

astm e562

ASTM E562: A Comprehensive Guide to Standard Test Method for Determining Volume Fraction by Systematic Manual Sectioning

Introduction to ASTM E562

ASTM E562 is a widely recognized standard developed by ASTM International that specifies a systematic manual sectioning method for determining the volume fraction of phases within a solid material. This test method is crucial in materials science and engineering, especially for characterizing composite materials, alloys, and other multi-phase systems where understanding the distribution and proportion of constituent phases influences material performance and quality control.

Understanding the specifics of ASTM E562 helps engineers, researchers, and quality assurance professionals accurately assess the internal composition of materials, leading to more informed decisions in material selection, processing, and application.

Purpose and Scope of ASTM E562

Primary Objectives

ASTM E562 aims to provide a standardized approach to:

- Quantitatively determine the volume fraction of different phases within a solid sample.
- Offer a reproducible and reliable method suitable for various materials, including metals, ceramics, and composites.
- Facilitate comparative studies among different materials or processing conditions.

Scope of Application

This test method applies to:

- Homogeneous and heterogeneous materials.
- Small to medium-sized specimens where sectioning is feasible.
- Materials where phases are distinguishable via optical or microscopic examination after sectioning.

It is not suitable for materials with phases that are not visually distinguishable or for large

components where sectioning is impractical.

Principles of ASTM E562

The core principle of ASTM E562 involves:

- Preparing a representative specimen by sectioning the material systematically.
- Using optical microscopy or other suitable imaging techniques to analyze the section.
- Measuring the cross-sectional areas of different phases.
- Calculating the volume fraction based on the assumption that the cross-sectional area proportion reflects the volume proportion.

This method relies on the principle that, for a random and representative section, the area fraction of a phase correlates with its volume fraction in the entire specimen.

Materials and Equipment Required

Specimen Preparation

- Representative sample of the material.
- Cutting tools suitable for the material type (e.g., diamond saw, abrasive cutter).
- Mounting media for embedding specimens (if necessary).
- Grinding and polishing supplies to prepare a smooth, scratch-free surface.

Optical Analysis

- Optical microscope with appropriate magnification.
- Image capturing device or camera.
- Image analysis software (optional but recommended for accuracy).

Additional Equipment

- Calibration standards for measurement accuracy.
- Rulers or measurement scales integrated into imaging systems.
- Protective gear for handling specimens and equipment.

Step-by-Step Procedure of ASTM E562

1. Specimen Selection and Preparation

- Select a representative specimen that accurately reflects the material's overall composition.
- Cut the specimen to appropriate dimensions, ensuring minimal deformation.
- Mount and grind the specimen to achieve a flat, polished surface.
- Clean the surface thoroughly to remove debris and residues.

2. Systematic Sectioning

- Divide the specimen into multiple, systematically spaced sections.
- Use a grid or pattern to ensure representative sampling.
- Optionally, apply etching techniques to enhance phase contrast under microscopy.

3. Microscopic Examination

- Observe the prepared sections under an optical microscope.
- Capture high-quality images of each section.
- Identify different phases based on optical properties, contrast, or staining.

4. Measurement of Phase Areas

- Use image analysis software or manual methods to measure the cross-sectional area of each phase within the images.
- Record the area measurements systematically for all sections.

5. Calculation of Volume Fraction

- Calculate the area fraction of each phase in each section.
- Average the area fractions across all sections to obtain a representative value.
- Convert area fractions to volume fractions, assuming the sections are random and representative.

6. Data Analysis and Reporting

- Compile the measurements and calculations.
- Document the specimen preparation, sectioning pattern, and analysis procedures.
- Report the volume fractions along with statistical measures of variability (e.g., standard deviation).

Data Interpretation and Quality Assurance

Ensuring Accuracy

To ensure reliable results:

- Use calibration standards to verify measurement accuracy.
- Prepare multiple sections to account for heterogeneity.
- Perform repeat measurements to assess reproducibility.
- Apply proper statistical methods to analyze data variability.

Limitations of ASTM E562

While effective, this method has some limitations:

- Assumes phases are randomly distributed and isotropic.
- Less effective for phases that are difficult to distinguish optically.
- Time-consuming for extensive sampling.
- Potential for sampling bias if sections are not representative.

Applications of ASTM E562

ASTM E562 finds diverse applications across industries and research areas, including:

- Metallurgy: Determining phase distributions in alloys such as steel, aluminum, and titanium.
- Ceramics: Quantifying different crystalline phases for performance assessment.
- Composite Materials: Measuring fiber or filler volume fractions within matrices.
- Quality Control: Ensuring consistent phase proportions in manufactured materials.
- Research and Development: Investigating the effects of processing parameters on phase distribution.

Advantages of ASTM E562

- Standardized Procedure: Promotes consistency across different laboratories and studies.
- Versatility: Applicable to various materials and phases.
- Relatively Simple: Does not require complex equipment beyond standard microscopy.
- Quantitative Results: Provides measurable data for phase proportions.

Conclusion

ASTM E562 is an essential standard for accurately determining the volume fraction of phases within a solid material through systematic manual sectioning and microscopic analysis. Its application supports quality assurance, research, and development efforts in materials science, enabling a deeper understanding of material microstructures and their impact on properties. While it requires meticulous specimen preparation and analysis, its standardized approach ensures reproducibility and comparability of results across different studies and industries.

By adhering to ASTM E562, professionals can confidently quantify phase distributions, contributing to improved material design, processing, and performance evaluation.

References and Further Reading

- ASTM International. (2020). ASTM E562-20, Standard Test Method for Determining Volume Fraction by Systematic Manual Sectioning.
- Callister, W. D., & Rethwisch, D. G. (2018). Materials Science and Engineering: An Introduction.
- Reed-Hill, R. E., & Abbaschian, R. (2009). Physical Metallurgy Principles.

For detailed procedural steps, calibration techniques, and case studies, consult the official ASTM E562 documentation and related materials in materials characterization literature.

Frequently Asked Questions

What is ASTM E562 and what does it measure?

ASTM E562 is a standard test method used to determine the bulk density and specific gravity of aggregates by the sink and pour method, providing essential data for construction and material applications.

Why is ASTM E562 important in construction materials testing?

ASTM E562 helps ensure the quality and consistency of aggregates by providing standardized procedures for measuring their density, which influences mix design, stability, and durability of concrete and other materials.

What are the key steps involved in performing the ASTM

E562 test?

The test involves filling a graduated cylinder with a specific amount of aggregate, then measuring the volume displaced when the aggregate sinks under a specified load, allowing calculation of bulk density and specific gravity.

What types of aggregates can be tested using ASTM E562?

ASTM E562 is applicable to a wide range of aggregates, including coarse and fine particles used in concrete, asphalt, and other construction materials.

How does ASTM E562 differ from other aggregate testing standards?

Unlike other standards that may focus on particle shape or strength, ASTM E562 specifically measures bulk density and specific gravity using the sink and pour method, providing crucial information about aggregate weight and porosity.

What equipment is required to perform ASTM E562?

The test requires a graduated cylinder, a density basket or sinker, a balance, and a container of water for immersion, along with standard procedures for handling and measurement.

What are typical applications of the data obtained from ASTM E562?

Data from ASTM E562 is used to calculate volumetric proportions in mix designs, assess aggregate quality, and predict performance characteristics like compaction and durability.

Are there any recent updates or revisions to ASTM E562?

As of October 2023, ASTM E562 is a well-established standard, but users should check the ASTM official website for any recent updates or revisions to ensure compliance with current practices.

What are common challenges when performing ASTM E562 testing?

Challenges include ensuring complete immersion of aggregates, avoiding air entrapment, and maintaining consistent sample preparation to obtain accurate and repeatable results.

How can I interpret the results obtained from ASTM E562 testing?

Results such as bulk density and specific gravity can be used to evaluate aggregate quality, influence mix proportions, and compare different materials to meet project specifications.

Additional Resources

ASTM E562: A Comprehensive Guide to the Standard for Determining Volume of Soil and Rock in Place by Water Displacement

Introduction

In the realm of geotechnical and environmental engineering, precise measurement of soil and rock volumes is fundamental for site assessments, excavation planning, foundation design, and environmental monitoring. Among the suite of standardized testing methods available, ASTM E562 stands out as a widely recognized and reliable procedure for determining the volume of soil and rock in place through water displacement. This article offers an in-depth exploration of ASTM E562, detailing its purpose, methodology, applications, advantages, limitations, and best practices.

What is ASTM E562?

ASTM E562 is an international standard developed by ASTM International (formerly known as the American Society for Testing and Materials). The full title is "Standard Test Method for Determining the Volume of Soil and Rock in Place by Water Displacement." It provides a systematic approach for engineers, geologists, and environmental professionals to accurately quantify the volume of in-situ soil or rock samples by measuring the water displaced when the sample is submerged.

Purpose and Significance

The primary goal of ASTM E562 is to determine the in-place volume of soil or rock, especially when direct measurement is impractical or impossible due to site constraints or irregular sample shapes. Accurate volume measurements are critical for:

- Calculating the quantity of excavated material
- Estimating the volume of in-situ geological formations
- Assessing the porosity and permeability of soil or rock layers
- Supporting environmental impact assessments
- Designing foundation and support systems

Scope and Applicability

ASTM E562 applies to both soil and rock specimens, regardless of size and shape, provided they can be submerged in water without damage. The method is versatile, suitable for:

- In-situ samples obtained via coring, drilling, or excavation
- Remolded and intact specimens
- Irregularly shaped samples where geometric methods are unsuitable

However, it is not suitable for materials that are porous to water with significant absorption or for samples that are chemically reactive with water, unless precautions are taken.

Fundamental Principles of ASTM E562

At its core, ASTM E562 relies on the principle of water displacement, a classical method dating back to Archimedes. When an object (or sample) is submerged in water, it displaces an amount equal to its volume. By accurately measuring the displaced water, one can determine the volume of the sample.

Key concepts include:

- Archimedes' Principle: The buoyant force equals the weight of displaced water.
- Water Displacement Method: Direct measurement of the volume of displaced water to infer the sample's volume.
- Minimizing Errors: Ensuring the sample is free of air bubbles, water-tight, and handling methods are precise.

Equipment and Materials Required

Implementing ASTM E562 necessitates specific equipment and materials, which include:

- Water Displacement Container: A graduated or calibrated container such as a overflow cup, graduated cylinder, or volumetric tank capable of collecting and measuring displaced water.
- Sample Container: A waterproof, non-reactive container for suspending or immersing the sample during measurement.
- Suspension Apparatus: Ropes, hooks, or frames designed to hold the sample securely without adding to its measured volume.
- Water Source: Clean, temperature-controlled water (preferably deionized or distilled) to minimize measurement variability.
- Thermometer: To record water temperature, which is essential for correcting the water density.
- Balance or Scale: To weigh the sample if needed for density calculations.
- Accessories: Tongs, gloves, and other handling tools to prevent contamination or damage.

Step-by-Step Procedure

While ASTM E562 provides detailed instructions, the typical process involves the following steps:

1. Preparation and Calibration

- Ensure all equipment is clean and free of debris.
- Calibrate the water displacement container by measuring its empty volume or ensuring the graduated markings are accurate.
- Record the temperature of the water, as water density varies with temperature.

2. Sample Preparation

- Carefully excavate or extract the soil or rock specimen, avoiding disturbance.
- Remove any extraneous material such as loose dirt, loose particles, or debris.
- If necessary, weigh the sample to assist in density calculations.

3. Submerging the Sample

- Attach the sample securely to the suspension apparatus, ensuring minimal air entrapment.
- Gently lower the sample into the water-filled container, avoiding the formation of air bubbles which can skew results.
- Ensure the entire sample is submerged without touching the container sides or bottom.

4. Measuring Displaced Water

- Allow the water level to stabilize.
- Collect and measure the displaced water volume using the graduated container.
- Record the volume carefully, noting the temperature.

5. Repeating and Validation

- Repeat the immersion process multiple times for consistency.
- Cross-verify measurements to account for any anomalies.

6. Data Calculation and Corrections

- Use water density data at the measured temperature to convert water volume to the actual volume of the sample.
- Correct for any residual air bubbles or measurement errors.

Data Calculations and Analysis

The core calculation in ASTM E562 involves converting the measured displaced water volume into the in-place volume of the sample, considering:

- Water Density Correction: Adjusting for temperature-dependent water density.
- Sample Weight and Density: If the sample's dry density is needed, combine volume data with weight measurements.
- Porosity and Permeability: Derived from the volume and weight data, useful for geotechnical assessments.

Sample Calculation:

$$\rho_{\text{sample}} = V_{\text{displaced}} \times \frac{\rho_{\text{water, at temperature}}}{\rho_{\text{standard}}}$$

Where:

- $V_{\text{displaced}}$ = measured water volume displaced
- $\rho_{\text{water, at temperature}}$ = density of water at the measurement temperature
- ρ_{standard} = standard reference density (usually 1 g/cm³)

Applications of ASTM E562

The versatility of ASTM E562 makes it applicable across various industries and projects:

1. Geotechnical Engineering

- Determining in-situ soil and rock volumes for foundation analysis
- Estimating excavation quantities
- Assessing the heterogeneity of subsurface materials

2. Environmental Monitoring

- Quantifying contaminant zones in soil
- Monitoring changes in soil volume due to subsidence or compaction
- Supporting remediation planning

3. Mining and Quarrying

- Estimating ore or mineral deposit volumes
- Planning extraction strategies

4. Construction and Infrastructure

- Calculating volume of backfill or cut-and-fill operations
- Designing retaining walls or underground structures

Advantages of ASTM E562

- Accuracy and Reliability: The water displacement method is precise when properly executed.
- Applicability to Irregular Shapes: Unlike geometric methods, it handles irregular or complex shapes effortlessly.
- Minimal Sample Disturbance: Proper handling preserves the sample's integrity.
- Versatility: Suitable for a broad range of soil and rock types.

Limitations and Potential Challenges

While ASTM E562 is robust, certain limitations must be acknowledged:

- Porous or Absorptive Samples: Water may infiltrate pores, leading to overestimation of volume.
- Samples that React with Water: Chemical reactions may alter the sample during measurement.
- Air Entrapment: Bubbles can significantly skew results; meticulous handling is necessary.
- Temperature Variations: Fluctuations affect water density; temperature correction is essential.
- Sample Size Constraints: Very large or fragile samples may require alternative methods.

Best Practices for Accurate Measurement

To maximize the accuracy and repeatability of ASTM E562:

- Use high-quality, calibrated equipment.
- Ensure water temperature is measured and corrected.
- Minimize air bubbles during immersion by slow, controlled submersion.
- Handle samples carefully to prevent disturbance or damage.
- Conduct multiple measurements and average the results.
- Document all conditions, including water temperature, equipment calibration, and procedures.

Conclusion

ASTM E562 remains a cornerstone method for in-situ volume determination of soil and rock, offering a blend of simplicity, precision, and adaptability. Its water displacement technique, rooted in classical physics, continues to serve geotechnical and environmental professionals worldwide, underpinning critical decisions in construction, remediation, and resource management. While it demands meticulous execution and awareness of its limitations, when performed correctly, ASTM E562 provides invaluable data that enhances understanding of subsurface conditions, ultimately contributing to safer, more efficient engineering practices.

Final Thoughts

In an era where accurate subsurface characterization is paramount, ASTM E562 exemplifies how standardized, well-established methods can deliver reliable insights. Professionals adopting this standard should prioritize rigorous training, equipment calibration, and adherence to procedural details to harness its full potential. As technology advances, integrating ASTM E562 with complementary methods, such as 3D imaging and geophysical surveys, can further enrich volume assessments, supporting sustainable and resilient infrastructure development.

Astm E562

astm e562: Practical Guide to Image Analysis ASM International, John J. Friel, 2000-01-01
Nine international specialists contribute information about the use of image analysis procedures to evaluate microstructural features. Coverage includes an historical overview of how quantitative image analysis developed; the evolution of current television computer-based analysis systems; the science

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This book provides a solid overview of the important metallurgical concepts related to the microstructures of irons and steels, and it provides detailed guidelines for the proper metallographic techniques used to reveal, capture, and understand microstructures. This book provides clearly written explanations of important concepts, and step-by-step instructions for equipment selection and use, microscopy techniques, specimen preparation, and etching. Dozens of concise and helpful "metallographic tips" are included in the chapters on laboratory practices and specimen preparation. The book features over 500 representative microstructures, with discussions of how the structures can be altered by heat treatment and other means. A handy index to these images is provided, so the book can also be used as an atlas of iron and steel microstructures.

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Materials metrology is the measurement science used for determining materials property data. An essential element is the symbiosis between the understanding of materials behaviour and the development of suitable measurement techniques which, through the provision of standards, enable design engineers and plant operators to acquire materials data of appropriate precision. This book is concerned only with those aspects of materials metrology and standards that relate to the design and performance in service of structures and consumer products. It does not consider their important role in the processing of materials. The editors are grateful for the commitment and patience of the experts who contributed the various chapters. In addition, help from staff in the Division of Materials Metrology, National Physical Laboratory, in assisting with the task of refereeing the chapters is gratefully acknowledged. The production of this book was carried out as part of the Materials Measurement Programme of underpinning research financed by the United Kingdom Department of Trade and Industry. Brian F. Dyson Malcolm S. Loveday Mark G. Gee
Division of Materials Metrology National Physical Laboratory Teddington, TW11 0LW UK
CHAPTER 1
Materials metrology and standards: an introduction B. F. Dyson, M. S. Loveday and M. G. Gee
1.1 MATERIALS ASPECTS OF STRUCTURAL DESIGN
Knowledge concerning the behaviour of materials has always been vital for the success of manufactured products, but never more so than at the present time.

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Failures or forced shutdowns in power plants are often due to boilers, and particularly failure of boiler tubes. This comprehensive resource deals

with the subject of failure investigation of boiler tubes from basic fundamentals to practical applications. Coverage includes properties and selection of materials for boiler tubes from a metallurgical view point, damage mechanisms responsible for failure of boiler tubes, and characterization techniques employed for investigating failures of boiler tubes in thermal power plants and utility boilers of industrial/commercial/institutional (ICI) boilers. A large number of case studies based on the actual failures from the field are described, along with photographs and microstructures to allow for easy comprehension of the theory behind the failures. This book is geared to practicing engineers and for studies in the major area of power plant engineering. For non-metallurgists, a chapter has been devoted to the basics of material science, metallurgy of steels, heat treatment, and structure-property correlation. A chapter on materials for boiler tubes covers composition and application of different grades of steels and high temperature alloys currently in use as boiler tubes and future materials to be used in supercritical, ultra-supercritical and advanced ultra-supercritical thermal power plants. A comprehensive discussion on different mechanisms of boiler tube failure is the heart of the book. Additional chapters detailing the role of advanced material characterization techniques in failure investigation and the role of water chemistry in tube failures are key contributions to the book. The authors have long-standing experience in the field of metallurgy and materials technology, failure investigation, remaining life assessment (RLA) and fitness for service (FFS) for industrial plant and equipment, including power plants. They have conducted a large number of failure investigations of boiler tubes and have recommended effective remedial measures in problem solving for power and utility boilers.

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astm e562: Macro- and Micro-Mechanics of High Velocity Deformation and Fracture

Kozo Kawata, Jumpei Shioiri, 2012-12-06 The IUTAM Symposium on Macro- and Micro-Mechanics of High Velocity Deformation and Fracture (MMMHVDF) (August 12 - 15, 1985) was held at Science Council of Japan, under the sponsor ship of IUTAM, Science Council of Japan, Japan Society for the Promotion of Science, The Commemorative Association for the Japan World Exposition (1970), and The Japan Society for Aeronautical and Space Sciences. The proposal of the symposium was accepted by the General Assembly of IUTAM, and the scientists mentioned below were appointed by the Bureau of IUTAM to serve as member of the Scientific Committee. The main object of the Symposium was to make a general survey of recent developments in the re search of high velocity solid mechanics and to explore further new ideas for dealing with unsettled problems, of fundamental nature as well as of practical importance. The subjects covered theoretical, experimental, and numerical fields in macro- and micro-mechanics associated with high velocity deformation~ and fracture in soldis, covering metals, ceramics, polymers, and composites.

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(Thomas) Eun, 2020-09-04 This handbook is an in-depth guide to the practical aspects of materials and corrosion engineering in the energy and chemical industries. The book covers materials, corrosion, welding, heat treatment, coating, test and inspection, and mechanical design and integrity. A central focus is placed on industrial requirements, including codes, standards, regulations, and specifications that practicing material and corrosion engineers and technicians face in all roles and in all areas of responsibility. The comprehensive resource provides expert guidance on general corrosion mechanisms and recommends materials for the control and prevention of corrosion damage, and offers readers industry-tested best practices, rationales, and case studies.

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astm e562: Electromagnetic Nondestructive Evaluation (XVI) J.M.A. Rebello, F. Kojima, T. Chady, 2013-12-18 Electromagnetic Nondestructive Evaluation (ENDE) is the process of inducing electric currents, magnetic fields or both within a test object to assess its condition by observing the electromagnetic response. An important tool in fields as diverse as engineering, medicine and art, it does not permanently alter the object being tested, thus proving invaluable for product evaluation, troubleshooting and research. This book presents the proceedings of the 17th International Workshop on Electromagnetic Nondestructive Evaluation (ENDE), held in Rio de Janeiro, Brazil, in July 2012. ENDE workshop is an important event for all scientists with interests in non-destructive testing. The first workshop took place in 1995 in London UK, and has been followed by workshops held in various parts of the world, but this is the first time this workshop series has come to a Latin American country. The workshops bring together scientists and engineers active in research, development and industrial applications of ENDE. The book is divided into five sections: advanced sensors; analytical and numerical modeling; systems and techniques for electromagnetic NDE; characterization of materials and NDE of cracks; and new developments and others. Each section includes papers on a variety of subjects. From the papers submitted for publication, thirty six peer reviewed articles have been accepted, six of which emanate from Latin American authors. The book

will be of interest to all those wishing to keep abreast of developments in the field, or who rely on the advanced techniques based on electromagnetic principles applied to nondestructive evaluation in their work.

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astm e562: Wastes: Solutions, Treatments and Opportunities III Candida Vilarinho, Fernando Castro, Margarida Gonçalves, Ana Luísa Fernando, 2019-08-08 Wastes: Solutions, Treatments and Opportunities III contains selected papers presented at the 5th edition of the International Conference Wastes: Solutions, Treatments and Opportunities, that took place on 3-6 September 2019, in Costa da Caparica, Portugal. The Wastes conference, which takes place biennially, is a prime forum for sharing innovation, technological development and sustainable solutions for the waste management and recycling sectors around the world, counting with the participation of experts from academia and industry. The papers included in this book cover a wide range of topics, including: Wastes as construction materials; Wastes as fuels; Waste treatment technologies; MSW management; Recycling of wastes and materials recovery; Environmental, economic and social aspects in waste management; Life cycle assessment; Circular economy and wastes refineries; Logistics, policies, regulatory constraints and markets in waste management.

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applications. This book comprises articles on a broad spectrum of topics from design, engineering, testing and computational evaluation of components and systems for fatigue, durability, and fracture mechanics. The topics covered include interdisciplinary discussions on working aspects related to materials testing, evaluation of damage, nondestructive testing (NDT), failure analysis, finite element modeling (FEM) analysis, fatigue and fracture, processing, performance, and reliability. The contents of this book will appeal not only to academic researchers, but also to design engineers, failure analysts, maintenance engineers, certification personnel, and R&D professionals involved in a wide variety of industries.

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