Particulate Emission Monitoring from Zinc Recovery Plant

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Abstract

This paper studies a particulate emission monitoring system installed at a zinc recovery plant owned and operated by Rezinal in Belgium.

The system was installed in 1994 in anticipation of requirements derived from Vlarem II, the environmental legislation in Flanders, Belgium. The monitoring requirements of this legislation are similar to existing and proposed legislation for non-ferrous industrial processes in the US and Europe.

The system includes six AC Electrodynamic (TriboACE®) type instruments, model DT-770, manufactured by PCME. These instruments are monitoring zinc oxide emissions from baghouses after mills and furnaces. Typical dust concentrations are in the range of 1 to 10 mg/m^3.

This paper summarizes the operational experience with the monitoring system. It also discusses the choice of technology and products in relation to the particular application. The paper concludes with a brief summary of changing legislative requirements in the US and Europe, effecting non-ferrous industrial processes and discusses the relevance of this case study in relation to new monitoring requirements.

1 Requirement For Monitoring

The issue of monitoring emissions to atmosphere is both topical and of growing importance throughout the industrial world, as a result of changing legislation and increasing environmental pressures. For many non-ferrous metal processing plants the major potential air pollutant is particulate matter, and with regulations requiring process operators to prove that emissions are properly controlled (due to the toxic nature of certain non-ferrous dusts), continuous particulate emission monitoring has grown in relevance and significance.

Rezinal's decision to install continuous particulate emission instruments on emission sources from their zinc recovery facility in Belgium was driven by their commitment to be ahead of changing legislative requirements. At that time changing regulatory requirements were expected from Vlarem II, (the air regulations in the Flemmish part of Belgium) which would require the plant to put an alarm on the emission concentrations in the Furnace and Smelting stacks. Rezinal, however, was more interested in trend monitoring rather than indicative monitoring. As expected, continuous monitoring has now become a regulatory requirement.

2 Process Description

The Rezinal facility produces about 20,000 tons of zinc a year. Particulate emissions from the zinc recovery process are controlled by the use of both cyclones and efficient reverse jet bagfilter (baghouse) systems. The particulate monitors were to be fitted on the clean side of the bagfilter systems to monitor both the amount of particulate being discharged to atmosphere and the operational condition of the baghouse.

Sources of particulate within the zinc recovery process are:

1. Induction Furnace (DIAGRAM 1) Metal from the ball is melted within a furnace. The particulate laden air created above and around the furnace is extracted and cleaned by a

cyclone and then bagfilter before being discharged to atmosphere.
2. Rotary Furnace (DIAGRAM 2) Old shredded zinc (from zinc roofing) is melted within a gas fired rotary furnace. Emissions from the furnace are neutralized with chalk and then collected in a cyclone and bagfilter.
3. Mills (DIAGRAM 3) Zinc ash is recycled within the facility but first must be separated in metal and oxide. Dust created within the oxide mill and materials handling systems is collected with a series of cyclones and bagfilters. Cleaned air is then discharged to atmosphere.

The amount of emissions from these sources is very low which had implications on the choice of monitoring system. Results from isokinetic tests showed these to be typically below 1mg/m^3 against an emission limit of 10mg/m^3.

3 Choosing The Monitoring System

Rezinal's approach to finding an appropriate system was to test and evaluate the performance of instruments in the actual application. The company had had some experience in operating a particulate monitor based on light backscatter placed after the mills for operational purposes, but was not satisfied with the reliability. Opacity systems were discounted early in the search for a monitoring system since typical emission levels and the emission limit were below 25mg/m^3 , the minimum detection level of transmissometers.

Two systems were short-listed for evaluation: the DT-200 manufactured by PCME and distributed in Belgium by Landre and Glinderman, and the Triboflow manufactured by Auburn International. At the time of testing, the DT-770 was still to be submitted for accreditation to TA Luft [1] standards for bagfilter applications and, therefore, the selection of both instruments for trial was made on stated performance provided by the manufacturers.

The evaluation period extended to 6 months in which time the DT-200 was tested on all 6 baghouse outlets. The output of the DT-200 was compared against the known operating profile of the emission sources over extended periods of time. In addition, calibrations of the instruments were evaluated with isokinetic testing at different times. Early testing showed the DT-200 to have a stable output with time. The TriboFlow did not match this property and therefore this was subsequently dropped from further testing. In parallel with Rezinal's own tests, Rezinal commissioned the University of Leuven to evaluate the DT-770 [2]

At the end of the evaluation period, Rezinal were satisfied that PCME's TriboACE® technology provided a solution to their monitoring requirement and purchased the instrument. While certainly not an exhaustive test of the instrument, the following important operating characteristics were confirmed:

- Minimum detection level of below 0.1 mg/m^3
- Sufficient measurement spans for the application (0.5 to 10mg/m^3)
- No maintenance required
- Stable, non-drifting output
- Appropriate response to changing bagfilter condition

In addition, Rezinal was convinced the measuring principal was working well and found that the AC based instrument showed much better stability than the DC based instrument. The DT-770 approach was chosen for the ease of datahandling and reporting system. Subsequently six further DT-770's have been installed at the Rezinal facility.

4 Monitoring System Description

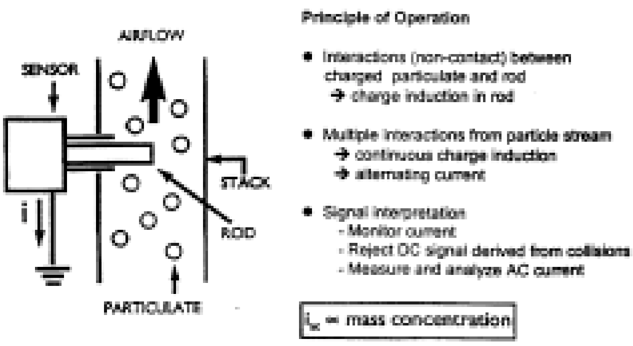
4.1 Measurement technique

The principal of operation of the DT-770 is to monitor the magnitude of the alternating current that results from charge induction as distributions of charged particles pass a grounded sensor rod. This technology is refered to as both AC electrodynamic [3] or TriboACE®. The magnitude of the AC current can be related to particulate concentration and under conditions found in most baghouses (ie constant material charge, particle size and material type) is proportional to dust concentration.

The instrument is engineered with a sensing probe installed across the stack in a position to be exposed to a representative profile of the particle emissions. The particles in the stack produce charge movement in the probe as a result of two kinds of interactions:

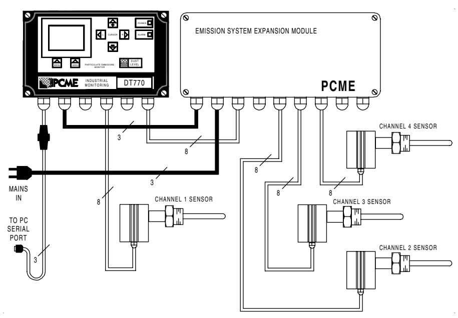
1) Direct collision
2) Charge induction (charge on the particle repels charge in the probe as it passes it)

The signal generated from direct collisions is a DC current and this is specifically filtered out, to leave the AC current produced by particle induction.



4.2 Instrument Functionality

The DT-770 comprises a separate sensor and control unit. The electronics in the sensor housing conditions and amplifies the signal created at the sensor probe. It is connected to the control unit by an eight core screened cable, of up to 300 metres in length. The control unit provides user interface, sensor control and datalogging capability for up to four sensors. Data stored within the control unit can be transferred to a PC and reported using the PC software provided with the instrument.



The DT-770 has a memory capacity of 150 days (@15 min averages), however, Rezinal transfer the data recorded within the DT-770 to their PC every week to ensure that data is being reviewed in a timely matter.

5 Installation Considerations

Sensors with 30 cm probes were installed in the 400 to 600 mm diameter stacks from the baghouses. The location of the sensors was chosen to ensure that the probe was exposed to a representative profile of the particulate. This was approximately 2 metres along a straight section of ducting and before the sampling ports used to perform isokinetic sampling.

The control units are located some 50 metres from the stack. The emission alarms from the DT-770 are connected to an audible alarm to alert plant operators if there should be an excursion in particulate emissions, so that maintenance can be scheduled for the baghouse. The RS-232 is connected to a PC located at the central lab for data transfer and analysis.

To avoid false signals from rain coming down the stack when the baghouse fan is not running, the instruments "plant running" input is connected to the fan controller. This enables the instrument to mark valid data and use only this in average computations. Problems with a chattering relay on the fan controller plant running signal were eliminated. The initial instrument supplied did not carry the CE marking for RFI immunity. This was upgraded to a version that had passed all relevant EC directive requirements at the time that the plant relay problem was fixed.

6 Results, Calibration And Validation

Isokinetic tests are performed twice per year by Rezinal and twice by Lisec, an independent laboratory. The latter tests are required by the regulations since the results are used to compute exact emission concentrations. However, in addition they are used to validate the calibration of the instruments. Results from the past 4 years have shown that the emission concentrations vary over the range 0.5 to 1.5 mg/m^3 and that the instrument calibration is satisfactorily stable. Typical results transferred from the DT-770 to the PC are shown in diagrams 4 and 5.
To assist quality assurance feedback is continuously provided by the instrument on its

correct operation, the instrument performs zero, span and probe checks on a 4 hourly cycle and has an alarm output to alert of a failure. These tests provide an additional source of confidence between isokinetic samples that the instrument is operating correctly.

It is very important to Rezinal that they see a stable real time signal which clearly shows process variations, broken bags or other problems. They are very satisfied with the operational control the instrument shows and are now running tests to use the TriboACE® in process control applications on the mills. Emission levels at Rezinal are now typically lower than 1mg/m^3 and it is a problem to test these low values with isokinetic tests.

After four years of operational experience with the DT-770, the user is satisfied that the instrument continues to perform reliably and without the need for maintenance.

7 Relevance To New Legislative Requirements In Europe And U S

Many industrial emission stacks are similar to those described in this paper in that there is an efficient bagfilter to control emissions and that typical particle emissions are in the range of 1 to 10 mg/m^3. It is these types of stacks especially in non-ferrous and chemical applications which are falling under new environmental regulations, as a result of the increased knowledge on the effects of particulates.

In Europe, most countries for some years have required continuous monitoring of particulate emissions when the quantity of particulates emitted per year is above defined thresholds. In recent times many countries have also required continuous monitoring if the particulate is toxic in nature, or there is the potential to emit should arrestment plant fail.

By definition, emission levels are much lower in these applications due to stricter emission standards and/or the use of efficient arrestment plant and it is to these applications that this paper is of particular relevance.

In the U S, the regulations effecting non ferrous and chemical processes are being changed with the publication of MACT (Maximum Achievable Control Technology) standards which amongst other things define, for processes emitting hazardous pollutants (HAPS) including hazardous particulates, how such processes should be monitored. It is likely that Compliance Assurance Monitoring which provides process type feedback on the operation of the baghouse will become standard operating practice for these types of plants. This new U S concept of particulate monitoring as a process feedback tool and not a legal instrument closely matches the approach already being taken at installations in Europe such as at Rezinal.

References:

[1] TUV Evaluation of DT-770
[2] University of Leuven Evaluation (Bulk International)
[3] Electrodynamic Technology – W. Averdieck (Pollution Equipment News)

Lead Authors Details:

William Averdieck founded PCME in 1990. He previously worked for Datel Inc managing sales and “design in” performance of European Distributors. He also spent two years at Auburn International as Marketing Manager/Product Engineer developing flow measurement instrumentation. William is a member of the European Institute of Business Administration. (INSEAD)