CHAPTER 1
INTRODUCTION

This chapter covers the background of study, problem statement, objectives and also scope of study for the project. All the information presented in this chapter is meant to provide the basic information on the suspended particles and application of laser in quantifying the suspended particles.

1.1 Background of Study

Suspended particles can be classified as solid particles and liquid droplets. The sizes of the particles are characterized by five terminologies, as shown in Table 1.1. Examples of the solid particles are such as dust, ash and flying particles in the fire while the liquid droplets are such as fog, sprayed fuel in the combustion chamber of car engines and sprayed fertilizers through a nozzle for aerial fertilization. The significances of quantifying the suspended particles are to characterize the suspended particles, determine the amount of suspended particles in the water for environmental control purposes and control the processes such as gas conditioning and evaporative cooling.

Table 1.1: The terminologies, sizes and characteristics of particles (Grimwood, 2000)

Terminology	Sizes (μm)	Characteristics
Colloidal	<1	Smoke.
Dust	$1-10$	Oil fog or sea fog.
Fine	$10-100$	Cloud or mist.
Average	$100-1000$	Drizzles or rain.
Coarse	$1000-10000$	Coarse heavy droplets.

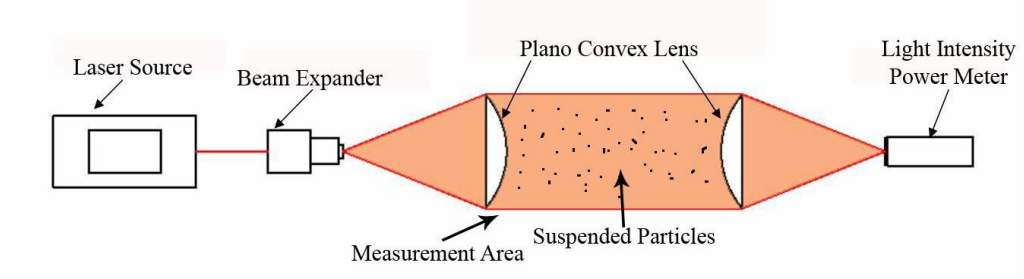

Figure 1.1: Typical setting of laser attenuation method for quantification of suspended particles (ETP Group 60, Universiti Teknologi PETRONAS, 2007)

Various methods have been used to quantify the suspended particles such as Phase Doppler Anemometry (PDA) and Phase Doppler Particle Analyzer (PDPA) for quantifying the size and concentration of suspended particles while Particle Image Velocimetry (PIV) and Laser Doppler Anemometry (LDA) are used for the quantification of velocity. Figure 1.1 shows a typical setting of laser attenuation method for quantifying the number density of suspended particles. Examples of the devices for quantification of suspended particles available in the market are such as APSS-200 for USP 788 (Particle Counter for Injectibles) from Particle Measuring Systems, Malvern Spraytec from Malvern Instruments and Interferometric Laser Imaging Droplet Sizer (ILIDS) from Kanomax. Figure 1.2 shows a typical setting for the measurement of droplet size and velocity in jet by using LDA/PDA system while Figure 1.3 shows the setting of PDPA technique for the measurement of droplet size.

Laser attenuation is a method which laser beam intensity becomes attenuated or reduced after encountering the suspended solid particles or liquid droplets. A portion of the incident flux is reflected at the entrance and exit surfaces, another portion is absorbed and the remainder is transmitted. The transmitted laser beam is detected by a light sensor. This method is safe, reliable, and flexible and also it utilizes the good properties of laser beam such as monochromatic, coherent and highly-directional.

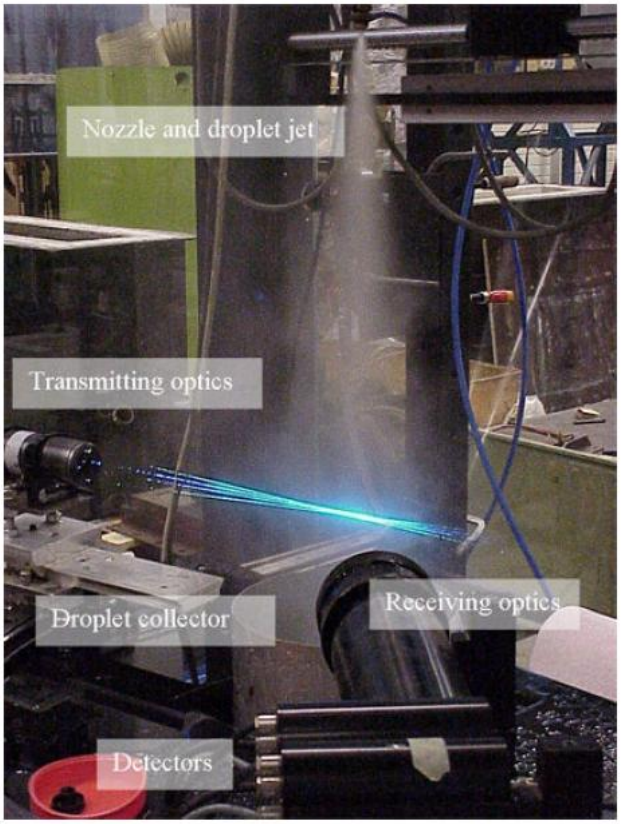

Figure 1.2: Droplet size and velocity measurement in jet by using LDA/PDA system (Tampere University of Technology, 2006)

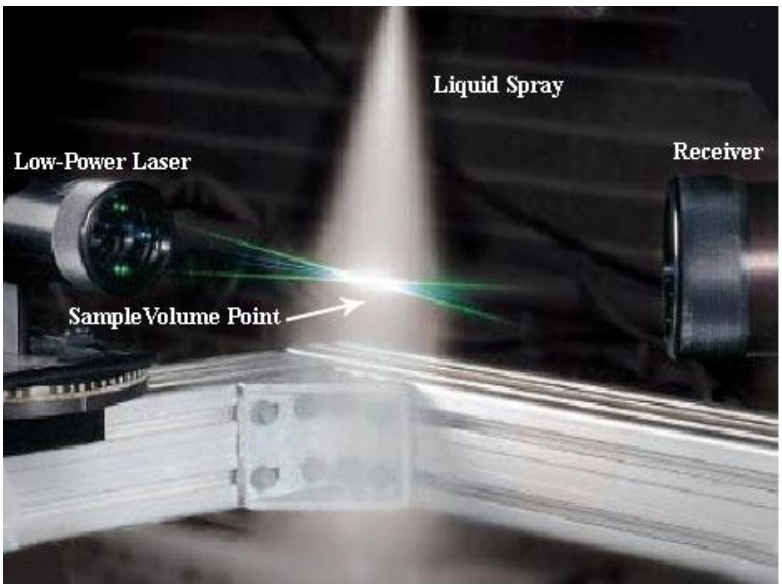

Figure 1.3: PDPA technique for droplet size measurement (Spraying Systems Co., 2008)

1.2 Problem Statement

Currently, there are many measurement systems using the application of laser for the quantification of suspended particles. Those systems are limited for the use with certain settings and experiments only. Yet, there are still not many systems which use the method of laser attenuation and also no such system is available in Universiti Teknologi PETRONAS (UTP).

1.3 Objective

The objective of this project is to develop a measurement system for the quantification of number density of the suspended particles by using laser attenuation method. The system is intended to have features like flexible, movable, reliable, stable, safe and light; so that the system can be used and set up anywhere for measurements in various experiment settings.

1.4 Scope of Study

The project starts with the research on the principle of laser and laser attenuation from the books, journals and internet so that all the basic principles used in this project can be understood before designing the measurement system. This is followed by the design of measurement system and selection of suitable components for the measurement system. The study also involves testing of the system through a series of experiments.