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AUTHOR Wooley, John F.
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ABSTRACT

Designed for individuals who have completed National Pollutant Discharge Elimination System (NPDES) level 1 laboratory training skills, this module on digestor gas analysis provides waste water treatment plant operators with the basic skills and information needed to: (1) successfully run the carbon dioxide analysis test; (2) accurately record data and observations; (3) organize data to perform required calculations for the test; (4) make general interpretations as to the quality of digestor gas utilized in the test; and (5) obtain reliable, consistent results from the test procedure. The instructor's manual contains a statement of instructional goals, lists of instructor/student activities and instructional materials, and student worksheet (with answers). The student workbook contains objectives, prerequisite skills needed before the module is started, sources of Fyrite Carbon Dioxide Analyzers, laboratory procedures (monitoring changes in digestor activity by determining carbon dioxide with a carbon dioxide analyzer), and worksheet. (Author/JN)

Operational Control Tests

for Wastewater Treatment Facilities

Percent CO_2

Instructor's Manual

CO_2

Linn-Benton Community College
Albany, Oregon

PERCENT CO_2

Written By:
John F. Wooley
Linn-Benton Community College
Albany, Oregon

Instructional Design:
Priscilla Hardin
Corvallis, Oregon

Project Management:
John W. Carnegie, Ph.D.
Linn-Benton Community College
Albany, Oregon

Project Officer:
Lynn S. Marshall
United States Environmental Protection Agency
National Training and Operational Technology Center
Cincinnati, Ohio

Developed Under:
EPA Grant #900953010
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PERCENT CO_2

CONTENTS

INSTRUCTIONAL GOALS

Upon completion of this module the student should be able to successfully run the CO_2 analysis test and accurately record the data and observations. The student also should be able to organize the data so as to perform the required calculations for this test. Based on values obtained the student should be able to make general interpretations as to the quality of digestor gas utilized in the test.

INSTRUCTOR ACTIVITY

For best results follow this sequence:

Activity	Time
1. Review the objectives with the students.	5 minutes
2. Have students read the procedure.	10 minutes
3. Demonstrate test procedures.	15 minutes
4. Discuss calculations: Method B	10 minutes
5. Assign worksheet.	5 minutes
6. Correct worksheet.	10 minutes
7. Perform tests.	30 minutes
8. Perform calculations - Method B	10 minutes

OTHER ACTIVITIES:

1. Prepare reagents - Method B

STUDENT ACTIVITY

1. Read objectives.
2. Read procedure.
3. Complete worksheet
4. Perform test.
5. Record data.
6. Calculate percent CO_2 - Method B
7. Interpret results.

INSTRUCTIONAL MATERIALS LIST

1. Instructor's Guide - CO_2 Analysis
2. Student workbook - CO_2 Analysis
3. Equipment listed in the Lab Procedures

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WORKSHEET

Directions: Place an "X" by the best answer. There is only one best answer for each question.

1. Digestor gas is generally composed of:
   a) ____ SO_2.
   b) ____ SO_2 and O_2.
   c) X ____ CO_2 and methane.
   d) ____ CO_2 and O_2.
   e) ____ SO_3 and NH_4.

2. Bleeding the digestor gas line is always necessary because:
   a) ____ all the CO_2 collects in the line.
   b) X ____ water collects in the line.
   c) ____ all the methane collects in the line.
   d) ____ SO_2 collects in the line.
   e) ____ None of the above.

3. The analysis of CO_2 is based upon the fact that:
   a) X ____ CO_2 is absorbed by chemicals in the test.
   b) ____ CO_2 remains unabsorbed.
   c) ____ methane is absorbed by chemicals in the test.
   d) ____ moisture is present in the sample.
   e) ____ None of the above.

4. The absorbent used in the test:
   a) X ____ is caustic and can cause burns.
   b) ____ is acidic and can cause burns.
   c) ____ is neutral.
   d) ____ All of the above.
   e) ____ None of the above.

5. When using the Fyrite analyzer:
   a) X ____ the chamber must be reset to zero.
   b) ____ you must prepare your own reagents.
   c) ____ the methane level is measured directly.
   d) ____ All of the above.
   e) ____ None of the above.

6. When using the Fyrite analyzer:

a) _____ the bottom of the meniscus is read.

b) __X__ the top of the meniscus is read.

c) _____ there is no meniscus.

d) _____ All of the above.

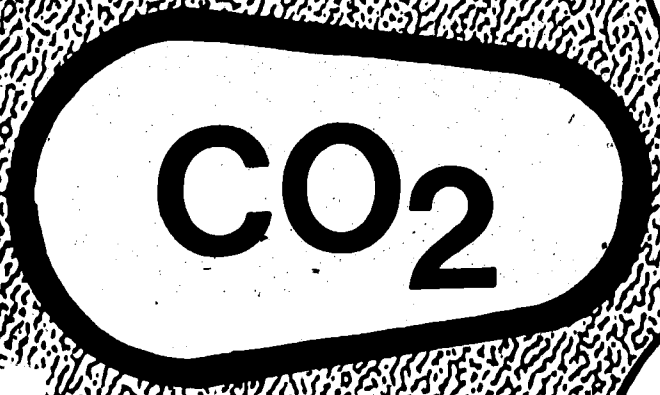
e) _____ None of the above.

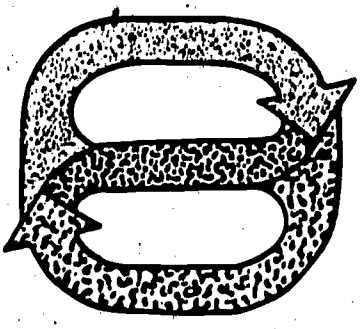
Operational Control Tests

for Wastewater Treatment Facilities

Percent CO_2

Student Workbook





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INTRODUCTION

This module on digestor gas analysis is intended to give the operator the basic information necessary to obtain reliable data from the test procedures. The mention of any brand names should not be taken as an endorsement of that material. This test procedure is intended to be used by individuals who have completed NPDES Level 1 laboratory skills training.

OBJECTIVES

Upon completion of this module you should be able to:

1. Describe the purpose of the gas analysis tests.
2. Describe the test procedure using a Fyrite CO_2 Indicator.
3. Describe the test procedure using the graduated cylinder method.
4. Read Fyrite Indicator.
5. Calculate percent CO_2 using graduate cylinder method.

PREREQUISITE SKILLS

In addition to the skills listed in the introduction, the following skills are needed for this test:

1. Knowledge of maintenance of Fyrite CO_2 Analyzer.
2. Knowledge of digestor gas sample site.
3. Knowledge of how to bleed digestor gas line.

RESOURCE LIST

1. Fisher Scientific
   2170 Martin Ave
   Santa Clara, CA 95050
   (408) 727-0660
   Fyrite CO_2 Analyzer
   #10-884

2. Scientific Products
   3660 148th Ave., N.E.
   Redmond, WN 98052
   (206) 885-4131
   Fyrite CO_2 Analyzer
   #G1725

3. VWR Scientific
   P.O. Box 14070
   Portland, OR 97214
   (503) 234-9272
   Fyrite CO_2 Analyzer
   #32022-000

DIGESTOR GAS ANALYSIS

PERCENT CO_2

INTRODUCTION

The activities taking place in an anaerobic digestor are reflected in the production of digestor gas. The gas is generally composted of approximately 30% carbon dioxide and 70% methane. If these general proportions vary appreciably from this ratio the operator should be aware of potential problems and may want to perform further and more extensive studies of the digestor content.

The easiest test procedure to use for monitoring changes in digestor activity is the determination of CO_2 with a CO_2 analyzer.

EQUIPMENT - METHOD A

Fyrite CO_2 Indicator, Model CND

PROCEDURE

1. RESET THE CHAMBER TO ZERO.

   The chamber is reset to zero by pressing the valve on top of the instrument which allows air to enter and the column of liquid to fall to zero.

2. ADJUST SCALE TO ZERO.

   The scale is adjustable. If the meniscus doesn't read exactly zero it should be adjusted to the zero line. Note that the zero is NOT read at the bottom of the meniscus but at the TOP.

3. BLEED GAS LINE FROM DIGESTOR.

   This blows out moisture and allows fresh gas to enter the line.

4. ATTACH HOSE TO GAS LINE.

5. PUMP GAS INTO CHAMBER.

   Hold the rubber connector tightly over the valve on top of the chamber with one hand and squeeze the bulb 18 times with the other hand.

6. INVERT THE CHAMBER SEVERAL TIMES TO MIX.

7. PLACE UP-RIGHT AND READ PERCENT OF CO_2 DIRECTLY.

Be sure to read the top of the meniscus.

EQUIPMENT - METHOD B

Plastic Tubing
100 ml Graduated Cylinder
250 ml Beaker
1 liter Volumetric Flask
1 liter Plastic Reagent Bottle
Reagents - Potassium Hydroxide (KOH)
Reagent Preparation
CO_2 Absorbent - Add 500 g potassium hydroxide to a 1 liter volumetric flask that has about 500 ml of distilled water in it. Swirl until dissolved. Bring up to the mark uith distilled water. Transfer to a 1 liter plastic reagent bottle. CAUTION: Never store strong basic solutions in glass stoppered bottles.

PROCEDURE

1. MEASURE VOLUME OF GRADUATED CYLINDER.

Measure the total volume of a 100 ml graduated cylinder by filling it to the top with water (approximately 125 ml). Record this volume.

2. ADD CO_2 ABSORBENT TO BEAKER.

Pour approximately 125 ml of CO_2 absorbent into the 250 ml beaker. CAUTION: This chemical is a strong basic solution (caustic) and will damage clothing and burn the skin.

3. BLEED THE GAS LINE FROM DIGESTOR.

This blows out moisture and allows fresh gas to enter the line.

4. ATTACH HOSE TO GAS LINE.

5. COLLECT SAMPLE.

With the gas running through the hose from the gas sampling outlet, place the hose inside the inverted, calibrated graduated cylinder and allow the gas to displace the air in the cylinder. Turn off gas. CAUTION: The proper mixture of digestor gas and air is explosive when exposed to an open flame.

6. PLACE GRADUATED CYLINDER INTO BEAKER OF CO_2 ABSORBENT.

Place the graduated cylinder full of digestor gas upside down in a beaker containing CO_2 absorbent.

7. INSERT GAS HOSE INTO GRADUATE.

Insert gas hose inside upside down graduated cylinder.

8. TURN ON GAS.

Turn on gas, but DO NOT blow the liquid out of the cylinder. Run gas for at least 60 seconds.

9. REMOVE HOSE.

Carefully remove the hose from the graduated cylinder with the gas still running.

10. IMMEDIATELY TURN OFF GAS.

11. WAIT TEN MINUTES.

Wait ten minutes and gently shake the graduated cylinder. If the liquid continues to rise, wait until it stops.

12. READ VOLUME OF GAS IN CYLINDER.

Read volume of gas remaining in graduated cylinder to the nearest milliliter.

CALCULATIONS

Percent CO_2

$$= \frac{\text{(Total volume, ml - gas remaining, ml)}}{\text{Total Volume, ml}} \times 100\%$$

EXAMPLE:

Total Volume of Cylinder	126 ml
Gas Remaining	80 ml

$$= \frac{126 \text{ ml} - 80 \text{ ml}}{126 \text{ ml}} \times 100\%$$

$$= \frac{46}{126} \times 100\%$$

$$= 37\%$$

% CO_2
(Fyrite Method)

Lab Technician_____ Date_____ Shift_____

Sample No.	Sample Time	$\%CO_2$

$\%CO_2$

(Graduated Cylinder Method)

Lab Technician _____ Date _____ Shift _____

Sample No.	Sample Time	Total Volume Cylinder, ml	Volume Gas Remaining,ml	$\%CO_2$

SAMPLE DATA SHEET

$\%CO_2$
(Graduated Cylinder Method)

Lab Technician RF Date 7/16 Shift 2

Sample No.	Sample Time	Total Volume Cylinder, ml	Volume Gas Remaining, ml	$\%CO_2$
1	9:15 pm	126 ml	80 ml	37%

CYLINDER CAPACITY

UNABSORBED GAS

PERCENT OF ABSORBED GAS

$\%CO_2$
(Fyrite Method)

Lab Technician RF Date 7/16 Shift 2

Sample No.	Sample Time	$\%CO_2$
1	9:15 pm	37%

READ PERCENT CO_2 DIRECTLY

PROCEDURE SUMMARY - Fyrite Method

PROCEDURE	CALCULATIONS
1. Reset chamber to zero. 2. Adjust scale to zero. 3. Bleed gas line from digestor. 4. Attach hose to gas line. 5. Pump gas into chamber. 6. Invert chamber several times to mix. 7. Place upright and read percent CO_2.	None

Fyrite Method - % CO_2

The above procedure summary is designed as a laboratory aid. It may be cut out and attached to a 5" X 7" index card for convient reference at the laboratory bench. To protect the card you may wish to cover it, front and back, with clear, self-adhesive shelf paper or similar clear material.

PROCEDURE SUMMARY - Graduated Cylinder Method

PROCEDURE

1. Measure volume of graduated cylinder.
2. Add CO_2 absorbent to beaker.
3. Bleed the gas line from digestor.
4. Attach hose to gas line.
5. Collect sample.
6. Place graduated cylinder into beaker of CO_2 absorbent.
7. Insert gas hose into graduate.
8. Turn on gas.
9. Remove hose.
10. Immediately turn off gas.
11. Wait ten minutes.
12. Read volume of gas in cylinder.

CALCULATIONS

$$\% CO_2 = \frac{\text{TOTAL VOLUME OF GRADUATED CYLINDER} - \text{VOLUME GAS REMAINING}}{\text{TOTAL VOLUME OF CYLINDER}} \times 100$$

Graduated Cylinder Method - % CO_2

The above procedure summary is designed as a laboratory aid. It may be cut out and attached to a 5" X 7" index card for convient reference at the laboratory bench. To protect the card you may wish to cover it, front and back, with clear, self-adhesive shelf paper or similar clear materjal.

PERCENT CO_2

WORKSHEET

Directions: Place an "X" by the best answer. There is only one best answer for each question.

1. Digestor gas is generally composed of:
   a)_____ SO_2.
   b)_____ SO_2 and O_2.
   c)_____ CO_2 and methane.
   d)_____ CO_2 and O_2.
   e)_____ SO_3 and NH_4.

2. Bleeding the digestor gas line is always necessary because:
   a)_____ all the CO_2 collects in the line.
   b)_____ water collects in the line.
   c)_____ all the methane collects in the line.
   d)_____ SO_2 collects in the line.
   e)_____ None of the above.

3. The analysis of CO_2 is based upon the fact that:
   a)_____ CO_2 is absorbed by chemicals in the test.
   b)_____ CO_2 remains unabsorbed.
   c)_____ methane is absorbed by chemicals in the test.
   d)_____ moisture is present in the sample.
   e)_____ None of the above.

4. The absorbent used in the test:
   a)_____ is caustic and can cause burns.
   b)_____ is acidic and can cause burns.
   c)_____ is neutral.
   d)_____ All of the above.
   e)_____ None of the above.

5. When using the Fyrite analyzer:
   a)_____ the chamber must be reset to zero.
   b)_____ you must prepare your own reagents.
   c)_____ the methane level is measured directly.
   d)_____ All of the above.
   e)_____ None of the above.

6. When using the Fyrite analyzer:

a)_____ the bottom of the meniscus is read.

b)_____ the top of the meniscus is read.

c)_____ there is no meniscus.

d)_____ All of the above.

e)_____ None of the above.