

source. In this case, the core of the system is an ultraviolet-sensitive television camera that visualizes the plume by observing the absorption of sulfur dioxide against the ultraviolet sky. Sulfur dioxide concentrations are obtained by focusing the instrument on a particular part of the plume and measuring the difference in absorption at two wavelengths. Atmospheric effects can be compensated for by measuring the absorption of light at the same wavelengths when the camera is focused outside the plume. The device does not have any

ranging capability, and therefore the concentration obtained is the total concentration along the device's optical pathlength.

The Visiplume also has the capability to determine effluent velocity by tracking fluctuations in the sulfur dioxide concentration as they move downstream. These fluctuations are actually large eddies that are produced at the stack lip as the flow mixes with ambient air. The correlation unit in the spectrometer determines the average distance moved by the fluctuations in a given time interval.

If the size of the stack opening is known, the sulfur dioxide emission rate can be determined by multiplying the average concentration by the velocity. The entire process is controlled by a microprocessor, and results can be displayed directly on the television screen or printed out for a permanent record.

The Visiplume has a maximum sensitivity of 50 ppm-m, and an effective range of about 500 to 600 meters under normal atmospheric conditions. It can monitor emission rates varying from 4 to 70 meters per second.—THOMAS H. MAUGH II

## At \$100 per Hour, Service Is a Big Concern

Like the rest of us, the instrument repairman is now paying more for gasoline, air travel, hotel rooms, and interest on his stock of repair parts—to the point where service calls now run between \$85 and \$100 per hour. Concerned by this increased cost, both instrument makers and users have been seeking new ways to reduce the need for service calls. Their ability to do this has been greatly abetted by the proliferation of microprocessors in even the least expensive analytical instruments.

The incorporation of a microprocessor and appropriate programming into a spectrophotometer, for example, makes it possible for the instrument to tell the user something as simple as "The source is not operating" or "The detector is inoperative," or something more complicated such as "The power supply is malfunctioning."

On some more sophisticated instruments, the problem can even be localized to a specific circuit board. The DuPont Company's 1090 thermal analyzer, for example, goes through an intricate testing sequence each time it is turned on to ensure that each circuit board and subcomponent is operating properly. Key-operated tests exercise specific areas of the electronics more extensively to pinpoint problems. In many cases, the defective circuit board can simply be replaced without having a service call. This type of self-diagnosis is rare now, but promises to become more common.

Taking the microprocessor one step further, certain mass spectrometers made by the Finnigan Corporation, for example, and some computers manufactured by Hewlett-Packard Company are available with a Modem that permits the instrument to be linked by telephone

with diagnostic equipment at the factory for precise analysis of the problem. For certain types of instruments, self-diagnosis by the instrument or a call to the company can solve 90 percent of service problems.

Once the problem is diagnosed, there are several approaches to eliminating it. Perhaps the newest approach for analytical instruments is user serviceability. Beckman Instruments, Inc., for example, this year introduced a line of instruments—including ultraviolet and infrared spectrophotometers and pH meters—in which most repairs can be made with a screwdriver.

Beckman also markets what it terms Rapid Kits for each of these instruments. These kits sell for about a third of the price of the instrument itself and contain a collection of the most frequently replaced parts. A Rapid Kit for one infrared spectrophotometer, for instance, contains a keyboard, the printer, a circuit board that controls both, the sample assembly, the source, and another circuit board that is the power supply—parts, says Nathaniel Brenner of Beckman, that account for 95 percent of all failures on such an instrument. The user simply replaces a defective part with the new one and mails the old part back to the factory for replacement. Whether analytical chemists will be sufficiently eager for immediate instrument repair to invest a substantial fraction of the purchase price in spare parts remains to be seen.

A more common trend in both universities and industry is to have electronic technicians whose sole job is to perform maintenance on a number of instruments. This has, of course, been going on for some time, but manufacturers

have become both more cognizant and more appreciative of the effort. Most major firms now offer 1- or 2-week training courses for these technicians to familiarize them with the instrument and servicing peculiarities.

Other companies, such as the Perkin-Elmer Corporation, are putting increased emphasis on preventive maintenance plans as a way to reduce service costs. Since travel, food, and lodging costs are reduced when several instruments at one location are serviced on one visit, total costs are reduced. A preventive maintenance plan, which includes two scheduled maintenance calls per year, costs between 5 and 7 percent of the initial cost of the instrument at Perkin-Elmer, whereas a full-protection plan that includes emergency service costs 9 to 12 percent of the purchase price.

A few companies are also consolidating their parts inventories to reduce the burden of financing large inventories at high interest rates. Varian Instrument Group, for example, has closed its regional parts centers and consolidated its inventory in the main facility at Sunnyvale, California. "With Federal Express and other couriers," says a spokesman, "we can provide overnight service to anywhere in the country from this one location, so the customer is not really losing any convenience."

No matter how well built they are, instruments are going to break down occasionally. As they become more sophisticated and complicated, the possibility of malfunction increases. Most of these new approaches to service are not going to prevent breakdowns. They may, however, make them a lot less painful.

—THOMAS H. MAUGH II