

**Frederick National Laboratory
for Cancer Research**

sponsored by the National Cancer Institute

Vaccine, Immunity and Cancer Directorate
Standard Operating Procedure

SOP Title: Use and Maintenance of the FYRITE Gas Analyzer

Document ID: 26027

Version

1.0

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Supersedes

New SOP

Effective Date: 07Sep21

Written by:

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1. PURPOSE

- 1.1. To describe the use and maintenance of the FYRITE® Gas Analyzer.

2. SCOPE

- 2.1. This procedure applies to all FYRITE® Gas Analyzers.

3. REFERENCES

- 3.1. FYRITE® Classic User Manual-Rev.13, Bacharach
- 3.2. 10007: Non-Routine Equipment Maintenance
- 3.3. 10009: General Record Review
- 3.4. 26016: Use and Maintenance of the Water Purification Systems
- 3.5. 15000: Waste Disposal at the Advanced Technology Research Facility

4. RESPONSIBILITIES

- 4.1. The Research Associate, hereafter referred to as Analyst, is responsible for reviewing and following this procedure, and documenting performance of equipment maintenance.
- 4.2. The Scientific Manager or designee is responsible for training personnel in this procedure and reviewing associated documentation.
- 4.3. The Quality Assurance Specialist is responsible for quality oversight and approval of this procedure.
- 4.4. Trained personnel perform equipment maintenance record review per "10009: General Record Review."

5. DEFINITIONS

- 5.1. As Needed Maintenance – maintenance that is performed outside of routine maintenance but is not performed in response to equipment malfunction.
- 5.2. Routine Maintenance – maintenance that is performed at planned intervals to identify and prevent problems before they result in equipment failure.

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- 5.3. Non-Routine Maintenance – maintenance that is performed in response to equipment malfunction or failure.

6. REAGENTS, MATERIALS, AND EQUIPMENT

- 6.1. FYRITE Carbon Dioxide Refill Kit, 20 & 60% (Bacharach, Cat # 0011-7047)
- 6.2. Gas Analyzer, FYRITE® (CO₂: 0-20%) (Bacharach, Cat# 0010-5000)
- 6.3. Rubber Connector Tip / Aspirator Bulb / Saturator Tube (FYRITE® Kit)
- 6.4. Type II Water – Pure/Analytical Grade, used for standard applications (Resistivity >1 MΩ-cm and TOC ≤ 50 ppb)

7. HEALTH AND SAFETY CONSIDERATIONS

- 7.1. Proper safety precautions should be taken while working in a laboratory setting. This includes, but is not limited to, proper protective equipment such as lab coats, safety glasses, closed-toe shoes, and non-latex gloves.
- 7.2. Refer to the respective Safety Data Sheet (SDS) when working with any chemicals.
- 7.3. Refer to “15000: Waste Disposal at the Advanced Technology Research Facility,” “EHS-WM-1: Disposal and Minimization of Chemical Waste,” and “EHS-WM-2: Biological Waste Handling and Disposal” for waste disposal processes.
- 7.4. FYRITE® is **corrosive** and care should be maintained when handling it to ensure liquid is not spilled from Gas Analyzer or allowed to settle around Plunger.
- 7.5. Vent FYRITE® by holding Gas Analyzer at 45° away from the Analyst and then depressing Plunger.
- 7.6. Never vent FYRITE® with the Gas Analyzer in the inverted position (Plunger facing downwards).

8. PROCEDURE

- 8.1. FYRITE® Gas Analyzer General Use

Note: FYRITE® employs the “Orsat” method of volumetric analysis involving chemical absorption of a sample gas, such as carbon dioxide (CO₂). The reagent used to absorb CO₂ is potassium hydroxide (dyed red).

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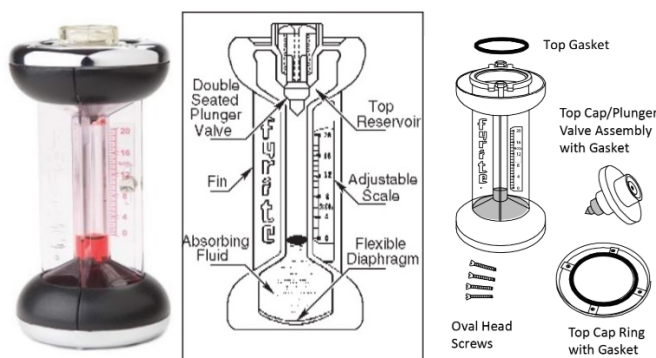
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Note: Accuracy of the FYRITE® Gas Analyzer is $\pm 0.5\%$.

8.1.1. Refer to Figure 1 for a diagram of the FYRITE® Gas Analyzer.

Figure 1: Diagram of the FYRITE® Gas Analyzer



- 8.1.2. Hold the Gas Analyzer by the Fin to prevent warming of fluid during analysis.
- 8.1.3. FYRITE® should always be in the bottom reservoir of Gas Analyzer before and during sample introduction.
- 8.1.4. Prior to using Gas Analyzer, verify Plunger is not corroded and able to spring back to its proper placement after depressed.
- 8.1.5. When inverting Gas Analyzer, verify Plunger is positioned correctly.
- 8.1.6. It is recommended to work over benchtop paper or trash can in case of spills.
- 8.1.7. The carrying case is stored at room temperature and with the Top Reservoir of the Gas Analyzer upright when not in use.
- 8.1.8. FYRITE® fluid refill bottles are stored at room temperature in the original packaging and used prior to expiration.
- 8.1.9. Precipitates or a darker red fluid which may be found in the FYRITE® absorbing fluid refill bottles do not affect performance.
- 8.1.10. Gradual loss of fluid or dried encrustation forming around the Plunge Valve does not indicate fluid leakage and is encountered during normal use.

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8.2. Preparing the FYRITE® Gas Analyzer

8.2.1. Remove the Gas Analyzer from the carrying case.

8.2.2. Separate the Plastic Tubing from the Filter Saturator Tube. Verify the Filter Saturator wool is saturated.

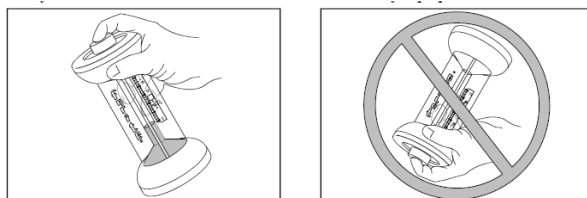
8.2.2.1. If the Filter Saturator wool is dry, saturate with tap water and wring out excess liquid. Replace the wool then reconnect the Filter Saturator Tube to the Plastic Tubing.

8.2.3. Check for leaks in the Tubing by plugging Rubber Connector Tip with finger, then squeeze the Aspirator Bulb, ensuring the rubber remains firm. Replace the Tubing or Aspirator Bulb if the rubber is no longer firm.

8.2.4. Vent and Zero the FYRITE® Gas Analyzer

Note: Never vent the FYRITE® Gas Analyzer in the inverted position, as this will cause leakage of fluid from inside the device. See Figure 2 below.

Figure 2: Proper Venting Position of the FYRITE® Gas Analyzer



8.2.4.1. Hold the Gas Analyzer in the up-right position with the fluid in the Bottom Reservoir.

8.2.4.2. Angle the Gas Analyzer away from Analyst's face and press down on the Plunger Valve for approximately 3-5 seconds to vent air into the device.

8.2.4.3. Release the Plunger Valve so that it fully closes.

8.2.4.4. Invert the Gas Analyzer while maintaining a slight angle to drain the fluid into the Top Reservoir.

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- 8.2.4.5. Turn upright and hold the Gas Analyzer at ~45° angle to allow the fluid to return to the Bottom Reservoir.
- 8.2.4.6. Hold the Gas Analyzer in the up-right position with the fluid in the Bottom Reservoir.
- 8.2.4.7. Angle the Gas Analyzer away from Analyst's face and press down on the Plunger Valve for approximately 3-5 seconds to vent air into the device.
- 8.2.4.8. The level of the fluid should match the "0" position on the Adjustable Scale located on one of the four Fins.
 - 8.2.4.8.1. If necessary, zero the Scale by placing Gas Analyzer on a flat, level surface.
 - 8.2.4.8.2. Loosen the Locknut that is holding the Scale to the Fin.
 - 8.2.4.8.3. Bring the "0" on the scale in-line to the top of the fluid column while sighting across the scale then tighten Locknut.
- 8.2.4.9. If the level of FYRITE® fluid is too low and the scale cannot be zeroed, then Type II Water may be added.
 - 8.2.4.9.1. Hold Gas Analyzer upright and cover the hole in the center of Plunger Valve with a gloved finger.
 - 8.2.4.9.2. Add Type II Water, dropwise into space around the Plunger Valve.
 - 8.2.4.9.3. Move the Plunger Valve up and down several times.
 - 8.2.4.9.4. Repeat steps 8.2.4.9.2 – 8.2.4.9.3 until fluid is at proper level. Refer to Figure 3.

Figure 3: Filling FYRITE® Gas Analyzer with Water

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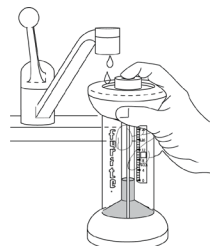
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8.3. CO₂ Reading

8.3.1. Once vented and zeroed, connect the end of the Sampling Tube into the "Sample Port" of an Incubator.

8.3.2. Put the Rubber Connector Tip on top of the Plunger Valve, press down on the valve and hold. The Connector allows the air to flow into the Gas Analyzer for sample collection. See Figure 4 below.

Figure 4: Connector Tip on Plunger Valve



8.3.3. While the Plunger Valve is depressed, squeeze/release the Aspirator Bulb 18- 20 times.

8.3.4. After the last squeeze, while still squeezing the Bulb, release the Rubber Connector Tip from the Plunger Valve, then release the Bulb.

8.3.5. Invert the Gas Analyzer, allowing the fluid to drain into the Top Reservoir.

8.3.6. Invert the Gas Analyzer to the up-right position allowing the fluid to drain into the Bottom Reservoir.

8.3.7. Repeat steps 8.3.5 and 8.3.6 one additional time.

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8.3.8. Hold the Gas Analyzer upright and put on a stable/level surface. Allow fluid in the column of the device to settle.

8.3.9. Immediately read the percentage of CO₂ by using the numbers on the Scale at the point corresponding to the top of the fluid column.

Note: The top of the fluid column of liquid FYRITE® within the Gas Analyzer can refer to either the top or the bottom of the meniscus of that fluid as long as the Analyst is consistent in using the same point when adjusting the scale and reading results.

Note: A delay in reading by 5-10 seconds may slightly decrease the accuracy, but longer delay could cause substantial error.

8.3.10. Store the Gas Analyzer with the Top Reservoir upright in the storage case.

9. MAINTENANCE

9.1. Annual Maintenance

9.1.1. FYRITE® Absorbance Fluid Replacement and Top Gasket

9.1.1.1. FYRITE® Absorbance Fluid Replacement and Top Gasket is changed annually.

9.1.1.2. Perform the Annual Maintenance near a sink with running tap water.

9.1.1.3. Remove 4 Screws, metal top Cap Ring, plastic Top Cap Assembly, and Top Gasket from the top of the Gas Analyzer. See Figure 5 below.

Figure 5: Gas Analyzer Assembly

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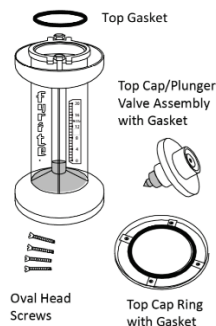
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- 9.1.1.4. Collect old fluid in a reagent bottle marked for pickup by Waste Management, per 15000.
- 9.1.1.5. Rinse all parts of the Gas Analyzer with clean, lukewarm tap water.
- 9.1.1.6. Drain all excess water into a beaker and transfer to the red Chemical Waste Container.
- 9.1.1.7. Record waste type and volume transferred to red Chemical Waste Container on Chemical Waste Form.
- 9.1.1.8. Perform a second rinse of the Gas Analyzer with clean, lukewarm tap water. Drain this excess water into sink.
- 9.1.1.9. Replace the Top Gasket and return the Top Gasket to the flange, or internal ridge, of the Gas Analyzer. Ensure that the Top Gasket is flush.
- 9.1.1.10. Open the bottle of FYRITE® Absorbent Fluid.
- 9.1.1.11. Invert the Gas Analyzer and place over the opened bottle of FYRITE® Absorbent Fluid. Invert both together to allow the Absorbent Fluid to drain into the Gas Analyzer. See Figure 6.

Figure 6: Filling the FYRITE® Gas Analyzer with Absorbent Fluid

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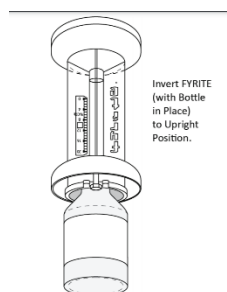
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- 9.1.1.12. Discard empty FYRITE® bottle and immediately install plastic Top Cap/Plunger Assembly and then the metal Top Ring with Gasket.

Note: Ensure the Gasket is situated between the metal Top Ring and the Plastic Cap/Plunger Assembly.

- 9.1.1.13. Replace the 4 Screws and hand tighten them down gently with light force. Draw down each with screwdriver at ¼ turn increments until all are firmly tightened.

Note: Do not use excessive force when drawing the Screws down, nor over tighten, as this could lead to the plastic components being damaged.

- 9.1.1.14. Record maintenance on “26027-01: Maintenance of the FYRITE Gas Analyzer Form.”

9.2. As needed Maintenance

- 9.2.1. If the CO₂ measurements are suspect when comparing to another FYRITE Analyzer, the FYRITE fluid may be changed (see 9.1.1 for instructions).

- 9.2.2. Record maintenance on “26027-01: Maintenance of the FYRITE Gas Analyzer Form.”

9.3. Non-routine Maintenance

- 9.3.1.1. In the case that the Gas Analyzer is not operating correctly, transition processes being performed to another unit (when

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applicable), post a sign stating the equipment is out of service and initiate non-routine maintenance documentation per "10007: Non-Routine Equipment Maintenance."

9.3.1.2. Document the nature of any failures or malfunctions, how and when it was discovered, and the personnel involved on "10007-01: Non-Routine Equipment Maintenance Form."

9.3.1.3. Initiate a service request and complete the non-routine maintenance process following 10007.

10. ATTACHMENTS

10.1. Attachment 1: 26027-01: Maintenance of the FYRITE Gas Analyzer Form

11. REVISION HISTORY

Version	Change	Reason
1.0	New SOP	New SOP was developed for the FYRITE Gas Analyzer.

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Attachment 1: 26027-01: Maintenance of the FYRITE Gas Analyzer Form

Frederick National Laboratory for Cancer Research <small>sponsored by the National Cancer Institute</small>		Vaccine, Immunity and Cancer Directorate Standard Operating Procedure Form	
Form Title: Maintenance of the FYRITE Gas Analyzer Form			
Document ID: 26027-01		Version:	1.0
Associated SOP: 26027		Effective Date:	07Sep21
Supersedes:	New	Page 1 of 1	

Equipment ID:		Maintenance Year (YYYY)	
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Annual Maintenance

FYRITE® Fluid Lot Number:		FYRITE® Fluid Expiration Date:	
Performed By/Date:		Reviewed By/Date:	

As Needed Maintenance: ☐ N/A

Date	Activity Performed	Recorded By/Date	Reviewed By/Date
<input type="checkbox"/> N/A			
<input type="checkbox"/> N/A			

QA Reviewed By/Date: _____

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