Immunoassay Test Kits for Atrazine

The U.S. EPA Environmental Technology Verification (ETV) Program's Advanced Monitoring Systems (AMS) Center, operated by Battelle under a cooperative agreement with EPA, has verified the performance of four immunoassay test kits for atrazine, three of which provide quantitative results, while the fourth is a qualitative method (**Table 1**).[1] These portable atrazine test kits detect atrazine in various drinking and environmental water matrices within hours. Results from these test kits, followed by subsequent laboratory confirmation, allow for quick corrective actions to reduce atrazine levels if detected at levels of concern. Conventional laboratory methods use gas chromatography/mass spectrometry (GC/MS) to measure atrazine in water. The verified test kits can offer advantages over GC/MS in terms of time and cost by providing a quick and cost-effective screening method for atrazine levels.

Table 1: Verified Immunoassay Test Kits for Atrazine in Water

Technology	Type of Result
Abraxis LLC Atrazine ELISA Kit	Quantitative
Beacon Analytical Systems, Inc. Atrazine Tube Kit	Quantitative
Silver Lake Research Corporation Watersafe® Pesticide Kit	Qualitative
Strategic Diagnostics, Inc. RaPID Assay® Kit	Quantitative

Technology Description and Verification Testing

The verified test kits are based on colorimetric immunoassay methods, which use specific antibodies to detect and measure atrazine. The verification tests were conducted in September 2003, on surface water samples collected in South Carolina, ground water samples from an aquifer on the Missouri River, and chlorinated drinking water samples from a Battelle laboratory in Duxbury, Massachusetts. ETV verified the test kits in collaboration with the Texas Commission on Environmental Quality (CEQ); EPA Office of Prevention, Pesticides, and Toxic Substances; National Oceanic and Atmospheric Administration (NOAA); and University of Missouri-Rolla. The three test kits which provided quantitative results were evaluated for accuracy, precision and linearity. All four test kits were evaluated for matrix interference, rate of false positives/negatives, method detection limit, cross-reactivity, and sample throughput. Table 2 lists the performance of the four ETV-verified immunoassay test kits for atrazine in water. Additional information is available in the full verification reports which can be found at http://www.epa.gov/etv/verifications/vcenter1-28.html.

Atrazine and Its Regulatory Background at a Glance

Atrazine, 2-chloro-4-(ethylamine)-6-(isopropylamine)-s-triazine, is a commonly used herbicide in the United States. Annually, approximately 76.5 million pounds of atrazine are used in formulations of various products which are applied mainly to agricultural crops such as corn and sorghum. Following application, atrazine is absorbed by plants or dispersed to the environment through surface run-off, water seepage, primary spray drift, and air dispersion and precipitation.

In 1991, because of its frequent usage and concerns about its health and environmental effects, EPA established a drinking water standard for atrazine of 3 parts per billion (ppb). EPA is currently re-evaluating the drinking water standard to determine if a revision is needed. As part of the Interim Reregistration Eligibility Decision (IRED) for atrazine in 2003, EPA updated the human health risk assessment for atrazine. The IRED also required additional atrazine monitoring for certain vulnerable public drinking water systems and watersheds.

A verified immunoassay test kit

[1]The ETV Program operates largely as a public-private partnership through competitive cooperative agreements with non-profit research institutes. The program provides objective quality-assured data on the performance of commercial-ready technologies. Verification does not imply product approval or effectiveness. ETV does not endorse the purchase or sale of any products or services mentioned in this document.

Table 2: Performance of Verified Test Kits for Atrazine in Water								
Technology[a]	Accuracy[c] (percent recovery)	Precision[c] (relative standard deviation)	Rate of False Positives[d]	Rate of False Negatives	Linearity[e]			Sample Throughput[f]
					Slope	Intercept	r	
A	PT: 96 to 151% Env: 102 to 156%	PT: 0.9 to 51.1% Env: 2.6 to 16.7%	4 of 38 (11%)	none	0.93	0.26	0.995	50-60 samples in 1.5 hours
B	PT: 102 to 127% Env: 100 to 140%	PT: 6.9 to 24.1% Env: 3.5 to 15.2%	4 of 38 (11%)	none	1.23	- 0.025	0.994	50 samples in 1.5 hours
C	PT: 82 to 133% Env: 83 to 171%	PT: 5.0 to 25.4% Env: 3.9 to 22.8%	6 of 38 (16%)	none	0.81	0.24	0.957	30 samples in 1 hour
D[b]	PT: 18 of 21 Env: 31 of 36	PT: 7 of 7 Env: 9 of 12	8 of 56 (14%)	none	Not evaluated	Not evaluated	Not evaluated	10 samples in ½ hour

[a] Because the ETV Program does not compare technologies, the performance results shown in the table do not identify the technologies associated with each result and are not in the same order listed in Table 1.
[b] For this vendor, "accuracy" refers to the number of accurate results out of the total number of tests, and "precision" refers to the number of consistent sets of replicate sample results out of total number of sets.
[c] PT = performance test sample; Env = environmental sample (overall range for all environmental samples); a result of 100% indicates perfect accuracy relative to the nominal spike level atrazine concentration for PT samples and relative to the reference method results for Env samples. A result of 0% indicates perfect precision.
[d] The test kits for the three quantitative technologies for false positive readings were compared to the lowest calibration standard of 0.1 ppb. For the qualitative technology, the false positive readings were compared to a 3 ppb threshold level.
[e] Linearity was assessed using PT samples.
[f] Sample throughput includes calibration standards, quality control samples, and test samples.

Selected Outcomes of Verified Immunoassay Test Kits for Atrazine

Based on data from the IRED and other sources, the ETV Program estimates that approximately 3,900 community surface water systems, 940,000 private wells, and 10,000 watersheds are located in atrazine use areas. With a 25% market penetration of the potential market, ETV estimates the following:

- The test kits would be used at 240,000 private water wells, 960 community surface water systems, and 2,500 watersheds to provide timely information on atrazine levels in water. These estimates include systems and watersheds that require additional monitoring under the IRED.
- The information provided by the test kits can be used to identify whether mitigation is needed to reduce atrazine levels. Ultimately, this information can assist in the reduction of atrazine exposure, with associated environmental and human health benefits.
- The test kits would reduce monitoring costs and save time, since the immunoassay analyses used by the verified technologies cost approximately five times less than GC/MS laboratory analyses and have significantly shorter sample turnaround times (hours versus days). Based on model sampling programs at 960 community surface water systems and 2,500 watersheds, and assuming that 25% of the samples required GC/MS confirmation, a national sampling cost savings of $5 million per year can be achieved.
- EPA is also using the data from the verification studies in deciding whether to withdraw or modify the approved analysis method used for monitoring compliance with drinking water regulations.
- The ETV verification results have been used by state and federal agencies, including NOAA's National Centers for Coastal Ocean Science Center for Coastal Environmental Health and Biomolecular Research in Charleston, South Carolina, Nebraska Department of Environmental Quality, and Texas CEQ. Based in part on the ETV results, a study sponsored by the American Water Works Association chose one of the verified test kits for use in weekly sampling of 47 drinking water facilities over a seven-month period.

References

U.S. EPA, ETV Case Studies: Demonstrating Program Outcomes, Volume II. EPA/600/R-06/082. September 2006. (primary source). http://www.epa.gov/etv/pdfs/publications/600r06082/600r06082.pdf.

U.S. EPA, ETV, http://www.epa.gov/etv.

ETV Advanced Monitoring Systems Center

Robert Fuerst, EPA
fuerst.robert@epa.gov
Tel: (919) 541-2220

Amy Dindal, Battelle
dindala@battelle.org
Tel: (561) 422-0113

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