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Design of a continuous emission monitoring system (CEMS) for the NH_3 analyzer at PT. Pusri Palembang

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ABSTRACT

PT. Pupuk Sriwidjaja Palembang (Pusri) is one of the urea fertilizer producers in Indonesia. Pusri is a fertilizer factory that received the Green PROPER award from the Ministry of the Environment in 2011 and 2012 and the Green Industry award from the President of the Republic of Indonesia in 2012. PT. Pusri demonstrated success in environmental management by achieving gold proper in 2022. Under the Minister of Environment Regulation (Permen LHK) No. 13 of 2021 concerning SISPEK (Continuous Industrial Monitoring Information System), which contains regulations regarding systems that aim to obtain emission data and information correctly, accurately, and continuously in an integrated manner. Data from monitoring stationary source emissions or stack emissions using continuous measurements or CEMS must be measured and evaluated. This study concerns the design of CEMS on the Induced Fan chimney in the Prilling Tower of the PIV Factory, which is designed to measure ammonia (NH_3 Analyzer). The sampling probe has an automatic blowback function controlled automatically with Programmable Logic Control (PLC) or a simple relay. Blowback will use a water instrument with an available pressure of 4-7 kg/cm^2. The NH3 (ammonia) measurement system is an extractive type. The NH_3 component was measured using a laser beam and a power supply with specifications of 220 VAC, 50 Hz, and 1 phase with a measurement range of 0 ± 600 mg/NM^3.

ABSTRAK

PT. Pupuk Sriwidjaja Palembang (Pusri) adalah salah satu produsen pupuk urea di Indonesia. Pusri adalah pabrik pupuk yang mendapatkan penghargaan PROPER Hijau dari Kementrian Lingkungan Hidup tahun 2011 dan 2012, dan penghargaan Industri Hijau dari Presiden RI tahun 2012. PT. Pusri menunjukkan keberhasilan dalam pengelolaan lingkungan, dengan meraih proper emas pada tahun 2022. Sesuai dengan Peraturan Menteri Lingkungan Hidup (Permen LHK) No. 13 tahun 2021 tentang SISPEK (Sistem Informasi Pemantauan Industri secara Terus Menerus), yang berisi aturang mengenai sistem yang bertujuan untuk mendapatkan data dan informasi emisi secara benar, akurat, dan terus-menerus secara terintegrasi. Data hasil pemantauan emisi sumber tidak bergerak atau emisi cerobong dengan pengukuran secara terus menerus atau CEMS harus diukur dan dievaluasi. Studi ini mengenai perancangan CEMS pada cerobong Induced Fan di Prilling Tower Pabrik PIV yang dirancang untuk mengukur ammonia (NH_3 Analyzer). Sampling probe memiliki fungsi automatic blow back yang dikontrol secara otomatis dengan Programable Logic Control (PLC) atau relay sederhana. Blow back akan menggunakan instrument air dengan tekanan yang tersedia 4-7 kg/cm^2. Sistem pengukuran NH_3 (ammoniak) termasuk jenis extractive. Pengukuran komponen NH3 menggunakan sinar laser, serta power supply dengan spesifikasi 220 VAC, 50 Hz, dan 1 phase dengan range pengukuran 0 ± 600 mg/NM^3.

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1. Introduction

In The development of the industrial sector in Indonesia is increasing in line with market and product needs to increase Indonesia's competitiveness at the regional level. However, industrial problems cannot be separated from the pain of waste produced [1]. On May 19, 2021, the Minister of Environment (LHK) Siti Nurbaya stipulated Regulation of the Minister of Environment and Forestry Number 13 of 2021 concerning Continuous Industrial Monitoring Information Systems (SISPEK), which aims to obtain emission data and information correctly accurately and it is necessary to monitor emissions in an integrated manner continuously.

Emissions in Minister of Environment and Forestry Regulation No. 13 of 2021 concerning SISPEK are air pollutants resulting from human activities that enter and are introduced into the air and do not have the potential for air pollution. Air pollution is one of the environmental problems currently of concern throughout the world, considering its influence, which can give rise to greenhouse gases, which can increase the temperature of the earth's surface, causing health problems for humans and other living creatures [2-3]. Air pollution is the presence of one or two more physical, chemical, and biological particles in the atmosphere in amounts that can endanger the environment, especially the health of humans, animals, and plants [4-5]. As well as disrupting environmental comfort and aesthetics, it can also damage property [6]. Some CEMS features include [7]:

a. Analyzer, which serves to assess the gas concentration in the flow.
b. Equipment to guide the gas flow sample to the analyzer in case of long-distance.
c. Equipment for conditioning gas samples by removing water and other components because they can interfere with the readings.
d. Pneumatic pipe with valve regulated by PLC to convey sample gas to and from analytical equipment.
e. Calibration and maintenance system for injection of calibration gas into the sample line.
f. Data acquisition and handling system (DAHS) to collect and store each spot data and carry out the calculations needed to receive the perfect mass emission.

Dust and smoke emissions have long been recognized as major atmospheric pollutants [8], primarily because emissions from such smokestacks are visible to observers. There has been a requirement to monitor and quantify these emissions for some time, and various instruments have been marketed worldwide. PT. Pusri Palembang, one of Indonesia's fertilizer-producing industries, is also obliged to comply with the Minister of Environment and Forestry Regulation Number 13 of 2021. Thus, monitoring emissions in the chimney area within the factory is necessary. One of them is at Prilling Tower Pusri IV. The waste that has the most potential to pollute the environment at the Ammonium Nitrate factory is ammonia (NH_3), which is released containing a lot of ammonia in gas form [9]. Moreover, the smell of ammonia is very 'nasty.' Suppose this waste is discharged directly into the ambient air and is now used by humans for breathing. In that case, this will affect the quality of the ambient air and reduce the level of human health, posing a potential danger to workers and the people living around the factory.

2. Method

The data source in this research is the factory production unit of PT. Pusri Palembang. The study was conducted at the Pusri IV factory in Palembang, Indonesia. The data source uses primary and secondary data collected from October 2022 to March 2023. The data collection method used in this research is [10]:

a. Primary Data. Primary data consists of data obtained from surveys to determine the situation in the field regarding the condition of the chimney and the availability of existing areas, followed by a review of relevant literature to calculate the main dimensions.
b. Secondary Data. Secondary data is obtained in a ready-made form, collected, and processed by other parties.

3. Results and Discussion

Continuous Emission Monitoring System (CEMS) on Stack GB-304 (Induced Fan) at Prilling Tower Pusri-IV. The planned CEMS system consists of an NH3 Analyzer, as shown in Figure 1. The CEMS measurement results will be recorded in data Acquistion and displayed on the PC (Personal Computer) Workstation in the Pusri IV Urea Control Room.

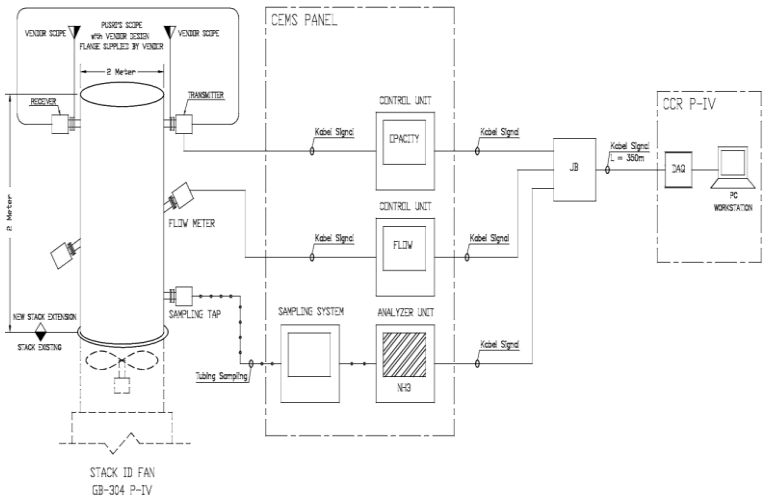

Figure 1. Continuous air emission quality monitoring system.

In this work, the tapping point for CEMS will be at the GB-304 Induce fan outlet stack, which is above the P-IV prilling tower. Engineering drawing for additional stacks that will be used as tapping points. The insertion pipe at the tap point is prepared as an instrumentation nozzle. The operating conditions in the stack are the ID Fan GB-304 output air mixed with urea dust with an average temperature of 40ºC and a maximum of 60ºC.

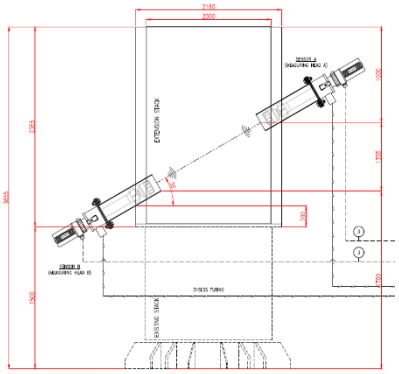

Figure 2. Engineering drawing for additional stack.

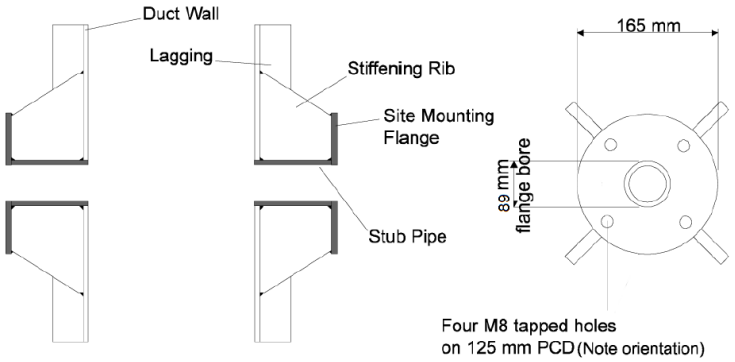

Figure 3. Installation of stub pipe.

CEMS is a dual-pass transmissometer configured to measure opacity and dust concentration in exhaust gases. Its unique optical arrangement provides continuous visible light transmissivity measurements across the stack in opposite directions, providing an accurate average of dust loading in the stack and a dynamic assessment of any alignment errors that may occur due to stack movement. The analyzer consists of stack-mounted transceivers designed to send and receive beams of visible light across the stack to obtain stack gas transmissivity measurements, from which opacity and dust concentration values are calculated. Consider two identical transceivers positioned on either side of a chimney (or duct), unit 1 and unit 2.

Since the two terms in brackets above are each measured from only one of the transceivers, the instrument output is independent of the shift of either detector. One CEMS package and its equipment consist of a tap point system, sample handling system NH3 analyzer, NH3 analyzer, one ultrasonic flowmeter package, one package of opacity and particulate measuring instruments, data acquisition, PC workstations, bulk installation materials: cables, cable trays, ss tubes, fittings, valve blocks, stanchions, etc., and calibration equipment.

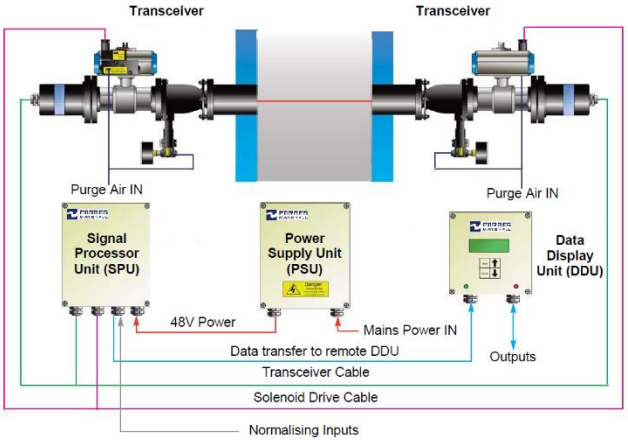

Figure 4. CEMS system settings.

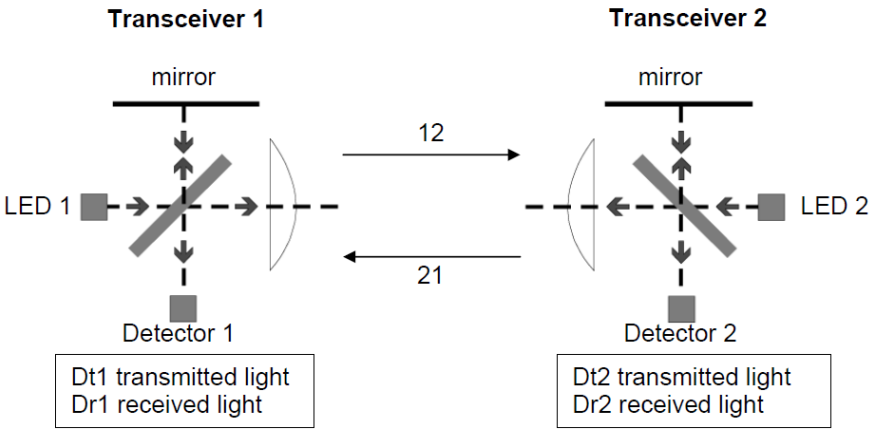

Figure 5. Schematic of the working principle of transmissivity.

The transceiver is controlled by a signal processing unit (SPU), which can be connected to a laptop computer via an RS232 serial link for commissioning and servicing. The remote data display unit (DDU) is connected to the processor via a 4-wire data bus up to 1 km long. This module

allows all output and diagnostic data to be accessed on the display and 2-line, 32-character alpha-numeric keypad. It also provides 2 x 4-20mA outputs and 2 x volt-free contact relays for alarms. This output is fully configurable from the keypad and display.

Sample handling system NH_3 analyzer

a. Pump : Diaphragm type
b. Casing and diaphragm ,aterial : 316L SS
c. Power supply : 220 VAC, 50 Hz, 1 phase
d. Ingress Protection : IP 65 or NEMA 4X with stainless steel material
e. Sampling probes must be equipped with heated ceramic filters, and all sampling lines must be fitted with heated bars.
f. The sampling probe must have an automatic blowback function controlled automatically with Programmable Logic Control (PLC) or a simple relay. Blowback will use a water instrument with an available pressure of 4 - 7 kg/cm^2. The blowback system must have an air regulator set and an air filter to regulate purging needs.
g. The Sample Handling System must be placed in a panel with IP 65 specifications and stainless steel material.

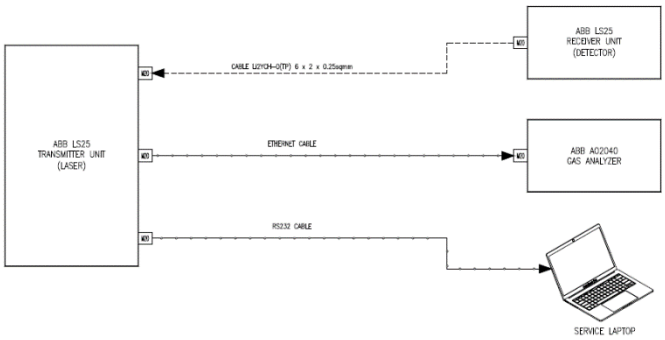

Figure 6. Communication wiring diagram.

The analyzer measures the NH3 component on 1 (one) Induced Fan Prilling Tower P-III. The NH3 measurement system is an attractive type. The analyzer is integrated into one panel and placed outdoors. The following are the specifications of the analyzer:

a. Repeatability : < ± 1 %
b. Power supply : 220 VAC, 50 Hz, 1 Phase
c. Measurement range : 0 ± 600 mg/NM^3
d. Measurement of the NH_3 component can use a laser beam.
e. Output: 4-20 mA analog signal for measurement results (concentration) and one standard fault alarm signal. Data communication using Ethernet with TCP/IP protocol with RJ-45 port.
f. The analyzer must have a local display, such as an LCD.
g. The analyzer system must be placed in a single panel equipped with weathertight glass windows with outdoor protection specifications NEMA-4X or IP 65 with stainless steel material.
h. Tools for calibrating/verifying the CEMS analyzer must be supplied by the Partner, both hardware and software, including the need for calibration gas (zero and span calibration gas) for 2 (two) years must be supplied by the Partner
i. CEMS must be equipped with a purging system to prevent urea dust from entering the CEMS system. Purging will use a water instrument with 4 - 7 kg/cm^2 available pressure. The purging system must have an air regulator set and an air filter to regulate purging needs.
j. NH_3 Analyzer must have a Quality Assurance Level (QAL) 1 (suitability test) certificate, which is still valid today. QAL 1 certification is to be submitted at the time of bidding.
k. NH_3 Analyzer must have a Quality Assurance Level (QAL) 2- (Installation and Calibration) certificate.

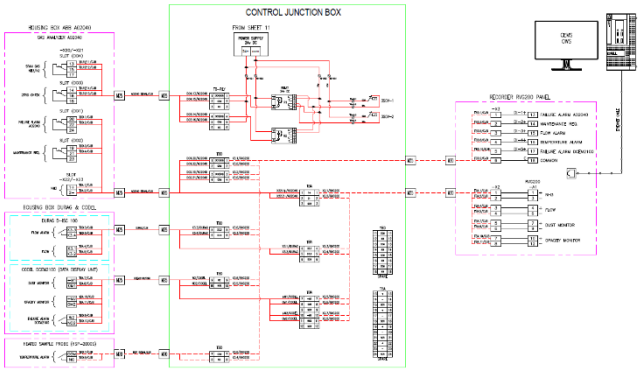

Figure 7. Signal wiring diagram.

The CEMS system must have data acquisition to measure, store, record, analyze, and display CEMS measurement results. Data acquisition can be done by data loggers or modular I/O data acquisition. Data Acquisition Specifications are as follows:

a. I/O Interface : Minimum eight analog input signals 4-20 mA and eight digital input signals
b. Accuracy : ± 0.2% span

c. Power supply : 110 VAC, 50 Hz, 1 phase
d. Network Interface : Web server, FTP file transfer, Ethernet TCP/IP, Modbus TCP/IP, OPC-UA
e. Equipped with software to display, record, and read history data on a PC.
f. Data Acquisition must be able to store measurement results data for at least one month (24 hours).

4. Conclusion

After conducting a study of the planned CEMS system consisting of an NH_3 Analyzer, several conclusions were obtained as follows: The NH_3 (ammonia) measurement system is an extractive type; measurement of the NH_3 component can use a laser beam; power supply: 220 VAC, 50 Hz, 1 phase; the analyzer system is placed on a panel equipped with IP 65 protection specifications with stainless steel material; measurement range: 0 ± 600 mg/NM^3; I/O Interface: Minimum eight analog input signals 4-20 mA and eight digital input signals; network interface: web server, FTP file transfer, Ethernet TCP/IP, Modbus TCP/IP, OPC-UA; and is equipped with software to display, record and read history data on a PC.

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