CONF-790917--8

DEVELOPMENTS IN INDUSTRIAL HYGIENE INSTRUMENTATION*

R. B. Gammage
Health and Safety Research Division
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37830

Contact with oils and tars presents potential skin and lung cancer hazards to workers involved in the production, transportation, or end use of synthetic fossil fuels. The principal group of carcinogen containing chemical compounds is polynuclear aromatic (PNA) hydrocarbons.

Skin contamination is difficult to avoid during maintenance or handling operations. The vapors of the more volatile aromatic components in oils can be inhaled easily. The industrial hygienist has few tools at his disposal for measuring either the build-up of hazardous concentrations, the extent of an exposure, or the effectiveness of decontamination.

Three types of instrumentation are being developed at the Oak Ridge National Laboratory to improve the degree of occupational health control available to an industrial hygienist. Each relies on the ability of PNA hydrocarbons to absorb and fluoresce in the ultraviolet-visible range of wavelengths.

To deal with contamination of work area surfaces by PNA hydrocarbons, two portable luminescence spill spotters are being fabricated and field tested at coal conversion plants such as the Solvent Refined

---

*Research sponsored by the Office of Health and Environmental Research, U.S. Department of Energy under contract W-7405-eng-26 with the Union Carbide Corporation.

DISCLAIMER

Coal Facility at Tacoma, Washington. These portable instruments, the size of home movie cameras, are being developed by Dan Schuresko of ~~the~~ Oak Ridge National Laboratory Chemical Technology Division.

A high pressure mercury arc lamp produces a cone of near ultraviolet light at 365 nm that is amplitude modulated at 1 kHz. The outgoing beam of illumination passes through a telephoto lens and is focused to a spot of 1 cm^2 at a distance of 40 cm. A portion of the modulated longer wavelength fluorescence is returned through the telephoto lens to a photomultiplier tube. The fluorescence measurement that is obtained is roughly independent of distance over the range 0 to 80 cm.

The spill spotter can be operated in either illuminated or darkened work areas. Spills can be detected remotely out to a distance of 2 m. One can also obtain a semiquantitative measure of the amount of spilled material. The instrument will be especially useful for monitoring the escape of oils from work areas into the "clean" areas of coal conversion plants such as lunch rooms, changing facilities, control rooms, and shops. Lower limits of sensitivity usually lie in the range 0.1-1000 μg with the actual limit depending on the specific PNA hydrocarbon content of the material and interferences which cause quenching of the fluorescence.

For the examination of skin a somewhat different approach is being taken by Tuan Vo-Dinh and Dick Gammage of the Health and Safety Research Division. One has to be concerned about a possible synergism between non-carcinogenic, long-wavelength ultraviolet light and the chemical compounds to produce a photocarcinogenic response on the skin. This may happen even with normally inocuous compounds such as n-paraffins. Unless the skin contamination is identified and removed, however, a worker entering an open environment will suffer direct exposure to the sun with its potential for photosensitization. A lightpipe luminoscope is being developed with an illuminating intensity less than that of sunlight in the range of wavelength 350-400 nm, which is about 1 mwatt/cm^2. ~~This is the logic for choosing a safe intensity limit.~~ I don't think this sentence is necessary. okay -E. out

The luminoscope transmits filtered ultraviolet light through a flexible lightpipe to a stethoscopic cap pressed against a small area of the skin. Only a small targeted area will be illuminated at any one time during an examination. The fluorescence is returned along the lightpipe by the same route to a photomultiplier tube with digital display of the output. Background lights present no problem to the measurement since the area of skin being examined is completely excluded from extraneous light by the stethoscopic head.

The lightpipe luminoscope is visualized as being used routinely in changing rooms or for quickly detecting accidental skin exposures that might occur in maintenance operations.

Because the more carcinogenically potent PNA hydrocarbons have high boiling points, they exist in the vapor phase only at extremely low levels and probably pose little hazard through vapor inhalation. Some of the lower-ringed PNA hydrocarbons have appreciable vapor pressures and should be considered an inhalation hazard. Volatile compounds such as the methylnaphthalenes and quinoline have been suggested as tumor promotors, inhibitors, or actual carcinogens.

A wavelength modulated, second-derivative ultraviolet-absorption spectrometer has been developed for real-time monitoring of aromatic vapors escaping from valves and flanges or evaporating from spills. Selectivity is improved, compared to conventional ultraviolet-absorption spectroscopy, because in the measurement of the curvature of absorption peaks, signals due to narrow band absorptions are enhanced while broad band absorptions are reduced. Additional advantages are an insensitivity to sample opacity and to variations in the light intensity of the source.

Instrument development is under the direction of Alan Hawthorne of the Health and Safety Research Division. Compared to a commercially available instrument there has been a considerable reduction in size to about a cubic foot. A commercial personal microcomputer provides data analysis, with a cathode ray tube (CRT) for display and concentration readout, a keyboard for communication with the spectrometer and for program selection, and a magnetic tape cassette data-storage system.

Part-per-billion levels of gas-phase PNA hydrocarbons such as naphthalene, alkylnaphthalenes, and acenaphthalene can be measured, as well as benzene, toulene, pyridine, phenol, and cresols. Evaluation will be at the University of Minnesota at Duluth low-Btu gasifier during the coming year.