TECHNICAL NOTE

EPA APPROVES
IN-SITU® OPTICAL RDO® METHODS

Determine DO, BOD, and CBOD under the Clean Water Act

FREQUENTLY ASKED QUESTIONS

EPA APPROVAL

1. Are the In-Situ Inc. Rugged Dissolved Oxygen (RDO®) optical DO methods EPA approved?

Yes. On May 18, 2012, three In-Situ RDO methods received nationwide U.S. Environmental Protection Agency (EPA) approval. The In-Situ RDO methods are included in the final Methods Update Rule (http://water.epa.gov/scitech/methods/cwa/update_index.cfm). National Pollution Discharge and Elimination System (NPDES) permit holders may begin monitoring with In-Situ RDO methods.

These optical (luminescent) methods can be used in the measurement of Biochemical Oxygen Demand (BOD), Carbonaceous Biochemical Oxygen Demand (CBOD), and Dissolved Oxygen (DO) under the Clean Water Act.

2. Is there a difference between EPA approval for the RDO optical DO methods and EPA approval for other optical (luminescent) DO methods?

Yes. This is the first optical DO method to receive nationwide, Tier 3 EPA approval for CBOD, along with BOD and DO.

3. Does this EPA approval apply to municipal wastewater?

Yes. The methods are approved for use in Clean Water Act programs. The EPA has granted nationwide approval to three In-Situ RDO optical DO methods. These methods can be used in the measurement of BOD, CBOD, and DO under the Clean Water Act. NPDES permit holders may begin monitoring with In-Situ RDO methods.

4. Does this EPA approval apply to industrial wastewater?

Yes. In-Situ RDO methods can be used to determine BOD, CBOD, and DO in many types of industrial wastewater under the Clean Water Act. NPDES permit holders may begin monitoring with the In-Situ RDO methods.

Figure 1. The EPA has granted nationwide approval to three In-Situ optical DO methods.

5. Now that the In-Situ RDO methods have EPA approval, where can I apply the technology?

The reliable, accurate RDO technology can be used at key monitoring points throughout a wastewater treatment plant, including influent, on-line process control and spot checking, laboratory BOD and CBOD, and plant effluent.

- **Plant Influent:** Treatment plants monitor DO levels in incoming untreated waste streams. Influent monitoring for conventional parameters, in addition to being mandated by the NPDES permit also is necessary for process control. Monitoring plant influent provides data to estimate loading rates and is the basis for determining treatment plant efficiency.
- **Process Control:** Monitoring DO levels during the treatment process ensures that the plant is operating at optimal efficiency and that aerobic and anaerobic microbes are effectively breaking down the waste.
- **Laboratory Analysis:** BOD and/or CBOD analysis are required as part of a facility's NPDES permit and can be used to gauge the effectiveness of the wastewater treatment operation.

Figure 2. RDO technology can be used at key monitoring points throughout the wastewater treatment plant–influent monitoring, on-line process control, spot checking, laboratory BOD and CBOD determinations, and effluent monitoring.

- **Plant Effluent:** Effluent monitoring characterizes the quality of the effluent discharged to a receiving body of water. The NPDES permit requires effluent monitoring and imposes permit limits to ensure the health of the receiving water.

6. How does recent EPA approval of the In-Situ RDO methods apply to ambient water quality monitoring?

Certain states also require the use of an EPA-approved method for ambient water quality monitoring. Users of the In-Situ RDO technology can be confident that they are using an accurate and well-validated technology for their monitoring projects.

7. Does EPA approval apply to drinking water?

The Safe Drinking Water Act (SDWA; 40 CFR 141) does not list a specific method for DO. The SDWA allows analysts to use any EPA-approved method for analytes/methods not listed in 40 CFR 141.

8. What are the complete and accurate names of the In-Situ methods?

- In-Situ Inc. Method 1003-8-2009 Biochemical Oxygen Demand (BOD) Measurement by Optical Probe (ATP Case No. N09-0020)
- In-Situ Inc. Method 1004-8-2009 Carbonaceous Biochemical Oxygen Demand (CBOD) Measurement by Optical Probe (ATP Case No. N09-0021)
- In-Situ Inc. Method 1002-8-2009 Dissolved Oxygen Measurement by Optical Probe (ATP Case No. N05-0014)

ATP VALIDATION DATA

1. What does "Tier 3" EPA approval mean?

According to the EPA, Tier 3 approval is intended to "allow nationwide use of a new method by all regulated entities and laboratories for all matrix types. The increased flexibility at Tier 3 should allow vendors to establish that new devices and reagents produce results that are acceptable for compliance monitoring purposes, and should allow commercial laboratory chains to apply new technologies and techniques throughout their chain of laboratories to all matrix types1 ."

In other words, Tier 3 ATP approval is intended to promote the nationwide adoption of advanced technologies that will improve water monitoring and enhance water quality. This is why the EPA ATP was approved for the In-Situ RDO methods for wastewater and matrices subject to Clean Water Act requirements.

Now, with the assurance that this ATP approval provides, water professionals across the United States can upgrade easily to In-Situ RDO methods and the latest generation of optical-based RDO water monitoring technology.

2. Why is ATP approval of the In-Situ method for the CBOD important to wastewater professionals?

The CBOD test is required for many NPDES permits. The In-Situ RDO ATP for CBOD is the only optical-based method that is EPA approved and allows wastewater treatment professionals to monitor for CBOD in full compliance with Clean Water Act requirements.

3. How conclusive were the test results that In-Situ Inc. provided to support the ATP that was submitted to the EPA for approval?

In-Situ Inc.'s successful application for ATP approval was supported by the most extensive and thorough body of test data ever generated in an ATP for an optical-based DO method. The data proves the accuracy and reliability of the RDO optical method for measuring BOD, CBOD, and DO.

This robust analysis consisted of tests conducted by 10 laboratories (validation requires a nine-laboratory validation study). Testing was conducted on all nine matrices required by the EPA for Tier 3 approval. More than 1,300 samples were analyzed. The scope of these tests is unprecedented, well exceeding Tier 3 requirements for nationwide EPA approval.

4. Where were the In-Situ RDO methods tested?

The In-Situ test program was conducted in 10 laboratories that were extremely diverse. Test sites included laboratories in small, mid-sized, and large wastewater facilities. The 10 sites also represented a mix of municipal, state, and commercial laboratories. All of the laboratories met either DMRQA, state wastewater certification, or NELAC requirements.

Figure 3. NPDES permit holders must monitor BOD, and many NPDES permits require CBOD analysis. The EPA has granted nationwide approval to In-Situ RDO methods and their use in determining BOD and CBOD.

Testing was conducted on all nine matrices as required by the EPA for Tier 3 approval. Because laboratory technicians found the analysis easy to perform and the instruments easy to operate, the technicians conducted significantly more tests than the number required by the EPA. In total, more than 1,300 tests were completed.

[1] EPA 821-B-98-002: Protocol for EPA Approval of ATP for Organic and Inorganic Analytes in Wastewater and Drinking Water, March 1999, p. 14

METHODS VALIDATED FOR ATP APPROVAL

MATRICES/APPLICATION	IN-SITU RDO METHODS	ASTM D888-05	STANDARD METHODS 5210-B FOR MEMBRANE PROBES
BOD	1003	✓	✓
BOD NON-STIRRED	1003	*	*
CBOD	1004	*	✓
CBOD NON-STIRRED	1004	*	*
MEETS STANDARD METHODS 5210 B G/GA STANDARDS	1002, 1003 and 1004	*	✓
MEETS STANDARD METHODS 5210 B QA/QC STANDARDS	1002, 1003 and 1004	*	✓
SURFACE WATER	1002	One vendor supplied method data	Standard Methods 4500 O-G
DRINKING WATER	1002	Unknown	Unknown
MUNICIPAL INFLUENT	1003 and 1004	One vendor supplied method data	✓
MUNICIPAL EFFLUENT	1002	One vendor supplied method data	✓
SIGNIFICANT INDUSTRIAL INFLUENT	1003 and 1004	Unknown	✓
ANIMAL BLOOD PRODUCTS	1003 and 1004	Unknown	Unknown
ANIMAL SLAUGHTER FACILITY	1003 and 1004	Unknown	Unknown
BREWERY	1003 and 1004	Unknown	Unknown
CANDY MANUFACTURER	1003 and 1004	Unknown	Unknown
DAIRY	1003 and 1004	Unknown	Unknown
ETHANOL PLANT	1003 and 1004	Unknown	Unknown
FOOD PROCESSORS	1003 and 1004	Unknown	Unknown
GELATIN PROCESSOR	1003 and 1004	Unknown	Unknown
MEAT BY-PRODUCT PROCESSOR	1003 and 1004	Unknown	Unknown
MEAT PROCESSOR	1003 and 1004	Unknown	Unknown
SODA POP MANUFACTURER	1003 and 1004	Unknown	Unknown
WET CORN MILL	1003 and 1004	Unknown	Unknown
WOOD PRODUCTS PROCESSING	1003 and 1004	Unknown	Unknown
CATEGORICAL INDUSTRIAL INFLUENT	1003 and 1004	Unknown	✓
IRON AND STEEL MANUFACTURING	1003 and 1004	Unknown	Unknown
METAL FINISHING	1003 and 1004	Unknown	Unknown
CENTRALIZED WASTE TREATMENT	1003 and 1004	Unknown	Unknown
TRANSPORTATION EQUIPMENT CLEANING	1003 and 1004	Unknown	Unknown

* Not tested for regulatory acceptance purposes

Figure 4. In-Situ Inc.'s successful ATP application was supported by testing conducted on all nine matrices required by the EPA for nationwide Tier 3 approval, including municipal influent and effluent, significant industrial influent, and categorical industrial influent.

5. How did the RDO Sensor perform in the matrices listed on page 4?

The RDO Sensor did not show any significant interferences in any of the sample matrices. Traditional industrial sewage samples from industries with high oil and grease discharges, such as animal processing and metal finishing plants, did not foul the probe. Sulfide showed no interference in any of the samples tested.

6. Why did In-Situ conduct tests that exceeded EPA requirements by such a wide margin?

The goal of the In-Situ Method Development Team was not simply to satisfy the EPA's basic requirements for approval of the In-Situ RDO method. Instead, the team designed the validation test program to:

- Prove the accuracy and reliability of the RDO method in a multitude of real-world applications.
- Offer water quality professionals the greatest possible level of confidence in methods for BOD, CBOD, and DO measurement.
- Deliver proven methods to water quality professionals who must meet NPDES permitting requirements.
- Confirm the value of the latest generation of In-Situ RDO technology.

7. How does the ASTM method compare to the ATP approved In-Situ methods?

The data set used to validate the ASTM method (D888-05) was for DO only. In addition, testing for BOD and CBOD was not conducted.

In-Situ Inc. followed EPA guidelines for validating methods for BOD, CBOD, and DO. Tests were conducted by 10 laboratories (the EPA requires a nine-laboratory study) on all nine matrices required by the EPA for Tier 3 approval. In addition, the In-Situ validation study included both stirred and non-stirred BOD, CBOD, and DO methods.

REAL-WORLD APPLICATION

1. Now that In-Situ RDO methods are EPA approved, what benefits will I gain by upgrading our plant to monitoring equipment that includes RDO technology?

- RDO technology offers the latest in optical-based measurement of BOD, CBOD, and DO. Advantages include:
- Greater accuracy and reliability than membrane-based methods
- Greater peace of mind—RDO methods are EPA approved for BOD, CBOD, and DO determination
- Option to use either stirred or non-stirred techniques for BOD, CBOD, and DO determinations
- No hydration effects – even if the sensor dries out
- Simple calibration procedures and a sensor cap loaded with calibration coefficients
- Stable, long-lasting calibration
- Excellent response time and stability in samples that range from surface water, to treated wastewater, to industrial sewer discharge
- Resists fouling by oils and fats
- Unaffected by interferences—Sulfides, sulfate, carbon dioxide, ammonia, pH, chloride, or chlorine
- Significantly less maintenance
- Lowers overall costs

2. Where can I use RDO technology in my plant?

The In-Situ RDO methods are included in the final Methods Update Rule that was published on May 18, 2012. NPDES permit holders may begin monitoring with the In-Situ RDO methods. The reliable, accurate RDO technology can be used at key monitoring points throughout a wastewater treatment plant, including:

- **Plant Influent:** Incoming untreated waste streams are often monitored with a process DO probe, such as the RDO PRO Probe.
- **Process Control:** Monitoring DO levels during the treatment process can be accomplished by using either an In-Situ RDO PRO Probe or a handheld meter. Both Thermo Scientific® and Mettler-Toledo® meters include the RDO Sensor.
- **Laboratory Analysis:** BOD and/or CBOD determinations are required as part of a facility's NPDES permit. Both BOD and CBOD analysis can be accomplished by using an instrument such as a Thermo Scientific or Mettler-Toledo handheld meter with RDO Sensor.
- **Plant Effluent:** Effluent is often monitored by a process DO probe, such as the RDO PRO Probe. The In-Situ Aqua TROLL® 400 Multiparameter Instrument with RDO Sensor can be used to monitor DO, conductivity, ORP, pH, temperature, and water level. The In-Situ TROLL® 9500 Water Quality Instrument with RDO Sensor can be used to monitor DO, conductivity, ORP, pH, and other parameters (e.g., turbidity, water level) in the effluent stream.

3. The method works without stirring the sample?

Yes. Thorough analysis of over 1,300 unique samples by 10 laboratories demonstrated that the RDO Sensor is comparable to the standard membrane-based DO sensor and that the RDO Sensor and method can be used either with or without the sample being stirred. The EPA approved methods are for both stirring and non-stirring applications of BOD, CBOD, and DO measurement.

4. Why doesn't the In-Situ RDO require stirring?

Breakthrough RDO technology does not require stirring because oxygen is not consumed during the measurement reaction. Older technologies and methods require stirring and sample flow.

Unlike other optical (luminescent) DO sensors, the In-Situ RDO Sensor had no observed differences in analytical results or stabilization times between stirred and non-stirred samples. This enabled the ATP approval of both stirred and non-stirred methods.

Figure 5. The Con TROLL PRO System with RDO PRO Probe can be used to monitor influent, effluent, and wastewater treatment processes.

5. Why does the RDO Sensor withstand hydration effects better than the competition?

In-Situ Inc.'s Sensor Development Team pioneered optical (luminescent) DO technology. Since In-Situ Inc. owns the technology, the Development Team is able to continuously improve the sensor and implement the latest advances in optical DO technology. Unlike other optical DO sensors, the In-Situ RDO technology has been specially developed to read within the accuracy specification, even if the sensor dries out.

6. Why is the RDO technology better suited than other technologies for QA/QC?

The RDO Sensor allows the user to perform 1- or 2-point calibrations. The sensor can be calibrated in air-saturated water or water-saturated air for the 100% point. For the 0% point, either nitrogen-saturated water or sodium-sulfite solution can be used. The 2-point calibration allows users to validate performance in low DO conditions.

7. How often do I need to calibrate the sensor?

The sensor accuracy out of the box is better than ±2%. For BOD, CBOD, or DO testing, users should follow In-Situ methods 1003 or 1004, respectively. Calibration frequency is typically determined by the plant's standard operating procedure for process control, however, the RDO Sensor has been shown to remain within accuracy specifications for six months or more without recalibration. For even better accuracy, the user can perform a 100% calibration before deploying the sensor for the first time. A 2-point calibration can also be performed if desired.

Figure 6. The Aqua TROLL 600 Multiparameter Sonde with RDO Sensor can be used to monitor effluent streams.

8. What maintenance does the RDO Sensor require?

The RDO Sensor operates for a full year before requiring sensor cap replacement. If the sensing element becomes dirty or fouled, a simple cleaning procedure will return the sensor to its original accuracy specifications. The RDO Sensor does not require troublesome wipers or brushes. The robust sensing cap will withstand manual scrubbing or air blasts.

9. Why doesn't In-Situ use a wiper on their sensor like some other manufacturers?

The In-Situ RDO Sensor features passive antifouling properties that help extend periods between service. Optical sensors that require wipers have been shown to:

- Abrade the sensing element, which requires frequent replacement of the element.
- Require wiper pad replacements every two weeks, especially in gritty water.
- Require annual factory service on wiper shaft seals in order to maintain the sensor warranty.
- Exhibit high field-failure rates of the wiper and wiper motor.

10. What interferences affect the RDO Sensor?

None. The RDO Sensor was tested in over 1,300 municipal, categorical, and significant industrial samples. No matrix interferences were found. For a more detailed chemical compatibility list, see the TROLL 9500 Water Quality Instrument specification sheet.

11. Can I use another manufacturer's optical DO sensor with the In-Situ RDO methods?

If you choose to use another optical DO probe, you are responsible for developing and providing equivalence data to an auditor. Since the In-Situ RDO methods were tested on 1,300 unique samples and nine matrices, development of equivalence data would require significant laboratory analyses that correspond to In-Situ Inc.'s ATP application.

Figure 7. For real-time monitoring of DO, conductivity, pH, ORP, turbidity, temperature, level and much more, use the Aqua TROLL 500 Multiparameter Sonde.

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