EES NOTES

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In This Issue:

UTILIZATION OF PEANUT HULLS

An ideal means of disposing of a solid waste material would be to convert it into a saleable product which, when used itself, would create no further disposal problem. M. D. Bowen of the Chemical Sciences and Materials Division has come up with a development which holds just such a promise. The waste product in this case is peanut hulls.

The dimensions of the problem can be realized from the fact that Georgia is the nation's largest peanut producing state. The peanut shelling companies, which are concentrated mostly in the western part of the state around Albany, annually produce approximately 120,000 tons of hulls as a by-product of the shelling operations. Formerly, these hulls were put to such uses as components in fertilizers and cattle feeds. These markets were lost, however, as a result of new technological developments in those products, and most shellers began to dispose of their hulls by burning.

Hulls are usually burned in a large metal incinerator called a tepee burner, capable of handling large amounts of such materials as peanut hulls. Since the tepee burners usually do not afford complete combustion, the exhaust from the burners contains large quantities of particulate matter. The smoke and fallout of fly ash in the vicinity of these burners have frequently brought complaints from the surrounding communities.

Representatives of the peanut shelling industry have approached the Experiment Station concerning the possibility of developing a more efficient method for burning hulls. In 1968, the Experiment Station began an exploratory study of the problem. The initial investigation dealt with ways of developing a more efficient incinerator which could burn the hulls without producing air pollution.

In examining the basic combustion properties of peanut hulls, Dr. Bowen was able to determine that their inherent characteristics offered opportunity for utilization in new products. It was found that under controlled combustion, a high-purity carbonaceous material can be recovered. The material could conceivably go into any of a number of end uses, such as charcoal briquets, activated charcoal, or carbon black pigments.

The Bowen process was originally carried out on a laboratory scale; then, in order to prove out the process, a prototype unit was fabricated in the EES Machine Shop and erected on campus. With hulls furnished by the peanut shelling industry, numerous tests have been made on the prototype to demonstrate the operating characteristics of the unit.

Many peanut shelling plants in Georgia have been confronted with the problem of conformance with air pollution regulations which effectively would prevent hull burning. Unless the shellers can burn their waste, they usually are unable to operate at all. In view of this potentially serious situation, a group of businessmen associated with the peanut shelling industry have formed a new corporation, Tech-Air, Inc., which has negotiated a license with the Georgia Tech Research Institute for the use of the Bowen process. Tech-Air currently is preparing plans for a plant in Camilla, Georgia, which will process hulls for shellers in that part of the state.

R. L. Yobs
Office of Industrial Assistance

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HIGH-LEVEL NEUTRON DETECTORS

In power reactors there is a need for in-core detectors that will respond rapidly to variations in neutron flux to monitor proper operation of the reactor by immediate detection of any irregularity in function. Because of the high radiation levels involved (both of neutrons and gamma-ray photons), which cause radiation damage, and the high operating temperature in the core, very few detectors are capable of operating in this environment. Furthermore, difficulties arise in attempting to discriminate between neutrons and photons. Few detectors available at the moment come even near the desired characteristics in terms of either their operational life or the flux level at which they can perform satisfactorily.

To meet this problem, we have been attempting to develop novel neutron detectors capable of operating at high temperatures and displaying good discrimination between neutrons and gamma rays. One type of detector investigated is a gas-filled cylindrical spark counter. In this detector, boron nitride converter disks stacked between a series of concentric aluminum washers release alpha particles when struck by neutrons. Gas discharges are initiated between the washers and the inner wall of the cylindrical shell by the ionization caused by the alpha particles. With argon or helium and isobutane filling, such counters were shown to operate in neutron fluxes up to 10^{10} n/cm^2 sec and at temperatures up to 550^{o}F. In higher flux environments the associated gamma-rays tend to keep the gas continually ionized, making the counter inoperative. The temperature limit is imposed primarily by the leakage characteristics of the currently available ceramic insulators used to seal the chamber. Within these limits, this type of detector possesses many advantages over other detectors because of the very large output signal, its robustness, and good discrimination between neutrons and photons.

Another type of detector is a "neutron thermometer" based on nitride compounds. This device uses the $^{14}N(n,p)^{14}C$ reaction; the incident neutron converts nitrogen to carbon with ejection of a proton. This proton is fully absorbed in the detector body, releasing heat. The temperature rise is, therefore, a function of incident neutron flux. When a low atomic number compound such as silicon nitride is used, gamma-ray heating can be minimized. This approach has advantages over the more usually proposed materials such as boron or uranium in that the absorption cross section is fairly flat over a wide range of neutron energies. Since the cross section is smaller, the material is less subject to burnup, i.e., is depleted less rapidly. Experiments with nitride materials in the form of small cylinders cemented to chromel-alumel thermocouples over a period of seven months in the Georgia Tech Research Reactor have shown that this simple system is capable of giving a consistent indication of neutron flux levels. The gamma-ray sensitivity is low; no change in performance was apparent after more than 1200 megawatt hours of operation in a flux of about 10^{13} n/cm^2 sec. Further work is required to turn this device into a well-engineered component suitable for insertion in a reactor core.

G. G. Eichholz
Nuclear and Biological Sciences Division

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MIRACODE INFORMATION RETRIEVAL SYSTEM

The information resources in the Basic Data Collection at the Industrial Development Division are now being more effectively utilized and manipulated through use of Miracode equipment. Miracode is a trade name identifying information retrieval equipment developed by Eastman Kodak. In a Miracode information system, coded microfilm is searched by mechanical means to retrieve information meeting specified requirements. The system consists of cartridges of coded and filmed material, a code or thesaurus identifying terms used, and a microfilm reader-printer which is connected to a retrieval console composed of four keyboards resembling large adding machines. The camera and coding equipment for preparation of the film are a separate installation. When a search is started, the film cartridge is inserted in the reader-printer; the thesaurus is consulted for the numbers identifying the desired characteristics; these specifications are entered on the console, and the search button is punched. A cartridge containing approximately 2,000 letter-size exposures can be searched in 8 seconds.

Newspaper clippings relating to industrial, commercial, and other business corporations in Georgia were the first items coded and filmed for retrieval. Approximately 950 clippings selected from 100 weekly and 17 daily papers are coded by

(1) geographic location, (2) company products, and (3) subject content of the article. The activity of the firm is coded by the appropriate number from the Standard Industrial Classification system of the U. S. Office of Statistical Standards. For example, all the clippings dealing with mobile home manufacturers or any facet of the retail, wholesale, or service trades can be retrieved. The contents of the newspaper articles are coded by use of a thesaurus, developed by the Basic Data Branch, which covers approximately 200 subjects. Topics such as expansion of existing retail operations, location of new manufacturing plants, job training programs, new products, sites located in industrial parks, mergers, and plant closings are included in this code. Use of the three codes enables one to search such questions as: (1) Are there any job training programs presently operating in South Georgia? (2) What tufted textile plants have recently located in Northwest Georgia? (3) What companies have research facilities? When articles meeting the search requirements have been identified, a hard copy can be produced from the film by a push of the appropriate button. Obviously, the answer to any of these questions would be difficult to produce by manual means.

At present only 1968 and 1969 clippings are on film, but the Basic Data Branch hopes eventually to film the stories clipped during the period 1958-1967. If this is accomplished, a wealth of information about Georgia's industrial and commercial activities will be readily retrievable. Plans are to film current clippings every six months.

Use of Miracode is not limited, however, to newspaper clippings. Approximately 700 descriptions and maps of industrial sites in Georgia have been coded and filmed. Previously these sites had been identified in a variety of reports and personal files. Each site is coded by county and area of the state, size of the site, size of community in which the site is located, location of site within or outside city limits, utilities available, and transportation available, including airport, highways, railroads, and water.

The equipment also has proved valuable in control of internal reports. Basic Data Branch personnel have filmed the title page, table of contents, and summary, if available, of 300 published reports written by IDD staff members. Items coded include type of report, statistics, tables and maps, geographic area covered, date, author, and product. When a report meeting the search specifications has been identified, the reader can know immediately by scanning the table of contents if he needs to look at the entire report. Or, for example, a table showing forecasts for hardwood production over a 10-year period can be located quickly. The Basic Data

Branch believes coding and filming of this nature is applicable to its entire book and pamphlet collection.

In another application of Miracode, the Branch has filmed and coded descriptions of 260 regional planning groups listed in a national directory. Information such as financing, size of staff, programs, and geographic coverage can be analyzed by participants in Economic Development Administration training workshops conducted by IDD.

The Basic Data Branch is eager to make this resource available to individuals and groups throughout the state.

Kay C. Rogers
Industrial Development Division

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ELECTRONIC AIDS FOR PUBLIC ROADWAYS: VEHICLE DIRECTION DETECTORS

Research has been initiated on developing electronic aids for public roadways, with emphasis on techniques and devices that will assist in improving traffic engineering. Efforts have concentrated on vehicle direction detectors -- devices that sense the presence of a moving vehicle and determine its direction of travel. Vehicle direction detectors can be used for detecting and warning of wrong-way traffic at critical locations such as entrance and exit ramps on expressways.

Various devices for establishing vehicle direction of travel have been developed in the past; however, usage has not been widespread because of several disadvantages. One drawback is that detection is limited by vehicle velocity -- low and high velocity vehicles cannot be detected reliably. Another disadvantage is high false alarm rates, especially when the devices are activated by trucks with many axles. In addition to alleviating the limited velocity and high false alarm problems, other goals of the research were to develop low-cost portable devices with low power consumption.

Vehicle direction detectors consist of three major sub-systems: the roadway sensor (or sensors), the signal processor, and the alarm unit. Research has been concentrated on the signal processor. A major objective has been to develop processors compatible with a variety of commonly used sensors, such as pneumatic tubes, pressure treadles, photoelectric detectors, and inductive loops.

The general approach has been to use dual sensors closely spaced on the roadway, with spacing much less than the shortest wheelbase of interest. Close spacing improves the response time to slowly moving vehicles and increases the probability of detecting a vehicle that stops on the roadway with a wheel between sensors. The sensor outputs are applied to the signal processor which functions as a signal sequence detector to separate right- and wrong-way vehicles. For example, a right-way vehicle sensor sequence produces no output, whereas a wrong-way vehicle sensor sequence provides an output to activate alarm and alert devices.

Two signal processor models have been developed. One was designed for use with any type of vehicle sensor; the other was designed exclusively for use with inductive loop sensors, which are quite common and widely used. In the former, an event sequence detector is used to detect an improper sensor output sequence. Event rates greatly exceeding the maximum required can be processed, allowing for very close spacing of the sensor elements. Total power consumption is approximately 50 milliwatts -- a level compatible with battery operation. In the second model, two inductive loops are used in a balanced AC bridge circuit; vehicle directionality is ascertained by noting the sequence of output signal polarity which occurs as the vehicle traverses the spaced loops. Fast response time, low power, low cost, and small size were obtained by using integrated circuit modules.

Laboratory and parking lot tests have verified the feasibility of the devices; however, roadway testing with vehicles at road speed is necessary before operational feasibility can be assured. Additional work needs to be performed in the area of sensor (input) and alarm (output) interfacing with the signal processing circuitry.

H. H. Jenkins
Electronics Division

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IMPROVEMENTS IN OPTICAL PYROMETRY

Optical pyrometry is the technique of measuring temperatures by optical methods. It is useful where contact devices such as thermometers and thermocouples are not suitable, for example, when the temperature to be measured is very high or the object is inaccessible.

All optical pyrometry is based on Planck's radiation law, which expresses the intensity of radiation given off by a "black body" as a function of wavelength for each temperature of the body. In practice, one measures the radiation intensity at one or more known wavelengths, then from Planck's law derives a temperature. At this point one of the major difficulties in optical pyrometry comes into focus. Note that Planck's law relates radiant intensity to wavelength and temperature only for a "black body," an ideal body which absorbs all radiation falling on it. Exposed surfaces generally radiate substantially less energy than a black body at the same temperature. The ratio of the radiation of a particular surface at a given temperature to that of a black body is defined as the emissivity under the specified conditions.

The heart of the problem is related to a well known dilemma, that of the chicken and the egg. If the investigator knows the emissivity of the object, he can obtain the temperature; if he knows the temperature he can obtain the emissivity. As you have surely guessed by now, he usually knows neither the emissivity nor the temperature.

There are several ways to deal with this dilemma. One frequently used method is to report the temperature obtained without regard to the emissivity and designate this a "brightness temperature" or "apparent temperature." Persons familiar with optical pyrometry translate these data to the expression "the temperature of the sample was high." Brightness or apparent temperatures are useful for comparative purposes among samples of the same material, however. Another way to circumvent this problem is to measure the sample's emissivity, possibly at a lower temperature where thermocouples can be attached to the sample, then assume it remains constant into the temperature range where optical measurements are required.

A third way to deal with the problem is to use two-color pyrometry. A simple mathematical exercise will show that if the radiant intensity is measured at two wavelengths (two colors), the true object temperature can be obtained if the emissivity is equal at the two wavelengths. The investigator need not know the value of the emissivity, but only that the emissivity is the same at both wavelengths. This assumption is often acceptable, and is usually much better than using a value of emissivity measured on another sample or at a lower temperature.

The problem of high-temperature optical pyrometry may be further complicated when one attempts to measure the temperature of surfaces which are transparent, are covered by flames, or when the acquisition times are very short. A study is in progress at HTMD in which very high temperatures, transparent surfaces, and viewing times of about 40 milliseconds are all combined. Two complete infrared pyrometers operating at different wavelengths are being adapted for use in the program; the wavelengths and operating characteristics were chosen to meet the special requirements of the study. Although certain accessory equipment is still being set up, preliminary experiments by CSMD and HTMD personnel indicate that the system will be capable of measuring surface temperatures to within about $\pm 50^{\circ}$ at temperatures in the range of 4000-4500°F.

S. H. Bomar, Jr.
High Temperature Materials Division

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HOLOGRAPHY IN AEROSOL TECHNOLOGY

The word "hologram" was first used by a British scientist, Dennis Gabor, in 1947. Its meaning is reflected in the word roots holo (complete) and gram (message). The hologram, although theoretically possible, could not be fully demonstrated until the invention of the laser, a coherent light source. A hologram is a developed photographic plate with an interference pattern on it. The interference pattern recorded on the plate results from the coincidence of two sets of coherent light waves. One set is that issuing from the scene to be recorded; the other is the reference wave train direct from the laser source. When the developed plate is illuminated with the same coherent light, a reconstructed image of the photographed scene is presented to the viewer in three dimensions. The viewer can see around an object in the foreground by moving his head to the left or to the right. The holographic display differs from a two-photograph stereo picture, in which only one view is available. Because no lenses are used in making the hologram, all objects in the scene, near and far, are in sharp focus.

Of several methods applicable in holography, the one commonly used for measurement of particle size in an aerosol is the reconstruction technique. This technique is a two-step process. The first step is data collection; a hologram is produced by the use of a pulsed ruby laser to "freeze" the motion of the particles in the sample volume. The second step is to reconstruct the original sample volume with a coherent beam of quasi-monochromatic light. Particle size and shape can then be determined throughout the sample volume. Magnification can be obtained by suitable choice of distance from a point source, i.e., the radius of curvature of the illuminating wave front. Furthermore, the use of an off-axis reference beam can improve the contrast in the reconstructed images. Particle size down to about 3 microns then can be measured. The basic limitations on particle size are the wavelength of the light, the spectral width, the coherence length, the resolution of the film, and the auxiliary optics, if any.

A different technique has been used to measure the size of spherical particles such as droplets. A relation between the droplet size and the Fraunhofer diffraction patterns is used to determine the size of droplets. This technique is simpler to set up than the previously described method, but it is suitable only for spherical particles. When the number concentration of the droplets is high, the light patterns overlap each other and make it difficult to distinguish each light pattern.

Particle velocity can be measured by obtaining double-exposure holograms. The laser is controlled so that it emits two equal-energy short-duration pulses with a known time interval. The double-exposed holograms reconstruct double images of each particle, permitting determination of both particle size and velocity. When a particle does not move parallel to the hologram plane, the out-of-plane velocity is established by vectorially adding the parallel and vertical velocity components.

Because of the basic limitations of the holographic techniques, particle size below 2 or 3 microns cannot be measured accurately. However, the presence of submicron particles, their concentration, and their spatial position can be determined in a three-dimensional sample, since these small particles act as point scatterers. The advantage of this technique is its large depth of field.

Edward Y. H. Keng
Chemical Sciences and Materials Division

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PROFESSIONAL ACTIVITIES

Papers and Speeches

Fred Bellinger, CSMD, recently spoke on "The Future of Chemical Engineering" to American Institute of Chemical Engineers Sections at Pensacola, Florida, and Savannah and Augusta, Georgia.

J. L. Brown, PSD, gave a talk on "Analytical Instrumentation Applied to Materials Problems" to the Atlanta Chapter of the American Institute of Mining Engineers on January 11.

R. B. Cassell, IDD, and L. T. Murphy, Jr., IDD, conducted an Industrial Development Seminar at Thomson, Georgia, February 2 under the auspices of the Central Savannah River Area Planning and Development Commission.

Joseph D. Clement, NBSD, and Fred Tarpley, IM, presented a paper before the annual meeting of the American Nuclear Society in Washington, D. C.; the topic was "A New Course in Financial Management and Economics of Nuclear Power."

Ross W. Hammond, IDD, was one of two participants from mainland American universities in the Planning Conference for New Science and Technology Programs held in Honolulu, Hawaii, March 17-23. It was sponsored by the East-West Technology and Development Institute in cooperation with the Asian Institute of Technology, Colorado State University, Georgia Tech, Korea Institute of Science and Technology, National Taiwan University, The Asia Foundation, and The Ford Foundation.

L. T. Murphy, Jr., IDD, spoke to the Augusta Chapter, American Institute of Industrial Engineers, on the industrial engineering functions of IDD.

On February 2, M. E. Sikorski, PSD, gave an invited talk, "A Catheter-Tip Transistor Pressure Transducer," at the Cardiology Research Seminar at the Medical College of Georgia in Augusta.

An invited paper entitled "Inductive Interference between Power and Signal Cables" was presented by James C. Toler, ED, at a meeting of the Eastern Signal Engineers Association in Washington, D. C., on February 24. The paper was one of four discussing theoretical aspects of electric and magnetic coupling effects between closely spaced wires.

At the American Nuclear Society conference in Washington, D. C., J. R. Williams, NBSD, presented four papers: "Angular and Wavelength Dependence of Thermal Radiation Transmitted Through Refractory Aerosols," "Radiant Heat Transfer in Heated Aerosols at 100 Atmospheres Pressure," "A Study of a Gas Core Reactor - MHD Power Plant Concept," and "Exploratory Calculations for a Gaseous Core Fast Breeder Reactor."

R. A. Young and P. E. Mackie, PSD, read two papers, "Occurrence of Simultaneous Diffraction Effects in a 'Typical' Case" and "Structural Location and Role of a Minor Substituent: An Example in Apatite," at the Winter Meeting of the American Crystallographic Association in Columbia, South Carolina, in February.

Publications

H. L. Bassett, ED, "A Free-Space Focused Microwave System to Determine the Complex Permittivity of Materials to Temperatures Exceeding 2000°C," Review of Scientific Instruments, Vol. 42, No. 2, February 1971.

R. J. Gerdes, PSD, and C. E. Wagner, PSD, "Scanning Electron Microscopy of Resonating Quartz Crystals," Applied Physics Letters, Vol. 18, No. 2, January 1971.

G. W. Simmons, formerly PSD, and E. J. Scheibner, PSD, "Order-Disorder Phenomena at the Surface of α-Titanium-Oxygen Solid Solutions," Journal of Materials, Vol. 5, No. 4, December 1970, pp. 933-949.

A photograph of the structure of gold indium film made by L. A. Woodward, Physics, and J. L. Brown, PSD, will be used by Scott, Foresman and Company, school textbook publishers, on the cover of one of the booklets in a kit of English workbooks for tenth-grade underachievers, Activity Concept English. The photograph also appears in The New Landscape by Gyorgy Kepes, courtesy of the late Richard B. Belser.

Honors

Fred Bellinger, CSMD, has been installed as a director of the Georgia Architectural and Engineering Society for a two-year term.

Tze I. Chiang, IDD, has been selected for inclusion in the eighth edition of the Dictionary of International Biography.

John E. Husted, CSMD, has been named as one of the editors of the new fourth edition of Industrial Minerals and Rocks, to be published by the American Institute of Mining Engineers. He also is a member of the Editorial Advisory Committee of the AIME Mining Handbook.

SUBMISSION OF ARTICLES

Contributors in the divisions should submit their articles to the appropriate division coordinator listed below. Others may send their contributions via campus mail to Martha Ann Deadmore at the Industrial Development Division.

Division Coordinators

Chemical Sciences and Materials Division	Walter H. Burrows
Electronics Division	H. A. Corriher, Jr.
High Temperature Materials Division	Nick E. Poulos
Industrial Development Division	Martha Ann Deadmore
Nuclear and Biological Sciences Division	Geoffrey G. Eichholz
Physical Sciences Division	Robert L. Bullock