Readout

HORIBA Technical Reports

March 1997

The ENDA-2000H Stack Emissions NOx Analyzer with High Response Speed Applicable to Coal Burning Power Plants

---

by

Masahiko FUJIWARA and Naohito SHIMIZU

HORIBA, Ltd.

Abstract

Real time measurement is essential to the effective control of NOx emission from plants that burn fossil fuels. After reviewing the conventional stack emission measurement lines, we developed a new NOx analyzer system, the HORIBA ENDA-2000H, which responds to changes in NOx concentration within 20 seconds and needs minimal maintenance. This paper describes improvements of the analyzer hardware, the cyclone dust filter, and the sample probe employed in the ENDA-2000H. It also describes dust conditions in the sample examined based on particle size distribution analysis.

1. Introduction

NOx emissions from steam generation power plants must be monitored at both the inlet and the outlet of the De-NOx system to confirm that combustion control functions at the minimal NOx level and to gather information about the efficiency of the De-NOx system. The faster the response, the more precise the control, resulting in optimal performance which protects the environment and saves energy. HORIBA has successfully supplied high-response-speed NOx analyzers for power plants with gas turbines that burn LNG. But, in power plants that burn coal or crude oil, the larger amount of soot and ash in the exhaust creates the need for frequent servicing of the sampling system, which prevents real time emission measurement.

2. System configuration for high-speed response

In coal or crude oil burning power plants, a conventional blow-back is frequently adopted to keep the filter unit from clogging. In the development of the ENDA-2000H, we studied analyzer hardware and sampling systems in order to achieve the maximal response speed to meet the needs of process control applications.

2.1 Analyzer hardware

A cross-flow modulation NDIR analyzer was selected based on its history of high performance in stack emission measurement application. The major improvements made were;

(1) The cross-flow switching time was reduced to 0.5 second, about half the normal time, to get a faster response, and

(2) The optical system was modified in design to have 10 times greater sensitivity at lower noise levels than the standard model.

2.2 Continual sample pretreatment system

The amount of soot and ash in the exhaust of a coal-burning boiler is generally 5 to 30 grams per cubic meter. The ENDA-2000H employs a mini-cyclone dust filter (*Fig.1*) in its continual dust removal system, which reduces the amount of dust within the small cavity. The interior path of the filter can be purged periodically by instrument air. The dust removal effect of the mini-cyclone filter was verified by examining the dust at the inlet and the outlet of the mini-cyclone filter with a particle size distribution analyzer (*Fig.2*). The dust separated in the cyclone is automatically discharged, and the sample gas is fed to the analyzer by a sampling pump in the instrument cabinet (*Fig.3*).

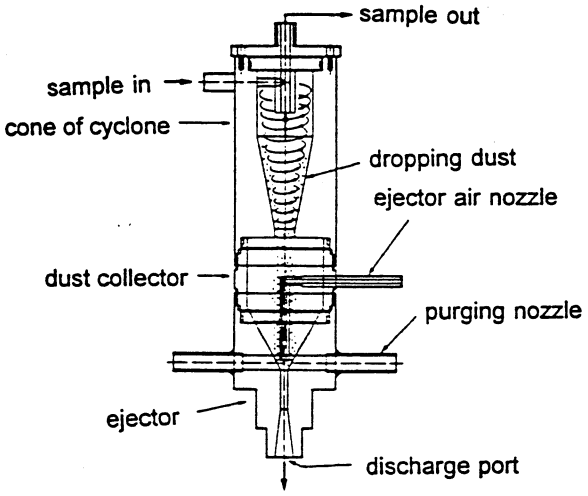

Fig.1 Cyclone Dust Filter

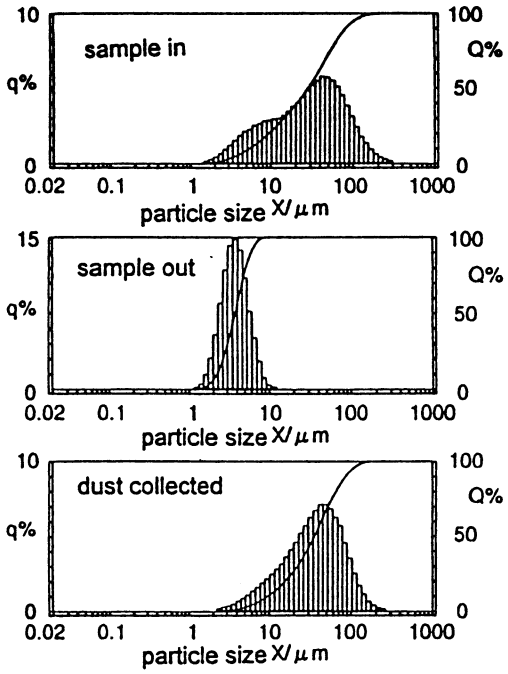

Fig. 2 Particle Size of Dust

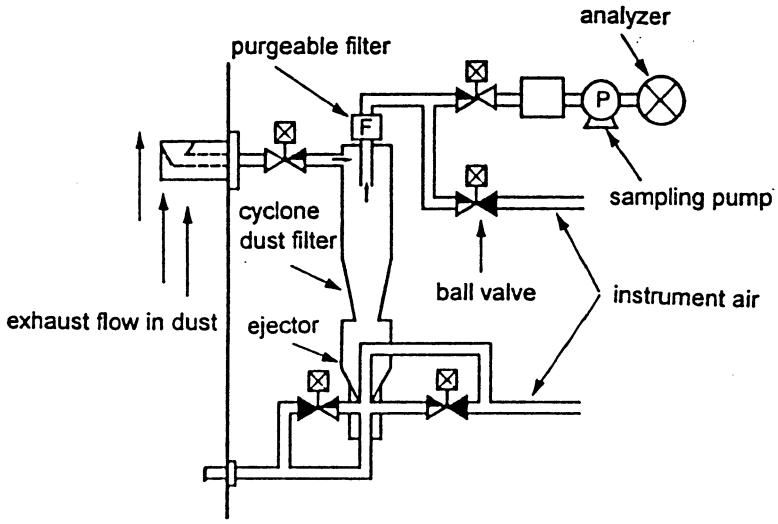

Fig. 3 Schematics of Dust Removal System

2.3 Sampling probe

A funnel-shaped sample probe decreases the velocity of the sample flow locally at the probe tip and reduces the amount of dust introduced downstream in the sample line. The combination of the funnel-shaped sample probe and the mini-cyclone dust filter removed 99.1% of the dust in raw exhaust that contained about 30 grams per cubic meter of dust before entering the sample probe. This system can be operated free from clogging with purging of the sampling system at 12-hour intervals. *Table 1* shows the typical time required by the major components in the response time of the system.

Table 1. Contribution to response time(T90 in second) by components

Component	Time required
Analyzer	7 seconds
Sample line	2 seconds
Purgeable filter	8 seconds
Mini-cyclone	3 seconds
Total	20 seconds

3. Field application

The ENDA-2000H was tested at the Mizushima Power Station of the Chugoku Electric Company during half a year of actual operation in a coal burning plant and in a crude oil burning plant which had different levels of soot and ash in their exhausts.

3.1 Verification with calibration gases

The system's response time was first tested with standard reference gases introduced at the inlet of the mini-cyclone filter. In this dry test, the ENDA-2000H indicated 90% of the final reading, T90, within 14 seconds, including the retention time in the sampling system (*Fig.4*).

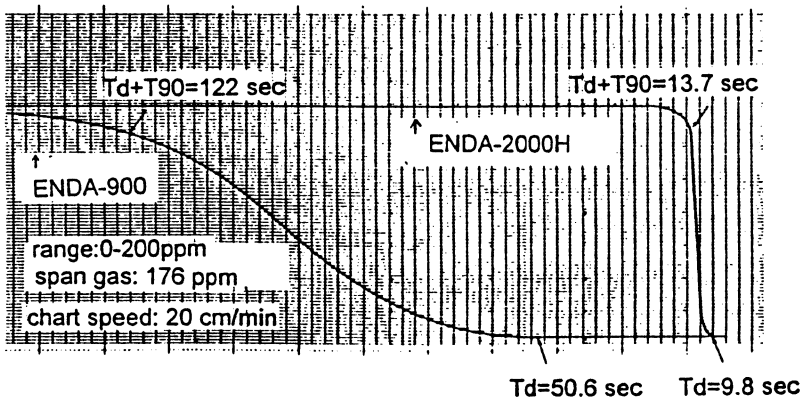

Fig. 4 Response to Standard Gases

3.2 Evaluation in an operating plant

The ENDA-2000H was compared with the conventional ENDA-900 at a power plant(*Fig.5*). The operating capacity of the plant changed rapidly during the test and the ENDA-2000H showed a significantly quick response changes in NOx concentration.

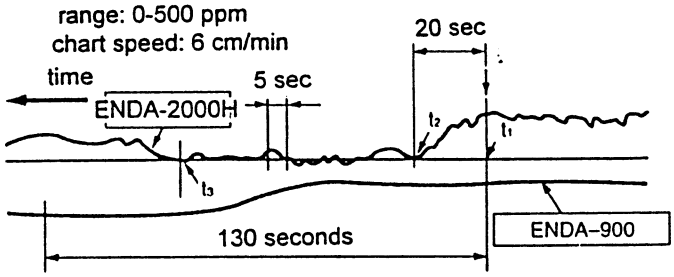

Fig. 5 Response in Field Application

4. Specifications

The actual response time in field applications depends on the length of the sample line between the sampling probe and the instrument cabinet, the sample flow rate, etc. *Table 2* lists the ENDA-2000H's specifications when applied in a plant where dust in the raw exhaust does not exceed 50 grams per cubic meter. The sample pretreatment system can be simplified for plants with little dust in the raw exhaust.

Table 2. Specifications ofENDA-2000H

Application	NOx at inlet or outlet of De-NOx system
Range	0 to 200/500 ppm for NOx 0 to 10/25 volume % for O2
Repeatability	0.5% of full scale
Zero Drift Span Drift	±1.0% of full scale for one week ±2.0% of full scale for one week If ambient temperature change is within ±5°C
Response Time (Td+T90)	Within 10 seconds, when the sample is supplied at the inlet of the system cabinet Within 5 seconds, when the calibration gas is supplied at the inlet of the system cabinet Within 25 seconds, when including a 20 meter, 6 mm i.d. sample line from the sample probe
Sample Flow	20 liters per minute

5. Discussion

The field application proved that the ENDA-2000H system performs real-time measurement of NOx emissions satisfactorily in power plants burning coal, crude oil, and LNG. High-speed response NOx measurement is essential to maintaining the De-NOx system in the optimal operating condition, so as to satisfy environmental protection programs and save energy by controlling the consumption of ammonia to be fed to the De-NOx system. The application of the newly developed ENDA-2000H dust removal systems will be extended to other types of plant operations in the future.