

PETRONAS TECHNICAL STANDARDS

DESIGN AND ENGINEERING PRACTICE

Guidelines on Selection and Installation of Continuous Emission Monitoring System (CEMS)

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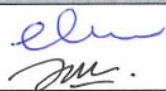
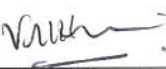
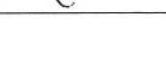
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This new PTS 32.31.50.39 - Guidelines on Selection and Installation of Continuous Emission Monitoring System (CEMS) has been developed to streamline the design and implementation CEMS throughout PETRONAS group companies.

This PTS also includes PETRONAS Lessons Learnt and PETRONAS Best Practice for the subject matter Guidelines on Selection and Installation of CEMS

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1. INTRODUCTION

This PTS was established to specify requirements and give recommendations for the design and construction of Continuous Emissions Monitoring System (CEMS) in accordance to Environmental Quality (Clean Air) Regulations 2008 - Draft. This guide also describes the various methods used to continuously monitor pollutants emitted from stationary sources.

1.1 Definitions

DOE	Department of Environment
PEFS	Process Engineering Flow Scheme.
Piping class	An assembly of piping components, suitable for a defined service and design limits, in a piping system. Piping classes for refining and chemicals are contained in PTS 31.38.01.12; piping classes for exploration and production are contained in PTS 31.38.01.15.
Nafion®	Nafion® is a DuPont™ copolymer of tetrafluoroethylene (Teflon®) and perfluoro-3, 6-dioxo-4-methyl-7-octene-sulfonic acid. Highly resistant to chemical attack, and it also exhibits highly selective absorption and transfer of compounds.
CEMS	Continuous Emissions Monitoring System
PEMS	Predictive Emissions Monitoring System
CEMS-DIS	CEMS Data Interface System
DCS	Distributed Control System
AMADAS	Analyzer Management and Data Acquisition System
CSV	Comma Separated Value. A file format is a particular way to encode information for storage in a computer file. Particularly, files encoded using the CSV format is used to store tabular data.
TDLAS	Tunable Diode Laser Absorption Spectroscopy. A new technology using tunable laser as optical source.
NIR	Near Infra-red is a spectroscopic method which uses the near infrared region of the electromagnetic spectrum (from about 800 nm to 2500 nm)
NDIR	Non-Dispersive Infra red uses a wider infra red region of the electromagnetic spectrum.
TPM	Total Particulate Meter
VOC	Volatile Organic Carbon
FID	Flame Ionization Detector
UV-VIS	Ultraviolet Visible
Process line	The piping used for transport of fluids (other than sample lines).
Sample	A representative portion of the product or process stream having all relevant properties of the product or the process stream itself.
Sample conditioning system	One or more devices that properly prepare a portion of the sample from the sample transport system for testing by the process analyzer to meet the requirements of the analyzer.
Sample line	The tube or pipe used for transporting the sample.

Sample pre-conditioning system	Consists of one or more devices that condition the sample (pressure, temperature, flow, change of state) so that it is suitable to be transported to the sample conditioning system. The sample pre-conditioning system forms part of the sample take-off system.
Sample probe	A device (usually in the form of a special tube) that is inserted into a defined point in the bulk of the process stream to extract a small portion as a sample.
Sample recovery system	A system that collects waste sample and/or by-products from the analyzer system for the purpose to either return them to an assigned point of disposal or to a suitable point in the process.
Sample take-off connection	A piping connection for the extraction of the sample from the process line and through which a sample probe may be inserted into the process.
Sample take-off point	The exact location from where the sample is extracted in the process, i.e., the location of either the tip of the sample probe or the pipe wall connection from where the sample fluid leaves the process piping.
Sample take-off system	The system that includes the sample probe and downstream components up to the connection with the sample transport system.
Sample transport system	A system used to transport a sample from the sample takeoff, either to the sample conditioning system (and from there to the analyzer) or directly to the analyzer, and to return the waste sample, if any is collected, from the sample conditioning system, either to a suitable point in the process or to a suitable utility system.
Sampling system	The complete system that includes the sample take-off, sample transport and sample conditioning systems.

2. REGULATORY REQUIREMENTS

Refer to Environment Quality (Clean Air) Regulation 2008 - Draft.

Table 1 is the summarized limits based on DOE regulation. This table is subject to change by DOE.

Table 1 – DOE Regulatory Pollutants Limits

Source Activities	Source Capacity	Fuel Type	Pollutants	Limit Value (mg/m ³)	Data Frequency
Heat & Power Generation	Boiler ≥ 10 MW	Solid & Liquid Fuels	SO ₂	500	½ H Average
			NO ₂	500	½ H Average
			CO	200	½ H Average
			Total PM	50	½ H Average
	Boiler ≥ 10 MW	Gaseous fuels	SO ₂	35	½ H Average
			NO ₂	350	½ H Average
			CO	50	½ H Average
			Total PM	5	½ H Average
	Combustion turbines ≥ 10 MW	Gaseous fuels	NO ₂	150	½ H Average
			CO	100	½ H Average
	Combustion turbines ≥ 10 MW	Liquid Fuels	NO ₂	200	½ H Average
			CO	100	½ H Average

Source Activities	Source Capacity	Fuel Type	Pollutants	Limit Value (mg/m ³)	Data Frequency
Iron & Steel Mills (all sizes) Production & Processing	Sinter plants (waste gas from the sintering belt)		SO ₂	500	½ H Average
			NO ₂	400	½ H Average
			Total PM	50	½ H Average
	Blast furnace (@ 3% O ₂)		Total PM	50	½ H Average
	Basic Oxygen furnace		Total PM	50	½ H Average
Non-ferrous metals ¹ Production & Processing	Sinter plants (waste gas from the sintering belt)		SO ₂	500	½ H Average
			NO ₂	400	½ H Average
			Total PM	50	½ H Average
	Production of copper & zinc		Total PM	20	½ H Average
	Production of lead or cadmium		Total PM	10	½ H Average
	Primary Aluminum		Total PM	10	½ H Average
	Secondary Aluminum		Total PM	10	½ H Average
Oil & Gas industries: Refineries (all sizes)	Catalytic Cracking		Total PM	40	½ H Average
			SO ₂	1200	½ H Average
	Calcination		Total PM	40	½ H Average
Non metallic industry	Cement kilns (all sizes)		NO ₂	800	½ H Average
			Total PM	50	½ H Average
	Glass furnaces (≥ 1 t/day)		SO ₂	800	½ H Average
			NO ₂	800	½ H Average
			Total PM	50	½ H Average
	Ceramic furnaces (>10 t/day)		SO ₂	800	½ H Average
			NO ₂	800	½ H Average
			Total PM	50	½ H Average
Waste incinerators (all sizes)			Total PM	10	½ H Average
			NMVOC as Total C	10	½ H Average
			HCl	10	½ H Average
			HF	1	½ H Average
			SO ₂	50	½ H Average
			NO ₂	200	½ H Average
			CO	50	½ H Average
Palm Oil Mills (all sizes)			Total PM	50	½ H Average
			Opacity (Smoke)	20%	Minute average

3. MONITORING TECHNOLOGY (SAMPLING SYSTEM)

Two main principles in monitoring pollutant emissions from stationary sources:

- 1) Extracting or locating a representative sample (Extractive)
- 2) Analyzing that sample directly (In-situ)

The choice and design of CEMS depends on both the regulatory requirements and the types of pollutants and/or parameters that are to be monitored.

The choice of sampling systems has to be compatible with the analyzers used to measure the analytes.

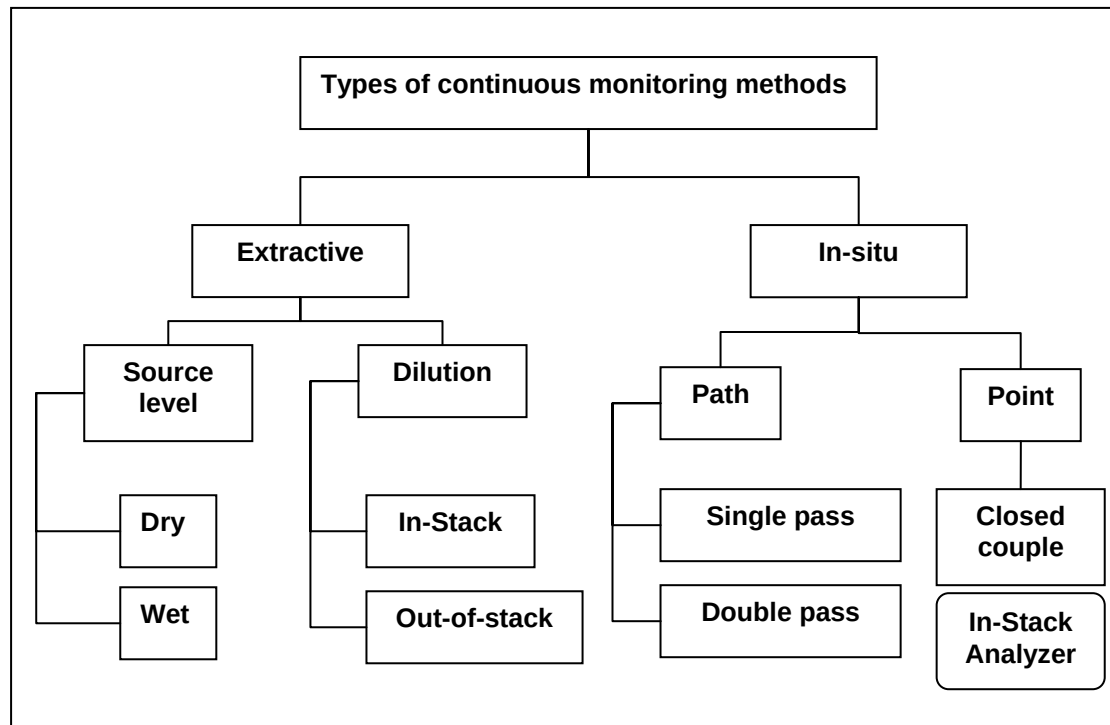


Figure 1 Flow chart of Methods

3.1 Extractive Sampling Systems Method

Extractive sampling systems is a system that extracts or withdraw sample from the stack and treat or condition samples to be analyzed.

Extractive sampling systems shall be designed and operated in a manner that provides consistently representative samples to the analyzer.

The design of the sampling system must eliminate, or at least minimize, any reactions or loss of the medium of interest before they reach the analyzer.

There are two types of extractive methods:

- 1) Source level (Hot-Wet systems and Cold-Dry systems)
- 2) Dilution (in-stack and out-of-stack)

3.1.1 Source level: - Hot-Wet (Hot and Wet) systems

This type of sampling system design is not preferred as it usually requires high maintenance and limited flexibility to analyze multi component using one analyzer

Hot-Wet systems are systems that maintain the sample temperature above its dew point throughout the sampling system and within the analyzer.

With this system, the sample being measured is at hot and wet condition (i.e. there is no water removal /condenser unit prior to transporting the sample)

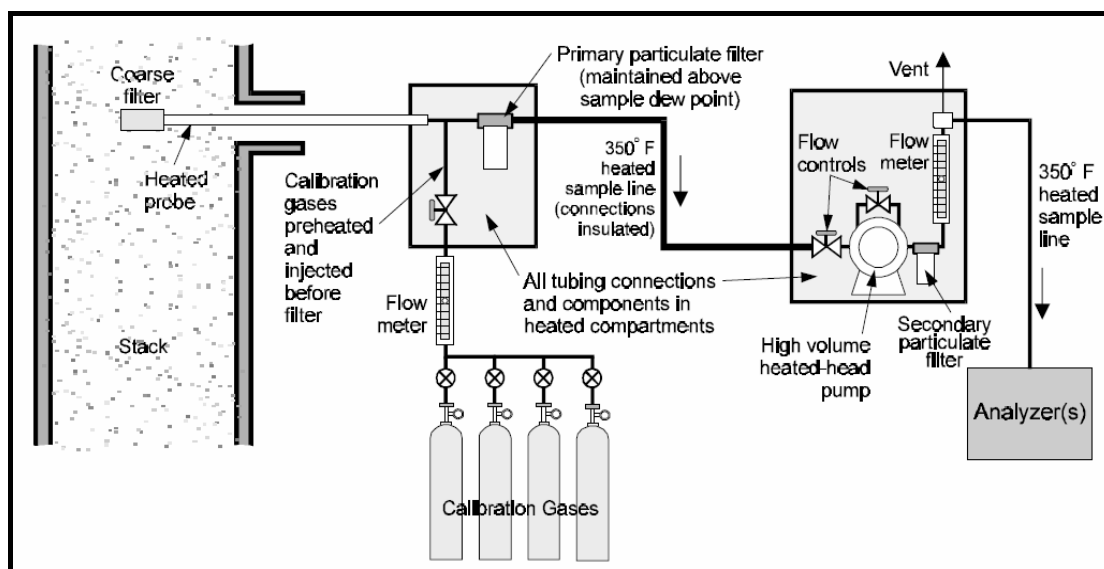


Figure 2 Typical Hot-Wet Systems

This system should be considered only for water soluble samples such as HCl, NH₃ and VOCs-

The hot/wet systems design should take the following factors into consideration:

- 1) Water solubility of the samples,
- 2) Adsorption capability of the samples or compounds,
- 3) Participations in chemical reactions with other stack gas.
- 4) Selected analyzer shall be able to withstand hot and wet sample and its measuring technology is insensitive to moisture content.

To minimize the effects of analytes adsorption into sample lines, the sampling lines material selection and operating temperature and pressure shall be considered.

High flow rates and short sampling will reduce the effects of analytes adsorption by minimizing the residence time of the samples inside the line.

All other accessories shall be selected meticulously to avoid adsorption or condensation. All cold spots within sampling lines such as connectors between heated lines segments shall be eliminated by heating the sample above the minimum dew point of the mixture.

The effects of temperature changes between the stack and the analyzer shall be considered to reduce the impact of chemical reactions of gases due to temperature change.