CIVILE, R., and DE RAEDT, H. Air-pollution control in the Amazonia region: Dust extraction in a silicon-metal plant. *INFACON 6. Proceedings of the 6th International Ferroalloys Congress, Cape Town.* Volume 1. Johannesburg, SAIMM, 1992. pp. 243–245.

Air-pollution Control in the Amazonia Region: Dust Extraction in a Silicon-metal Plant

R. CIVILE and H. DE RAEDT

NEU Aerodinamica Group, Sao Paulo, Brazil

The need for economic development without damage to the environment has become a major concern worldwide, particularly in the Amazonia Forest region. The ferroalloy industry in Brazil is reviewing the traditional concepts of environmental control.

This paper describes the installation of a state-of-the-art dust-control system on four electric furnaces (18 MVA each) in the first silicon-metal plant in North Amazonia.

Introduction

The Amazonia area is one of the last great natural regions left on the planet. The economic development of the area without harm to the environment has become a major Brazilian challenge, and has aroused world-wide concern.

The vast variety of natural resources in the region, together with the availability of power from the hydro-electric plant at Tucurui, which has considerably improved the supply of electrical energy to the country, has led our client, one the biggest Brazilian private groups, to build a silicon-metal plant in the centre of the Amazon area.

The plant is in Tucurui, state of Paá, approximately 300 km from the port of Belém, the State's capital city (Figures 1 and 2).

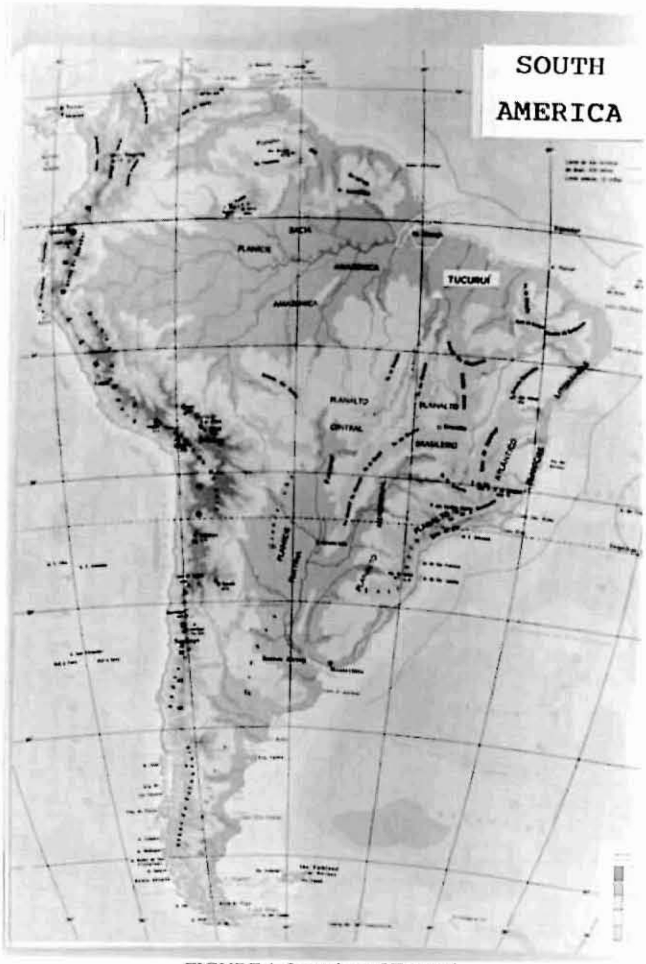

FIGURE 1. Location of Tucurui

Description of the Project

The client selected four DEMAG furnaces of the open-hearth type, which can also operate as semi-closed (or semi-open) furnaces since the peripheral opening can be partly closed. A very useful feature of this type of furnace is that interior access is very easy whenever any kind of maintenance or repair work is required within the furnace. However, a higher fume-extraction rate is needed in order to prevent the diffusion of fumes into the production hall.

The main characteristics of each furnace are as follows:

Capacity	18 MVA
Inside diameter	5 500 mm
Hearth depth	2 500 mm
Electrode diameter	1 016 mm
Rotation	3,5 to 3,7 m/day.

The following are the gas characteristics for each furnace:

Flowrate	210 000 Nm^3/h
Temperature	280°C (average) 320°C (maximum)
Concentration	3,5 to 4,0 g/Nm^3
Density of powder	250 kg/m^3.

In the case of a fully open furnace, the fume extraction rate is determined by the factors detailed below.

(1) The volume of fumes produced by the reducing

reaction within the furnace depends essentially on the composition of the furnace charge and the electric power (in megawatts) dissipated by the electrodes inside the furnace (each furnace being rated at 14 MW). The furnace charge consists largely of very low-density charcoal, which can very easily be carried by the upward flux in the furnace stack.

(2) Dilution with ambient air is necessary in order to obtain the lowest possible percentage of carbon monoxide by combustion with the oxygen present in the dilution air and a fume temperature compatible with the cleaning system.

(3) Efficient dust removal in the production hall depends on the velocities of the dilution air, which are created in the free (i.e. peripheral) zone around the furnace.

It is obvious that several methods can be used in order to meet the requirements of (2) above. The fumes could be extracted at a comparatively high temperature (400 to 450°C), this being obtained by partial closure of the partitions around the furnace, which would result in a smaller volume of fumes. A plain tube cooler, possibly of the forced-convection type, would be provided. However, some factors militate against this technical choice.

- The particles contained in the fumes are very fine, 80 to 90 per cent less than 1 μm. Clogging (sometimes under the effect of electrostatic charges) would occur, and the cooler would have to be cleaned.
- The cooler would cause an appreciable pressure drop in the suction circuit. Therefore, owing to the high volume of fumes involved, the overall consumption of electric power would increase.

Solution Adopted

These considerations led to the following decisions.

(1) The selected flowrate of 210 000 Nm^3/h would be based on an open furnace without partition. However, the client provided for part partitioning around the furnace.

(2) The temperature of the fumes collected in the hood above the furnace would be 'low' (approximately 280 to 320°C).

The flowsheet of the plant is shown in Figure 2.

A so-called hot-temperature solution for the filtration system was adopted for the filter chosen, which had a low filtering rate and reverse-flow cleaning, i.e. a baghouse type of filter fitted with filter bags of glass cloth capable of withstanding continuous temperatures up to between 230 and 260°C and peak temperatures of 300 to 310°C.

The filter is pressurized, which means that the exhaust fans are located upstream of the filter. This solution offers the following advantages.

- Without any risk of deterioration of the filtering medium, the filter is able to absorb any major heat flow that may occur, for instance at the time of an explosion or 'blow off' in the furnace. In fact, as a result of the open construction of the filter, dilution takes place continuously as ambient air is sucked in at the lower part of the filter (natural-convection effect).
- The filter bags are easily accessible and can be controlled through direct accesses, in the lower part of the bags, ventilated by the same natural-convection effect.
- The filtering speed is very low, the air-to-cloth ratio being approximately 36 $m^3/h/m^2$, which results in a minimum pressure drop and a very low dust-emission level (normally less than 1 to 2 mg/Nm^3).
- The reverse-flow cleaning system puts only a slight strain on the filter bags, and consequently the bags can have a useful life of at least 4 years, and sometimes up to 6 or 7 years.
- The filtration medium is inexpensive compared with other media like NOMEX, P84, TEFLON, and TEFAIR.

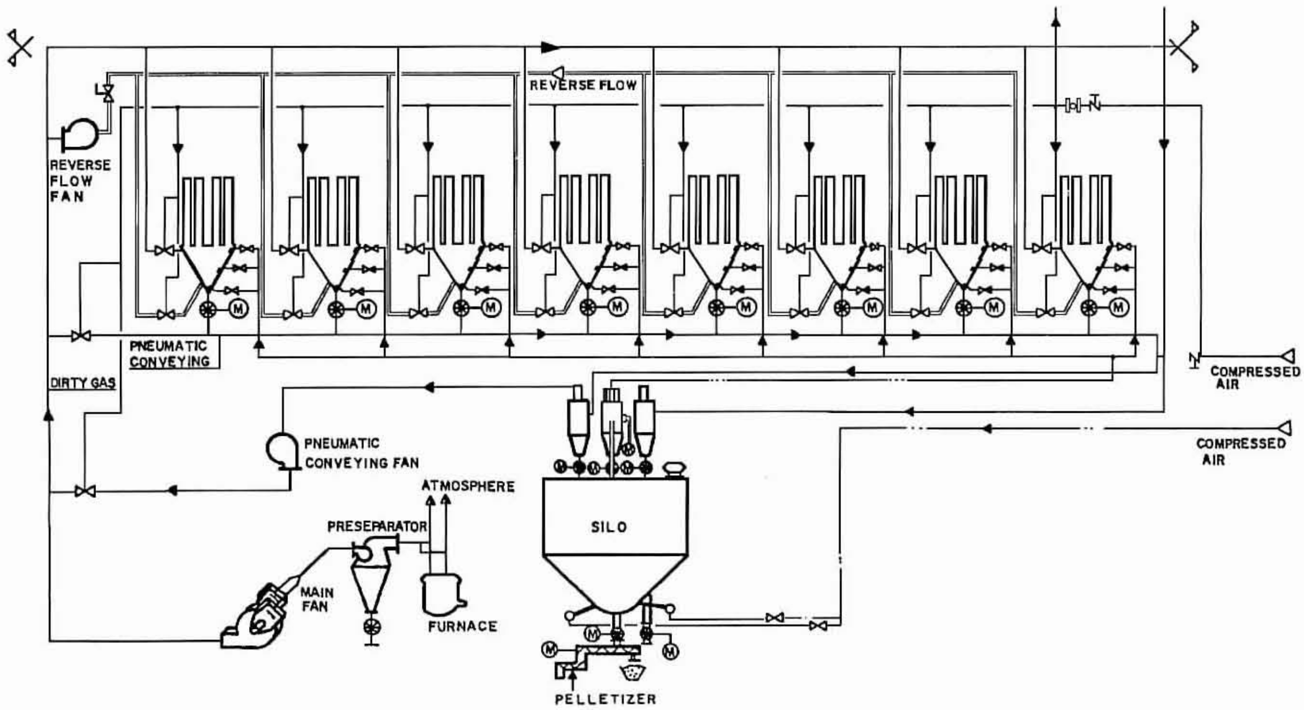

FIGURE 2. Flowsheet of the Tucurui plant

Particular care was taken in the selection of the preseparator, which protects the cleaning system from incandescent particles and from large particles that would cause abrasion of the rotor of the main exhaust fan and of the filter equipment (valves, rotary valves, etc.).

The preseparator selected is of the cyclone type with a horizontal body, which results in a comparatively high efficiency – for a pressure drop that is quite acceptable, it is approximately 60 to 70 mm w.g. (millimetres of water gauge).

The efficiency of this preseparator played an important role in the project because of the presence of charcoal particles with a very low density (sometimes with a diameter of several millimetres), which can easily be drawn from the furnace charge. These particles ignite very quickly and keep on burning for a long distance (several hundreds of metres).

Another important problem was the location of the exhaust fans. In theory, the placing of a fan in dirty gas is always a critical point.

Three most important considerations guided the choice of fan.

- The dust is very fine (80 to 90 per cent less than 1 μm). Consequently, the particles have no great effect as far as rotor abrasion is concerned.
- The large particles have already been removed by the preseparator, and it is, in fact, these larger particles that could accelerate the abrasion of the rotor.
- The concentration of the dust contained in the fumes is comparatively low, and does not exceed 5 g/Nm^3.

Besides, previous experience had shown that rotors can be kept in maintenance-free service for a period of 3 to 4 years. Moreover, the rotor blades are equipped with removeable wear plates, which can be changed once wear has started.

Another major advantage of the arrangement selected for the fans comes from the regulation of the volume of fumes drawn from each furnace. Each fan operates independently; consequently, a fine adjustment can be performed by a damper control in the fan's inlet on each furnace by means of a simple temperature transmitter placed in the fume collector approximately 50 m upstream of the preseparators.

The filters (two in all), each containing 16 compartments, are mounted in parallel, each one serving two furnaces (Figure 3).

FIGURE 3. The system installed at Tucurui

The filtering data for each filter are as follows:

Filtration rate	28,3 m^3/h/m^2 with all the compartments in use for filtering and 35,5 m^3/h/m^2 when one compartment is being cleaned
Filter area (total)	57 000 m^2
Pressure drop	180 to 200 mm w.g.
Main fan power	2 x 820 kW (installed).

The dust collected under each hopper of the filter is discharged pneumatically. A rotary valve driven by a low-speed geared motor ensures gas tightness between the pressurized filter and the low-pressure pneumatic conveying circuit.

When the end of the transport circuit is reached, the particles are separated in a cyclone, and then discharged into a storage bin (two storage bins being provided for each filter). The dust thus recovered is valuable to some industries, for instance to the cement industry, where it is used as an additive to improve the mechanical characteristics of concrete.

In order to improve the marketability of the dust, the client decided to install a system that would increase the density of the collected dust by means of a fluidization process lasting 48 to 72 hours. The product obtained has a bulk density of 500 to 600 kg/m^3 compared with 250 to 300 kg/m^3 before processing. The volume of dust particles to be put into 'big bags' is therefore half the initial volume. Furthermore, because of the bonded composition of this product (due to the electrostatic charges created during the fluidization process), it can be transported without setting.

Conclusions

After approximately 3 years of operation of the dust-collection system, the following conclusions can be drawn.

(1) The collection of the fumes produced in the furnace is efficient, and there is no diffusion of fumes into the production hall.

(2) The efficiency of the cyclone preseparators has been proved: the complete recovery of large particles and the absence of burn marks on the filter bags show that this is so.

(3) The filtration is efficient, and a dust-emission level of 1 to 2 mg/Nm^3 has been recorded. (The Brazilian standard for this kind of emission is actually 50 mg/Nm^3.)

(4) The density-increasing process works as expected, i.e. after 36 to 48 hours of fluidization, a density of 550 kg/m^3 is obtained.

(5) No abnormal wear of the rotors of the main fans has been observed.

(6) The number of filter bags that have had to be replaced is negligible. (A few had to be removed as a result of poor handling during the assembly operations.)

Bibliography

Billings, C.E. (1970). *Handbook of fabric filter technology.* EGCA Corporation-NTIS.

Bouilliez, L. (1982). Les dépoussiéreurs filtrants. *Étude technique,* 82.DS.01. NEU Group.

Environmental Protection Agency, USA (1973). *Air pollution engineering manual.*

The McIlvaine Company. (1979). *The fabric filter manual,* vol.1-2-3.

VDI-Richtlinie VDI.2576 VDI-Koommission Reinhaltung der Luft. (1981). *Emission control in electrothermic and metallothermic ferroalloy production.*