

AIR POLLUTION AND NOISE LABORATORY

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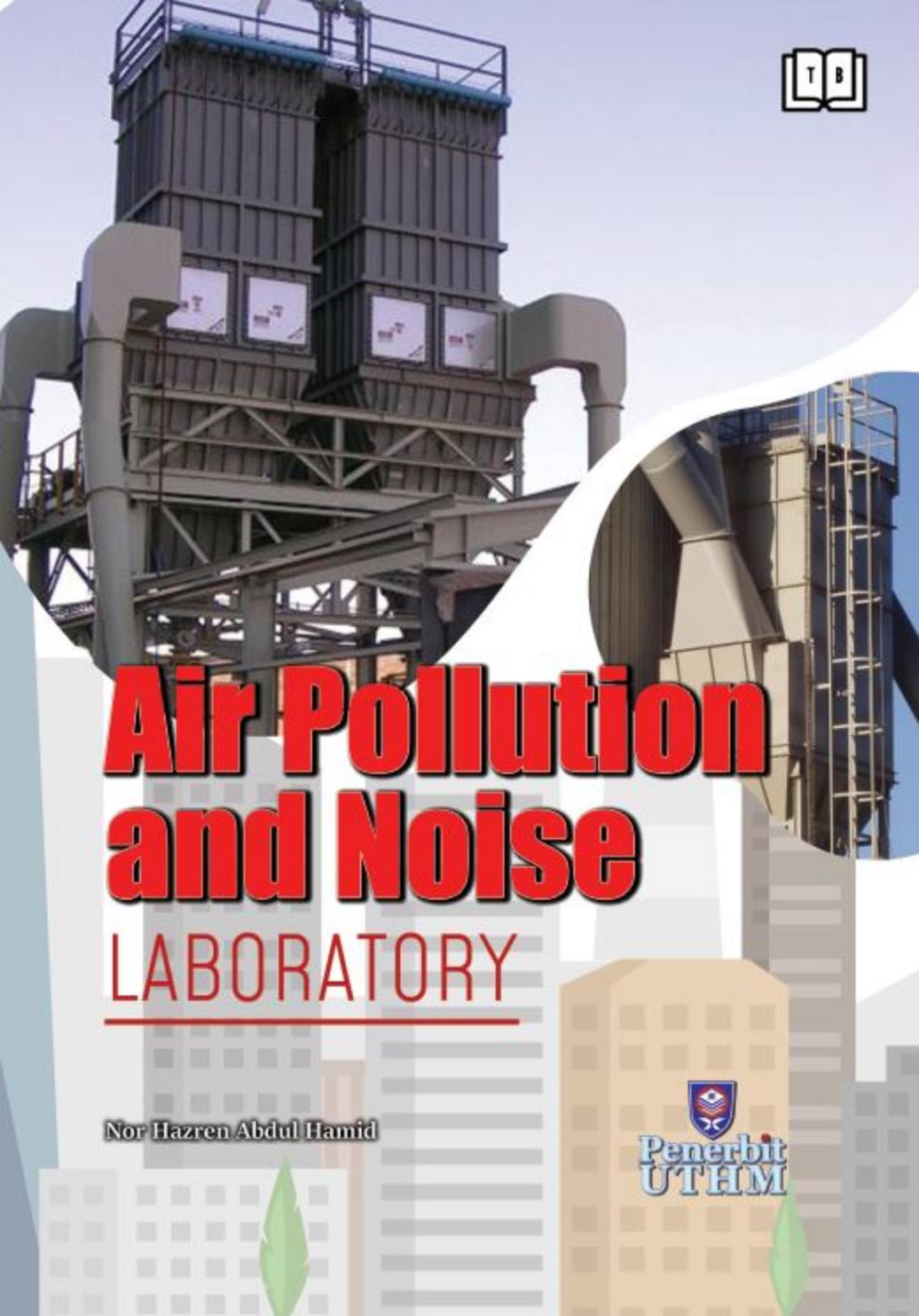
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Abstract:

Air pollution and noise laboratory book presents the hands-on activities that can be performed by students of Bachelor of Civil Engineering Technology (Environment), UTHM which relates to the fundamentals of air pollution and noise control. This book is a student's guideline for performing experimental works on instruments and devices in controlling air and noise pollution. In chapter 1, the pulsed jet bag filter system has been custom-designed to introduce the students of Civil Engineering Technology to dust pollution control using a fabric filter. Next, in chapter 2, students will determine the cyclone collection efficiency and compare the efficiency of the larger cyclone to the smaller one. Students may also compare the efficiency of a single cyclone operation and a double cyclone operation. In chapter 3, students will demonstrate the spray chamber operations using five different spraying nozzles and study the effect of droplet sizes on separation efficiency. In chapter 4, student will demonstrate venturi scrubber operations by varying several parameters such as liquid to gas (L/G) ratio to estimate its effect on separation efficiency and verify the theoretical relationship between total pressure drop and air inlet velocity. Chapter 5 demonstrates that E-SAMPLER is a type of nephelometer which automatically measures and records real-time airborne of PM10, PM2.5, or TSP particulate concentration levels using the principle of forward laser light scatter. In Chapter 6, student need to determine the air velocity and detect changes in some physical property of the fluid using anemometers or the effect of the fluid on a mechanical device inserted into the flow. Finally, chapter 7 present the measurement of noise engineering, quality control, health prevention and various environmental noise, including noise measurement in such various places around factories, offices, transporting routes, workshops, road and residential.

Keywords: Air pollution, noise laboratory, noise control, guideline for performing experimental works

The background features a large industrial facility with multiple tall, grey, rectangular structures and a complex network of pipes and metal walkways. The sky is a clear, light blue. In the foreground, there are stylized, semi-transparent illustrations of city buildings in various shades of grey and tan, and two green leaves on the left and right sides.

Air Pollution and Noise

LABORATORY

Nor Hazren Abdul Hamid



Penerbit
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Nor Hazren Abdul Hamid



2024

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Published 2024

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Published & Printed by:
Penerbit UTHM
Universiti Tun Hussein Onn Malaysia
86400 Parit Raja, Batu Pahat, Johor
Tel: 07-453 8698/8529
Fax: 07-453 6145

Website: <http://penerbit.uthm.edu.my>
E-mail: pt@uthm.edu.my
<http://e-bookstore.uthm.edu.my>

Penerbit UTHM is a member of
Majlis Penerbitan Ilmiah Malaysia
(MAPIM)

Printed by:
Rahman Cetak
28, Jalan PBS 14/11,
Taman Perindustrian Bukit Serdang,
43300 Seri Kembangan, Selangor
Tel: 019-387 3227



Cataloguing-in-Publication Data
Perpustakaan Negara Malaysia
A catalogue record for this book is available
from the National Library of Malaysia
ISBN 978-629-490-076-9

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PREFACE

Air pollution and noise laboratory book presents the hands-on activities that can be performed by students of Bachelor of Civil Engineering Technology (Environment), UTHM which relates to the fundamentals of air pollution and noise control. This book is a student's guideline for performing experimental works on instruments and devices in controlling air and noise pollution. In chapter 1, the pulsed jet bag filter system has been custom-designed to introduce the students of Civil Engineering Technology to dust pollution control using a fabric filter. Next, in chapter 2, students will determine the cyclone collection efficiency and compare the efficiency of the larger cyclone to the smaller one. Students may also compare the efficiency of a single cyclone operation and a double cyclone operation. In chapter 3, students will demonstrate the spray chamber operations using five different spraying nozzles and study the effect of droplet sizes on separation efficiency. In chapter 4, student will demonstrate venturi scrubber operations by varying several parameters such as liquid to gas (L/G) ratio to estimate its effect on separation efficiency and verify the theoretical relationship between total pressure drop and air inlet velocity. Chapter 5 demonstrates that E-SAMPLER is a type of nephelometer which automatically measures and records real-time airborne of PM10, PM2.5, or TSP particulate concentration levels using the principle of forward laser light scatter. In Chapter 6, student need to determine the air velocity and detect changes in some physical property of the fluid using anemometers or the effect of the fluid on a mechanical device inserted into the flow. Finally, chapter 7 present the measurement of noise engineering, quality control, health prevention and various environmental noise, including noise measurement in such various places around factories, offices, transporting routes, workshops, road and residential.

CHAPTER 1

PULSED JET BAG FILTER SYSTEM

1.1 INTRODUCTION

The SOLTEQ® Pulsed-Jet Bag Filter System (Model: AP04) has been locally manufactured to a high standard with emphasis on ease of use and operational safety. It consists of a bag house, a pulsed-jet cleaning system, a feed container with a control valve, an air blower, an outlet dust filter, and an air flow meter. The unit has been custom designed to introduce students of Civil Engineering Technology to dust pollution control using a fabric filter (Figure 1.1).

The bag house is divided into two sections: top and bottom sections. The top section is made of stainless steel and connected to a compressed air tank that is part of the pulsed-jet cleaning mechanism (Figure 1.2). The bottom section is made of durable clear PVC with dust collector in the form of removable drawer. Student can view through the bottom section about the filtering and cleaning activities of the bag filter system. The cleaning mechanism consists of a compressed air tank, pressure regulator, a solenoid valve with remote selectable timer and a portable air compressor. Four units of polyester fabric filters are installed in a row inside the bottom section of the bag house.

An air blower installed at the outlet is capable of drawing 222 m³/hr of air through the system. The air velocity is set by adjusting the speed of the blower which is controlled by an inverter. A valve is installed below the feed container to control the amount of dust particles sample introduced into the air stream before being filtered inside the bag house. Two digital differential pressure indicators have been installed for the purpose of measuring pressure drops (DP) across the bag house and venturi.

CHAPTER 2

MULTI CYCLONE SYSTEM

2.1 INTRODUCTION

This Multi Cyclone System has been manufactured to a high standard with emphasis on ease of use and operational safety. It consists of mainly three cyclones of different body diameters, a dust feeding system, and an air blower. A flow measurement device for the incoming air is also provided. The unit has been designed for student demonstration on dust pollution control using cyclone separator (Figure 2.1).

Two of the cyclones are made of stainless steel with body diameter of 200 mm. The other cyclone with 100 mm body diameter is made of borosilicate glass. Each cyclone has a dust hopper for dust collection. The cyclones are arranged in such a way that students may run single cyclone or two cyclones in series by appropriately changing the flow of dust-laden air. The dust feeding system consists of an air pump and a transparent dust container. A suitable feeding rate can be achieved by manipulating the air flow rate out of the air pump. An air blower is installed at the outlet is capable of drawing 222 m³/hr of air through the system. The air velocity is regulated through adjusting the blower speed.

Four differential pressure measurements are provided for each cyclone and venturi meter to measure pressure drop, ΔP . The pressure drop across the cyclone is directly related to the velocity of air at the cyclone inlet. Students will determine the cyclone collection efficiency and compare the efficiency of the larger cyclone to the smaller one. Students may also compare the efficiency for a single cyclone operation and a double cyclone operation.

CHAPTER 3

SPRAY CHAMBER SYSTEM

3.1 INTRODUCTION

The spray chamber system consists of spray chamber, a water re-circulation system, a feed container with a valve, an air blower, an outlet dust filter and an air flow meter with control valve (Figure 3.1). It is made of durable clear water PVC measuring approximately 0.3 m diameter and 2 m tall. Five different spray nozzles have been installed inside the chamber. A mist eliminator of different sizes at the top section of the chamber prevents any water droplets from escaping. The water re-circulation tank consists of a water tank, water pump, digital flow meters and pressure transmitter.

An air blower installed at the outlet is capable of drawing 222 m³/hr of air through the system. The air velocity is set by adjusting the speed of blower which is controlled by an inverter. With the aid of a pneumatic vibrator, a valve is installed below the feed container to control the amount of dust particles sample introduced into the system.

A pressure regulator is used to regulate the pneumatic vibrator. Two differential pressure transmitters have been installed on the control panel for pressure drop (DP) readings across the separation chamber and venture meter. Student will demonstrate the spray chamber operations using five different spraying nozzles and study the effect of droplet sizes upon separation efficiency. The effect of liquid-to-gas (L/G) ratio to separation efficiency will also be demonstrated.

CHAPTER 4

VENTURI SCRUBBER SYSTEM

4.1 INTRODUCTION

The venturi scrubber system is designed and manufactured to a standard with emphasis on ease of use and operational safety for introduction of air pollution control by using venturi scrubber system to Civil Engineering Technology students. It consists mainly of transparent cylindrical venturi scrubber, a separation chamber, a water recirculation chamber, a powder-feeder system, an air blower, an outlet dust filter, and air flow meter (Figure 4.1).

The venturi scrubber system is made of a durable clear PVC with throat diameter of 32 mm and both convergence and divergence diameter of 101.6 mm. The separation chamber is also made of durable clear PVC with dimension of 0.6 m diameter and 2 m height. The chamber has a rectangular tangential inlet at the bottom of the venturi chamber. A mist eliminator is located at the top section of the chamber to prevent any water droplets from escaping. The water recirculation tank consists of a water tank, water pump, digital flow meter, pressure transmitter and a needle valve.

An air blower installed at the outlet is capable of drawing 222 m³/hr of air through the system. The air velocity is set by adjusting the speed of the blower which is controlled by an inverter. With the aid of a pneumatic vibrator, a valve is installed below the feed container to control the amount of dust particles sample introduced into the system (Figure 4.2). A pressure regulator is used to regulate the pneumatic vibrator. Three digital differential pressure transmitters have been installed for measuring pressure drops across the bag house, venturi meter, and air flow rate. Student will demonstrate venturi scrubber operations by varying several parameters such as liquid to gas (L/G) ratio to estimate its effect on separation efficiency and verify the theoretical relationship between total pressure drop and air inlet velocity.

CHAPTER 5

E-SAMPLER

5.1 INTRODUCTION

The E-SAMPLER is a dual technology instrument that combines the unequalled real-time measurement of light scatter with the accuracy standard of filter methods. The simple filter loading process testifies to the seamless blending of both technologies. Filters can be extracted and replaced in less than one minute and filter medium can be selected based on laboratory analysis. Particulate loading on the filter does not reduce performance due to the Met One actual flow control protocol. Ambient temperature and pressure are measured and actual flow is calculated and controlled by the E-SAMPLER microprocessor independent of filter loading change.

The Met One Instruments, Inc. model E-SAMPLER is a type of nephelometer which automatically measures and records real-time airborne PM₁₀, PM_{2.5}, or TSP particulate concentration levels using the principle of forward laser light scatter. In addition, the E-SAMPLER has a built-in 47mm filter sampler which can optionally be used to collect the particulate for subsequent gravimetric mass or laboratory evaluation. The E-Sampler combines the excellent real-time response of a nephelometer with the accuracy and traceability of a manual gravimetric sampler. This section describes the measurement systems.

5.2 OBJECTIVES

1. To measure Particulate Matter in the 0 to 10 μm size range (PM₁₀).
2. To ensure that PM₁₀ are compliance with Recommended Malaysian Air Quality Guideline.

CHAPTER 6

ANEMOMETER

6.1 INTRODUCTION

The purpose of this experiment is to familiarize the students with the ventilation facilities, select stations for ventilation readings, measure the cross-sectional area of the selected stations, and the distance between the selected stations. The second portion of the lab is to familiarize the students with the common velocity measuring instruments, utilize these instruments in making an airflow survey and determine airflow directions at measuring stations throughout this experimental.

An anemometer is an instrument used to measure the speed or velocity of air (gases) either in a contained flow, such as airflow in a duct, or in unconfined flows, such as atmospheric wind (Figure 6.1). Anemometers detect change in some physical property of the fluid or the effect of the fluid on a mechanical device inserted into the flow, which to determine the air velocity.

There are a variety of ways to measure air flow rate in a field test setting. Unlike other fluid flow rate measurements of water or natural gas, air flow is not necessarily constrained to a pipe. Air flow rate in ducts is one place that air flow can be measured, but there are other places in the home that air flow rate may be desired, such as at the outlet of a vent. Some methods are more applicable in a short-term test situation, rather than a long-term installation. Collecting airflow rate measurements would be an important task when investigating the performance of heating, ventilation, and air conditioning (HVAC) equipment or when looking for duct leakage, for instance.

The Vernier Anemometer is an impeller-type anemometer with the axis of rotation parallel to the direction of the wind. It uses a magnet located in the impeller and an inductor. The wind causes rotation of the impeller, the magnet, and the shaft. The rotation of the magnet produces an electrical signal proportional to the wind speed.

CHAPTER 7

DIGITAL SOUND LEVEL METER

7.1 INTRODUCTION

The purpose of this lab is to have the student to measure the noise level at two different locations (indoor and outdoor) using a digital sound level meter. Digital sound level meter is a stable, safe, and reliable sound level meter. The digital sound level meter (Figure 7.1) is applicable for measurement of noise engineering, quality control, health prevention and various environmental noise, including noise measurement in such various places around factories, offices, transporting routes, workshops, road and residential.

A sound level meter (SLM) is a measuring instrument used to assess noise or sound levels by measuring sound pressure. Often referred to as a sound pressure level (SPL) meter, decibel (dB) meter, noise meter or noise dosimeter, a sound level meter uses a microphone to capture sound. The sound is then evaluated within the sound level meter and acoustic measurement values are shown on the display of the sound level meter. The most common unit of acoustic measurement for sound is the decibel (dB); however, some sound level meter devices also determine the equivalent continuous sound level (L_{eq}) and other acoustic parameters. With a portable sound level meter, industrial hygiene and workplace safety professionals can measure sound levels in multiple locations to ensure environmental conditions fall within recommended permissible sound level (L_{Aeq}). Some sound level meter devices can be permanently installed for continuous monitoring of sound levels at a work or job site.

7.2 OBJECTIVES

1. To measure noise levels at four different locations (four sources) using a digital sound level meter.
2. To be able to analyze the collected data with the recommended permissible sound level (L_{Aeq}).

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ISBN 978-629-490-075-2



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