

THE ENVIRONMENTAL TECHNOLOGY VERIFICATION
PROGRAM



ETV Joint Verification Statement

TECHNOLOGY TYPE: Arsenic Test Kit

APPLICATION: ANALYSIS OF ARSENIC IN WATER

TECHNOLOGY NAME: Quick™

COMPANY: Industrial Test Systems, Inc.

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The U.S. Environmental Protection Agency (EPA) has created the Environmental Technology Verification (ETV) Program to facilitate the deployment of innovative or improved environmental technologies through performance verification and dissemination of information. The goal of the ETV Program is to further environmental protection by substantially accelerating the acceptance and use of improved and cost-effective technologies. ETV seeks to achieve this goal by providing high-quality, peer-reviewed data on technology performance to those involved in the design, distribution, financing, permitting, purchase, and use of environmental technologies.

ETV works in partnership with recognized standards and testing organizations; with stakeholder groups that consist of buyers, vendor organizations, and permittees; and with the full participation of individual technology developers. The program evaluates the performance of innovative technologies by developing test plans that are responsive to the needs of stakeholders, conducting field or laboratory tests (as appropriate), collecting and analyzing data, and preparing peer-reviewed reports. All evaluations are conducted in accordance with rigorous quality assurance (QA) protocols to ensure that data of known and adequate quality are generated and that the results are defensible.

The Advanced Monitoring Systems (AMS) Center, one of six technology areas under ETV, is operated by Battelle in cooperation with EPA's National Exposure Research Laboratory. The AMS Center has recently evaluated the performance of four portable analyzers for arsenic in water. This verification statement provides a summary of the test results for the Industrial Test Systems, Inc. Quick™ arsenic test kit.

VERIFICATION TEST DESCRIPTION

The Quick™ test kit is an inexpensive, portable, rapid device designed for on-site analysis of arsenic in water. The Quick™ test kit was verified in terms of its performance on the following parameters: accuracy, precision,

linearity, method detection limit, matrix interference effects, operator bias, and rate of false positives/false negatives. All preparation and analyses were performed according to the manufacturer's recommended procedures. Results from the Quick™ test kit were compared to those from the reference method to assess accuracy, linearity, and detection limit. Multiple aliquots of performance test samples and drinking water samples were analyzed to assess precision. Identical sets of samples were analyzed independently by two separate operators (a technical and a non-technical Battelle staff member) to test for operator bias. Matrix interference effects were assessed by challenging the test kit with performance test samples of known arsenic concentrations containing both low-level and high-level interferences. False positives and negatives were evaluated relative to the recently established 10-ppb maximum contaminant level for arsenic in drinking water. In addition to the analytical results, the time required for sample analysis and operator observations concerning the use of the test kit (e.g., frequency of calibration, ease of use, maintenance) were recorded.

Three types of samples were used in the verification test: quality control (QC) samples, performance test (PT) samples, and environmental water samples. The QC and PT samples were prepared from National Institute of Standards and Technology traceable purchased standards. The environmental water samples were collected from various drinking water and surface water sources. All samples were analyzed using the Quick™ test kits and by a laboratory reference method. Every tenth sample was analyzed twice by the reference method to document the reference method's precision.

QA oversight of verification testing was provided by Battelle. Battelle QA staff conducted a data quality audit of 10% of the test data, a performance evaluation audit, and a technical systems audit of the procedures used in this verification.

TECHNOLOGY DESCRIPTION

The Quick™ can be used to test for total arsenic in water. The vendor indicates that up to 2.0 mg/L of hydrogen sulfide is tolerated without test result interference, and up to 5 parts per million of antimony is tolerated. The Quick™ consists primarily of two reaction bottles, two caps for holding the test strip, three spoons, three bottles of reagent, and one bottle of arsenic test strips in a waterproof, plastic case. The three reagents are added sequentially to the water sample and shaken. A test strip is placed into the turret of the cap. The test strip is exposed to arsine gas evolved from the sample solution, resulting in a color change in the test strip. When the reaction is complete, the test strip is compared with a color chart provided with the kit. The intensity of the yellow/brown color developed on the test strip relative to the color chart is proportional to the arsenic concentration in the sample and, therefore, provides a semi-quantitative analysis of the arsenic concentration. The color chart consists of the gradations: 0, 5, 10, 20, 40, 60, 100, 200, 300, and 500 parts per billion (ppb). In a few cases, the operator interpolated between gradations to estimate the arsenic concentration. The kits are available in three sizes: for two tests, 50 tests, or 100 tests.

VERIFICATION OF PERFORMANCE

Accuracy: An assessment of quantitative accuracy of the Quick™ showed that percent bias values ranged from 8 to 83% for the non-technical operator and 8 to 84% for the technical operator for the individual PT samples. The percent bias ranged from 8 to 92% for the non-technical operator and 8 to 54% for the technical operator for the drinking water samples. For the freshwater samples, the percent bias ranged from 2 to 320% for both the non-technical and the technical operator. An additional criterion for accuracy was the percentage of samples for which the Quick™ result was within 25% of the reference result or within a corresponding "less than" range. By this criterion, the Quick™ yielded a qualitative accuracy for the PT samples of 71% for the non-technical operator and 55% for the technical operator. The qualitative accuracy for the drinking water samples was 57% for the non-technical operator and 52% for the technical operator. The qualitative accuracy for the freshwater samples was 96% for the non-technical operator and 54% for the technical operator.

Precision: Seven of the 14 replicate sets for the PT samples showed a relative standard deviation (RSD) of 0%, i.e., all results were identical. The remaining replicate sets for the non-technical operator had an RSD ranging from 29 to 50%, and the remaining replicate set for the technical operator had an RSD of 29%. For the drinking

water samples, the RSDs for the non-technical operator ranged from 29 to 100%, and the RSDs for the technical operator ranged from 0 to 18%.

Linearity: The linearity of response of the Quick™ was assessed using the PT samples containing 2 to 112 ppb arsenic. The linear regression for the Quick™ results for the non-technical operator was $\text{ppb} = 0.90 (\pm 0.086) \times (\text{reference, ppb}) - 5.2 (\pm 4.1) \text{ ppb}$, with a correlation coefficient (r) of 0.974. The corresponding equation for the results for the technical operator was $\text{ppb} = 0.88 (\pm 0.056) \times (\text{reference, ppb}) - 0.45 (\pm 2.7) \text{ ppb}$, with a correlation coefficient (r) of 0.988.

Method detection limit: The manufacturer's estimated detection limit for the Quick™ is 5 ppb. A total of seven replicate PT samples were analyzed at a concentration of 25 ppb. The non-technical operator reported arsenic between 5 and 20 ppb, the technical operator reported all seven replicates at 20 ppb. Since the Quick™ test kit is only semi-quantitative, no MDL was calculated from these data.

Matrix interference effects: The Quick™ showed a minor tendency toward higher readings (3 ppb on average) with higher levels of sodium chloride, iron, sulfide, and acidity. Because of the study design, it was not possible to determine which ion was responsible for the observed result.

Operator bias: The operator skill level does not appear to be a major factor determining Quick™ results.

Rate of false positives/false negatives: The rates of false positives and false negatives for the Quick™ were assessed relative to the reference method using 10 ppb of arsenic as the decision level. The rate of false positives for the Quick™ was 4% for the non-technical operator and 0% for the technical operator. The rate of false negatives was 16% for the non-technical operator and 5% for the technical operator.

Other factors: The Quick™ is available in three sizes, with the smallest being capable of analyzing two samples at a cost of \$12.99. The 50-sample test kit costs \$79.99. The large kit, capable of analyzing 100 samples, sells for \$139.99. The Quick™ allows two samples to be analyzed simultaneously. The total reaction time is less than 15 minutes. The reagents are ready to use with no preparation required. Three scoop sizes are included in the Quick™, making addition of the reagents simple, but the size and shape of the reaction containers limit the ease of use of the kit. This kit requires no liquids or concentrated acids, making it safe and easy to carry in the field. The solid reagents contain no toxic materials.

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