

Steel mill keeps its emissions record stainless

Process instrumentation fed by multiple 4-20mA loops enables mill operator to keep a watchful eye on pollutants

Application Note

Field Applications Case Study



Robert Applegate feels compelled to stay current with process control technology – especially when it may have a direct impact on controlling acid rain and other pollutants. Twenty weeks out of his year are devoted to a high-pressure boiler–emission monitoring system at a northeastern steel mill, where he is a consultant.

also used for proper/safe boiler operation, is NOT available for troubleshooting/calibration while operating the boiler.

It's in the chemistry

What role do low-current loops play in efficiently operating the mill and limiting pollutant levels to abide with the EPA-mandated standard? The

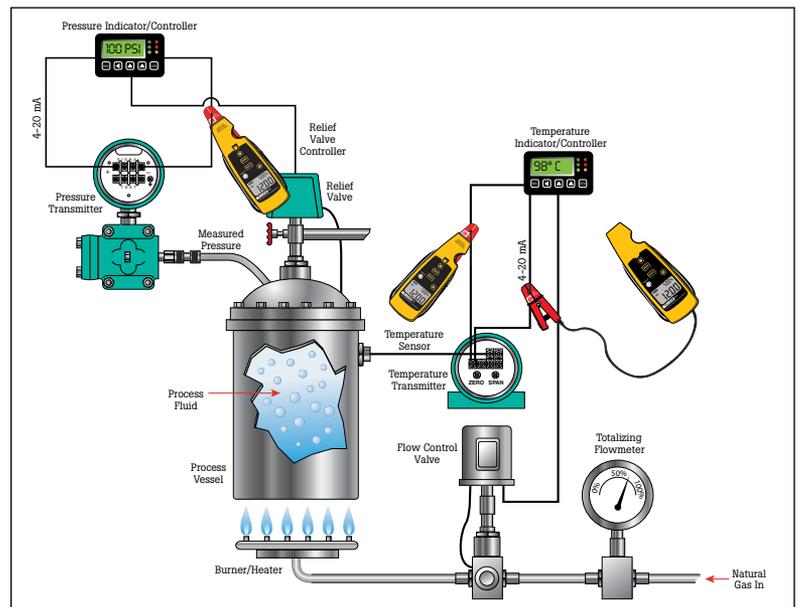


Figure 1: Standard 4-20mA measurement points in a boiler pressure control loop.

At the mill, critical readings about system operations are taken from field instruments connected via 4-20mA loops to a central distributed-control system or DCS. Additional DCS loops send control information to the emission monitoring system, enabling the mill operator to verify continued compliance with EPA-mandated requirements. The DCS data,

mill contains five major boilers whose outputs feed into stacks. The emission-monitoring system extracts continuous stack samples, measuring the nitrous oxide and oxygen concentration levels. "They call nitrous oxide NO_x because there is more than one version," says Applegate. "It could be NO, or it could be NO₂, and hence the term

Tool: Fluke 771 Milliamp Process Clamp Meter

Profile: Robert Applegate - Manager Applegate Automation Enterprises, LLC

Measurements: Input/output percentage checks on a 4-20mA loop. Loop controls process instruments for a steel mill emission monitoring system.



Figure 2: In specific applications, percentage readings on the Fluke 771 may be more useful than the underlying current readings – for example, when a control output must be maintained within a range of 25-30 % of the maximum level. Here, the Fluke 771 is connected to the emission control loop.

NOx. NOx is a precursor to a visible haze of pollution, which itself is a precursor to acid rain.”

The idea, he says, is that by controlling the admission of NOx and sulfur dioxide, or SO₂, mills can lower the concentration of nitric acid and sulfuric acid, or H₂SO₄ (the result of SO₂ combined with water). “That’s a major step toward reducing acid rain, which in the eastern US is threatening to devastate major forests,” says Applegate.

“This is where 4-20mA technology comes in, and why it’s critical to derive what we call “emission factor.” We look at all the fuels that flow into the boiler, the monitoring instruments that report the fuel flow rates. Then we take those rates, combine them with the amount of heat present in that fuel, and generate the heat input. Now we have a heat input to the boiler and a steam flow out of the boiler, and we have the concentration in the stack. From those three measurements, we develop the emission factor.”

The system determines how much NOx went up the stack in that set of circumstances. Here Applegate points to the critical need for “noninvasive” testing. “The instruments reporting fuel flows are also used to control the boiler, and they have to be calibrated. I can’t go out there and say ‘I’ll just disconnect the oil flow meter and measure the flow.’ If I did that, the boiler would trip.”

No more shutdowns

At one time, he says, the only way to troubleshoot those instruments was to shut the boilers down – which meant waiting for once- or twice-a-year planned outages. “That meant there were long periods when I couldn’t verify what a process control instrument was actually doing – unless I had a tool like the Fluke 771. Now I can go out there and measure the circuit loop between the instrument and the DCS, and say ‘Alright, I’m at 55 %.’ Now I look at what’s coming to the NOx system and verify that it’s also 55 %. You can compare the input side to the output side without disconnecting anything.”

Percentage readings, he notes, give the technician another way to track critical indicators. A unique feature of the Fluke 771 is its dual readings: milliamps and percent of scale. For example: “A reading of 4mA equates to zero percent of scale, and a reading of 20mA equates to 100 %,” he says. “In my case, 55 % would give me a reading of 12.8mA.” And how do units of flow equate to currents and percentages? “When you set everything up, you pick a span number. You say the span is going to be full-scale. If it’s an oil flow meter, it might be zero to 30 gallons per minute. At 30gpm, you’d be generating 20mA, and you’d be looking for 100 % at the DCS level.”

He notes that, in the ‘DCS world,’ readings of all kinds are converted from absolute readings of current between 4mA and 20mA, to a percent of some factor. Working with percentages is often easier than keeping current values in mind, while achieving the same results.

“We’re using the instrument for dual purposes: (1) To monitor the boiler and ensure it’s safe for continuous operation, and (2) To compare the amount of heat created by the boiler with the gas concentration in the stack. Those numbers calculate the emission factor, which tells us how much NOx the system is generating.”

About the Fluke 771 Milliamp Process Clamp Meter

Physical design.

The jaws on the Fluke 771 detach from the body of the meter to allow for measurement in tight spaces, while allowing the user to read the screen in a less cramped or better lit area. The 771 also features a built-in measurement spotlight to illuminate hard-to-see wires in tight locations or dark enclosures.

Measurement functionality.

The Fluke-771 Hold function captures and displays changing measurements. With this function, users can make a measurement, remove the meter from the circuit, and retain the reading for easy viewing and recording.

Percentage Span function.

In this mode, the technician can see not only the current reading, but also the percentage of the span represented by that reading. For example, a reading of 12mA would also produce a “percentage of span” reading of 50 % on the meter’s dual display (the reading 50 % between 4mA and 20mA).

All loops are created equal

Applegate points out an inherent advantage of 4-20mA technology. "At the mill, a regulator device sources that current. Within limits, it doesn't care whether that loop is 10 feet or 1000 feet long. The current is the same everywhere in the loop. The longer it is, the higher the resistance. But, because it's regulating current, the system just increases the voltage in order to drive the current to the level it wants to be. It's a low-impedance circuit that isn't impacted by noise in the surrounding area. That's because the current is high enough that any noise generated in the proximity of the circuit doesn't compare with the strength of that low-imped-

ance, relatively high-current circuit."

In a sense, 4-20mA technology is a great equalizer. And that is perhaps why the technology is still used in new industrial systems, even as newer bus technologies have been introduced.

But an enduring technology requires durable, easy-to-use tools. "What I like about the Fluke 771 is that it's uncomplicated," says Applegate. "It's not huge or unwieldy, and it's straightforward

to use. A 4-20mA tester like the Fluke 771 is the kind of tool that everybody in the process control world needs to do this type of work effectively. It's going to be like a flashlight."

Why 4-20?

The 4-20mA current loop is a common method of transmitting sensor information in many industrial process-monitoring applications – typically in systems monitoring pressure, temperature, pH, or other physical factors. These systems employ the familiar 2-wire, 4-20mA current loop, in which a single twisted-pair cable supplies power to a module and also carries the output signal.

Transmitting sensor information via a current loop is particularly useful when the signal has to travel long distances – 1,000 feet is not uncommon.

The use of basic two-wire technology makes the installation both inexpensive and simple to wire, maintain, and troubleshoot.

The loop's operation is straightforward: A sensor's output signal is first converted to a proportional current, with 4mA normally representing the sensor's zero-level output and 20mA representing the sensor's full-scale output. A reading of 20 mA means that a valve, for exam-

ple, is 100 % open, and a reading of 4mA means that it's closed. Readings between the maximum and minimum values mean the circuit is controlling the valve.

Why is 4mA chosen as the lower threshold representing the 'off' or 'closed' position? The design takes into account that there must be a means of representing a fault caused by an open circuit or a lost feed. Therefore, a reading of 0mA is essentially "reserved" to signal a fault in the system, while a reading of approximately 4mA or 20mA would indicate a properly working circuit.

Key among the advantages of 4-20mA current loop technology is that the accuracy of the signal is not affected by voltage drop in the interconnecting wiring, and that the loop can supply operating power to the device. Even if there is significant electrical resistance in the line, the current loop transmitter will maintain the proper current, up to its maximum voltage capability.

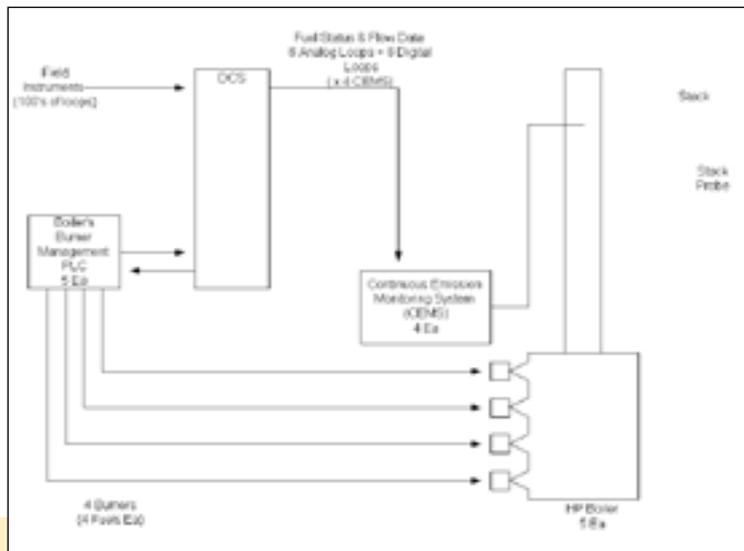


Figure 3: Loop diagram of the steel mill's emission monitoring system.

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Fluke Corporation
PO Box 9090, Everett, WA USA 98206

Fluke Europe B.V.
PO Box 1186, 5602 BD
Eindhoven, The Netherlands

For more information call:
In the U.S.A. (800) 443-5853 or
Fax (425) 446-5116
In Europe/M-East/Africa +31 (0) 40 2675 200 or
Fax +31 (0) 40 2675 222
In Canada (800)-36-FLUKE or
Fax (905) 890-6866
From other countries +1 (425) 446-5500 or
Fax +1 (425) 446-5116
Web access: <http://www.fluke.com>

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