instrument designers, experimentalists, and theoreticians will each do their work aggressively and well.

References and Notes

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Determination of Sources of Particulate Atmospheric Carbon

George D. Clayton, James R. Arnold, Frank A. Patty

The Los Angeles smog is probably the most publicized of any air pollution problem. Millions of dollars have been spent, and additional millions are presently being expended in an effort to determine the causative agent or agents that produce eye irritation, reduced visibility, rubber cracking, and plant damage. The attack on the problem by the multitude of agencies and organizations may be classified into two broad categories: (i) determination of the contaminant or contaminants causing the smog; and (ii) determination of the sources of pollution.

There is substantial evidence that an irradiated gaseous mixture of hydrocarbons and oxides of nitrogen produce the strong oxidizing property found in the Los Angeles basin air. It has been proved in experiments that a laboratory mixture having similar oxidizing properties to that found in the Los Angeles air (reported as ozone, with concentrations reported as high as 1.0 part per million) can cause rubber cracking, eye irritation, and plant damage.

The sources of contaminants have been extensively studied, and it is reported that the largest quantity of air contaminants in Los Angeles originate from combustion processes. It is estimated that approximately half of the pollution is created by auto exhausts and backyard incineration. According to calculations based on the consumption of gasoline, approximately 1000 tons of hydrocarbons, 300 tons of organic acids and aldehydes, and oxides of nitrogen and sulfur are emitted from exhaust pipes daily.

Larson (*1*) states that, on the basis of 3 pounds of rubbish per person per day, commercial and household rubbish amounts to about 6000 tons each day, with most of this material being disposed of by backyard incineration. Industrial rubbish, amounting to 3000 tons per day, is handled either by industrial incineration or by "cut and fill" operation.

Although extensive work has been done in studying the effluent of single sources of pollution, it has been understandably difficult to relate these findings to what is found in the general atmosphere.

It is well known that particulate matter in the atmosphere influences visibility. Photographs taken while backyard incineration was in progress show the effect this source has on reduced visibility in Los Angeles. The purpose of our investigation was to study the origin of the carbon constituent of atmospheric particulate matter.

There exists an unequivocal method for distinguishing between carbonaceous

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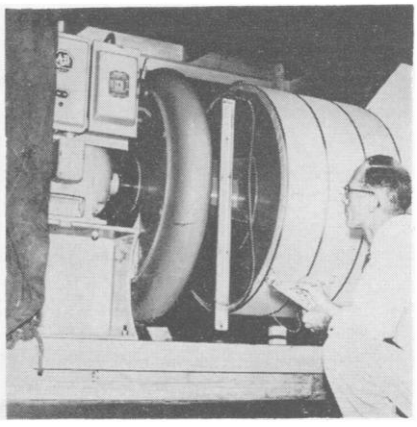

Fig. 1. Sampler.

material arising from biological sources and that from fossil fuels such as coal, oil, and natural gas. This method is based on the carbon-14 content of the living materials (*2*). It has been shown that all biological materials contain an almost exactly constant proportion of radioactive carbon-14 relative to their normal carbon. The half-life of carbon-14 (about 5600 years) insures that no activity remains in the carbon of fossil fuels. Materials of ages from 1000 to perhaps 40,000 years contain intermediate but detectable amounts of carbon-14 activity. Since the materials contaminating the atmosphere above a city are either contemporary—that is, they contain the same amount of activity as all other living materials—or inert, a measurement of the carbon-14 activity of such a sample will indicate the fraction attributable to biological sources of all kinds. These might include carbon originating from trash burning, pollen, forest fires, and other sources.

Instrument. To determine the carbon content of the particulate matter in Los Angeles atmosphere during a period of smog, a special sampler was constructed (Fig. 1). The fan is American Blower Size 6 Type F 28-inch wheel driven by a 25-horsepower, 220-volt motor. The filter cage or holder is 38 inches in diameter with a screened surface 2 feet wide and 10 feet in circumference. An inner screen was made of ½-inch mesh hardware cloth covered with 16-mesh bronze screen. This filter cage was equipped with four quick acting bands to hold three strips of 8-inch filter in position over the screen. The outlet side of the fan was equipped with a 3⅜-inch orifice plate to hold the amperage of the motor down to within the permissible load. The inlet side of the fan, between fan and filter, was equipped with a 5-inch diameter plate orifice and manometer for estimating air flow rates. One water manometer indicates the pressure across the orifice plate and another indicates the total suction on the filter.

The sampler was calibrated by means of a pitot tube. It was found that it collected an average of about 1000 cubic feet per minute.

The collecting medium was Hurlbut filter No. 935 with a distortion point of 611°C; 99.95 percent efficient in 0.3 microns dioctyl phthate (DOP) smoke particles; resistance, 110 millimeters of water at 28 feet per minute, with glass fibers 0.5 to 0.75 micron in diameter. The material used was purchased from the Mine Safety Appliance Company.

Measurement procedures. The carbon-14 assay of the samples was measured by a liquid scintillation method (*3*). This involved the conversion of the sample carbon into liquid hydrocarbon suitable for measurement. The procedure is briefly the following. The sample is burned in a stream of oxygen, and the resulting carbon dioxide is collected in ammonium hydroxide solution. It is then precipitated as strontium carbonate, which is converted to the carbide by reaction with magnesium metal. This is then hydrolyzed to give acetylene, which is polymerized in the presence of cuprous chloride to give unsaturated C_6 and C_8 hydrocarbons. These are then hydrogenated to give a product that is chiefly hexane and octane. This chemical procedure was adapted, with modifications, from the work of Suess (*4*) and Nieuwland (*5*). The carbon content of the liquid is determined by a combustion analysis, and the carbon-13 to carbon-12 ratio is determined in order to correct for hydrocarbon fractionation in nature or in the laboratory.

The method of measuring the carbon-14 content of the sample has been previously described (*3*). A description of a number of minor improvements is in preparation. Because of the small size of the samples involved, a cell of 10-milliliter capacity was used. With a sample of approximately 2 grams of liquid hydrocarbon, we were able to measure the percentage of living carbon to an accuracy of ± 1.5 percent in 24 hours of counting.

Table 1. Carbon analysis of air samples

Sample	Air vol. (10^6 cubic feet)	Total weight (grams)	Total carbon content (grams)	Contemporary carbon (percentage)
Detroit I	6.1	35	6	†
Detroit II	3.2	18*	3*	12.6 ± 3.0
Los Angeles I	6.25	31	6	25.7 ± 1.6
Los Angeles II	8.5	41.7	8	23.2 ± 1.4

* Approximate value—filter torn. † Sample lost in processing.

Table 2. Beryllium-7 analysis of air samples. Units are disintegrations of beryllium-7 per minute, per thousand cubic feet at the time of collection

Sample	Activity zero days
Detroit I	4.5
Detroit II	1.0
Los Angeles I	1.3
Los Angeles II	2.4

Sampling period and locations. Samples were collected at one location in Detroit and one location in Los Angeles. It may be noted that the sampler operated from 4 to 6 days for the collection of each sample. The selection of sampling sites and the collection of samples were under the supervision of Vincent J. Castrop, Industrial Hygiene Department, Research Laboratories Division, General Motors Corporation. Four samples were collected, as follows: (i) *Detroit I,* 3 Sept. 1954 at 2:25 P.M. continuously until 7 Sept. 1954 at 8:15 A.M., from a location on the roof of the 11-story General Motors Research Building; (ii) *Detroit II,* 7 Sept. 1954 at 9:35 A.M., until 2:20 P.M. 13 Sept. 1954, intermittently while calibrating for approximately 2 hours, 14 Sept. 1954 at 8:45 A.M. continuously until 16 Sept. 1954 at 8:45 A.M. from the same location as *Detroit I*; (iii) *Los Angeles I,* 14 Oct. 1954, ½ hour, 15 Oct. 1954 at 8:30 A.M. continuously until 19 Oct. 1954 at 4:20 P.M. from a location in Brookside Park (about ½ mile south of the Rose Bowl); (iv) *Los Angeles II,* 19 Oct. 1954 at 11:50 P.M. continuously until 25 Oct. 1954 at 1:30 P.M. from the same location and filter area as *Los Angeles I.*

Weather conditions. In Detroit, haze, smoke, and fog were moderately light and present during less than 20 percent of the sampling period. There were winds of 5 to 15 miles per hour and brief showers. Visibility ranged from 3 to 14 miles and for most of the period was above 10 miles. In Los Angeles, both samples were taken during a period of fog and severe haze. Complaints of eye smarting were frequent during daylight hours.

Results of study. Table 1 presents the results of the investigation. It is of interest to note that the total carbon content of each sample was only about 20

percent of the total weight. Thus, carbon is a minor constituent of the total particulate load found in the Los Angeles and Detroit atmospheres.

Beryllium-7, with a half-life of 53 days, has recently been found to be produced by cosmic rays in the atmosphere (*6*). We have analyzed the present samples for beryllium-7 content. There is as yet an insufficient number of comparison samples to make the results highly meaningful. They are, however, presented in Table 2. It is possible that, when sufficient results have been obtained, a useful measure of the rate of subsidence of the atmosphere in the Los Angeles area can be obtained using this isotope.

The sensitive counting techniques used in this study may be applied to tracer experiments as well as to natural activities. Simple calculation shows that it would be quite practical to introduce sufficient tracer, either carbon-14 or some other isotope, into any suspected source of contamination in an area the size of the Los Angeles basin, in order to determine the percentage of contamination arising from this particular source. For example, the entire gasoline supply could be tagged at an adequate level for a period of 30 days, in order to determine the contribution of automobile exhausts to the atmospheric carbon. Since the level of radioactivity in the consumer product can be well below that of the human body, no safety hazard to the public is involved.

The tests conducted proved the effectiveness of the technique used and reveal that this procedure is a useful tool in determining whether or not the atmospheric carbon is newly formed, as from rubbish burning, or is aged, as from petroleum, gas, and coal sources.

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I. M. Cline, Expert on Hurricanes

Isaac Monroe Cline, who achieved an international reputation as a weatherman, died in New Orleans, Louisiana, on 3 August 1955 at the age of 94. The career of Cline, who rose from plow boy to principal meteorologist of the U.S. Weather Bureau, with medicine and art on the side, distinguished him as one of New Orleans' truly remarkable men. His professional career in meteorology embraced 53 years of service with the Weather Bureau during which time the weather service developed from a unit in the Signal Corps of the Army to a separate bureau in the Department of Agriculture.

Cline was born in Monroe county, Tennessee, on 13 October 1861. He received his B.A. degree from Hiwassee college in 1882 and was awarded a medical degree from the University of Arkansas in 1885, while he was working as an observer for the weather service in Little Rock, Arkansas. He served as observer at Fort Concho and Abilene, Texas. In 1889 he was appointed as section director at Galveston, and in 1891 the weather service was transferred to the Department of Agriculture. During this period he carried out research and made significant contributions in the field of medical climatology and a study of the hot summer winds on the Great Plains. He received his Ph.D. degree from Texas Christian University while he was at Galveston.

The Galveston hurricane of 8 September 1900 established Cline as an expert on tropical hurricanes. Notwithstanding the fact that 6000 residents of Galveston had been hurled to death in a few hours by the winds and tides, the warnings that were sent out by Cline are said to have saved tens of thousands of lives along the coast. Despite his heroic attempts at rescue, Cline suffered personal tragedy in the loss of his wife, Cora May Ballew, during this disaster. As a result of his experiences during this hurricane Cline resolved to devote his life to research and study of this natural phenomenon.

In 1901 he was transferred as official-in-charge of the southern forecast district in New Orleans, Louisiana. It was during his 34 years at New Orleans that Cline rose to international fame in the field of hurricane and flood forecasting. His superb forecasts of the Mississippi River floods of 1903 and 1927, as well as the tropical hurricanes at New Orleans, 29 September 1915 and the Texas Gulf Coast, 21–22 June 1921, are accorded a high place in the annals of Weather Bureau history. His intimate knowledge and study of tropical hurricanes resulted in the publication of his book *Tropical Cyclones* in 1926.

During his years in New Orleans, Cline found time to pursue his hobby of art collecting. As a result, some of the finest portraits painted by American artists were rescued from oblivion, preserved from destruction, and now hang in the National Gallery of Art in Washington. He became an expert in the restoration of masterpieces of portraiture.

In 1934 Cline retired from active service with the Weather Bureau. Tulane University awarded him an honorary D.Sc. degree for his achievements in the science of meteorology and his contribution to the cause of humanity by the saving of life and property during floods and tropical hurricanes.

After retirement he operated an antique shop in New Orleans and became affectionately known as the "dean" of the famous French Quarter, the habitat of writers and artists and the cultural center of the city's activities. Ten years later he published *Storms, Floods and Sunshine,* an entertaining autobiography, which has undergone several revisions.

The keynote of his life was the proper utilization of time, particularly the efficient use of recreation time. His life was an excellent example of it.

He was a member of numerous scientific societies and congresses. He served as president of the American Meteorological society in 1934–35 and the New Orleans Academy of Sciences in 1935–36. In the words of former President Herbert C. Hoover, his work "has been more than the mere routine interpretation of technical data. It required judgment and discretion, which amounted to genius. He has been an honor to the Weather Bureau."

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