US Environmental Protection Agency

Robotics Technology in Environmental Sample Preparation

Introduction

The National Exposure Research Laboratory Exposure Dose Research Branch in Las Vegas (EDRB-LV) is supporting the use of robotics technology for routine analyses of environmental samples. The EDRB-LV currently uses two robotics systems for inorganic analyses. Robotics minimizes the incidence of operator error and provides legally defensible documentation following chain-of-custody requirements. Increasingly sophisticated robotics technology coupled with software that is user-friendly make robotics attractive to laboratories that are concerned about the number of samples that can be analyzed with consistently high precision and improved accuracy.

The EDRB-LV will provide technical document review and consultation to EPA Regions which are considering the purchase of a robotics system. Evaluations of manufacturers bids and demonstrations of the EDRB-LV systems are available through the Technology Support Center at the EDRB-LV. This technology has increased the laboratory's ability to perform quick-turnaround analyses that are backed up by strong documentation.

Hardware

In a sense, robotics hardware is really analytical laboratory hardware. When the robot is used to weigh, dilute, and prepare samples for chromatographic analysis, for example, the hardware is a table, a rack of sample jars, an analytical balance, a solvent vessel, a shaker, and various arms and pipets that allow the work to progress. When a robotics network is being designed, it is important to consider parallel uses that might be added for little extra expense. This design stage is critical in the cost effectiveness of the system. Scientists at the EDRB-LV worked with manufacturers to ensure that the instruments were customized for particular uses, but were not confined to a single application.

An operator still weighs out the samples for analysis because environmental samples are too complex for the robot to judiciously segregate. For a soil sample containing fine, coarse gravel, and a few miscellaneous twigs, human oversight is needed. The analytical balance, however, is tied into the robotics network so that transcription errors are eliminated. Therefore, robotics reduces human error but does not eliminate human intervention.

Software

Robotics systems come with easily modified software packages. Solvent amounts, volume of internal standards and surrogates, and time on the shaker can be adjusted easily. Software allows the robot to recognize bar codes, and to stop operation if a sample is dropped or broken.

A strong round robin study can be done when several laboratories use the same robotics software. The elimination of operator bias gives a better indication of the true sources of variance in any investigation. The correct robotics system provides chain-of-custody records, fraud detection, simpler analytical QA, and round-the-clock performance.

The robotics system can be described as a "computer with arms." As such, it is no smarter than the designers and operators of the system. The robot is not foolproof but merely fool-resistant. It will follow orders, add solvents, and shake samples. It cannot differentiate between HPLC grade and less pure methylene chloride, for example. The responsibility for good laboratory practice remains with the analyst.

Future Research

Robotics usage will be enhanced with increased ability for error recovery, allowing the system to know when samples have been switched, for example, and to correctly match samples with their weights. Artificial intelligence and expert system technology might be coupled with robotics to give users systems that are capable of more intricate sample handling and decision making. Microwave digestion applications and complex extraction procedures may soon be programmable at the robotics workstation.

References

Hillman, D. C., P. Nowinski, M. A. Stapanian, J. E. Teberg, and L. C. Butler, "A Single Laboratory Evaluation of a Robotic Microwave Digestive System," EMSL-LV, 1992.

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For Further Information

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A copy of a video illustrating the EDRB-LV robot in action is available free to Agency users from L. Butler.

For information about the services available through the Technology Support Center at ESD, contact:

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