MODERN AIR POLLUTION TECHNOLOGY ON LOW CARBON SILICA MANGANESE FURNACE FOR ADVALLOY

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Titaco Projects (Pty) Limited, for and on behalf of Advalloy which in turn is a joint venture between Samancor, Japanese Metals & Chemicals and Mitsui, were responsible for the EPCM of a complete production plant for the manufacture of medium, low and ultra low carbon ferro manganese, as well as ultra low carbon sillco manganese alloys.

1. PROCESSES

In designing the gas cleaning plant, fume and dust had to be removed from the following processes:

- 8.5 MVA SiMn Furnace
- 6 MVA Slag Melting furnace
- SiMn Stirrer Station
- Molten Slag Stirring Station
- SiMn Tapping

2. COMBINATIONS

Various combinations of the above plants could be on line simultaneously, but the widest fluctuation would be:

Table 1 - Combinations

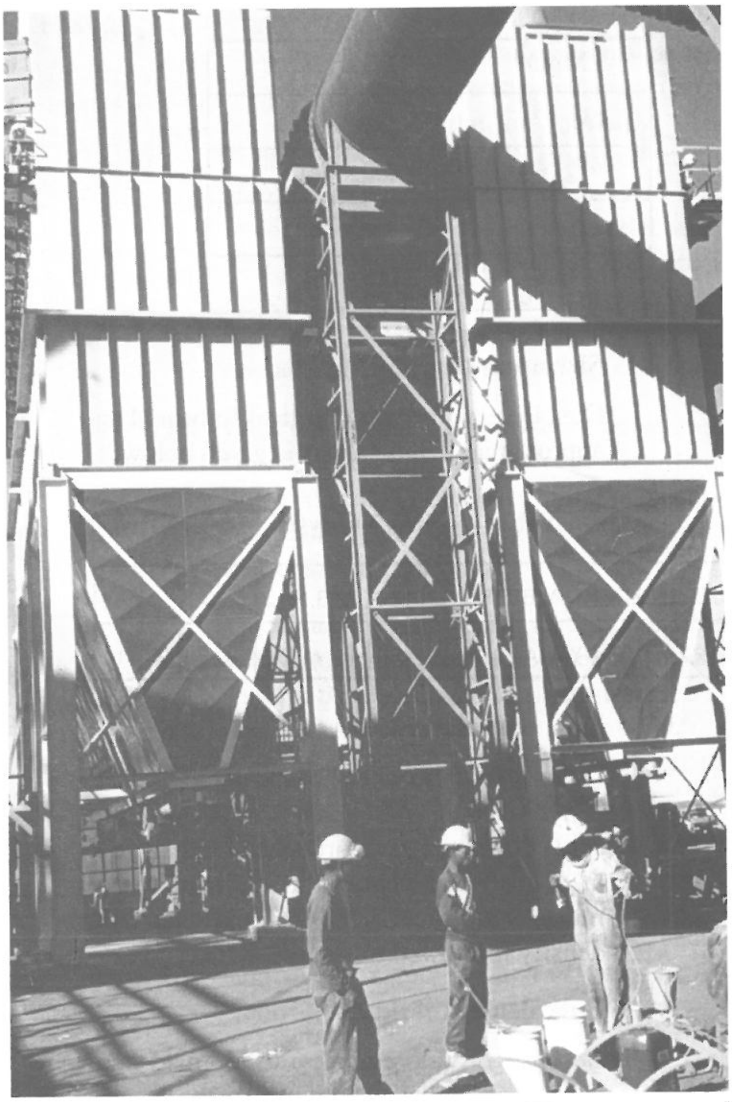
CONDITION A	CONDITION B
All plants on line simultaneously	SiMn furnace on line only

3. VOLUMES OF OFF GAS

The volumes of off gas to be handled under these conditions are given below:

Table 2 - Volumes of Off Gas

	CONDITION A	CONDITION B
Temperature of gas in the ducts 10m from hood of SiMn Furnace	134°C	190°C
Raw gas volume	200 000 Nm³/h	100 000 Nm³/h



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4. CHARACTERISTIC OF DUST IN THE OFF GAS

3.1 Dust load: 12 gm/Nm³max

3.2 Dust chemical analysis:

Table 3 - Dust chemical analysis

ELEMENT	% BY MASS
Mn	12.5 - 27.6
SIO_2	55.0 - 51.6
Fe	0.8 - 0.6
$A1_2O_3$	1.8 - 1.4
CaO	15.2 - 12.2
MgO	2.3 - 1.8
C	1.2 - 0.9
P	0.0 - 0.0
K_2O	3.2 - 2.6
Na_2O	0.5 - 0.4

3.2 Size analysis:

Dust is very fine metallurgical fume and an approximate size analysis is given below:

Table 4 - Size Analysis

SIZE IN MICRO METERS	20	10	5	3.5	2	1	0.7	0.5	0.3
% PASSING BY MASS	95	80	66	60	52	43	34	24	14

3.3 Dust characteristics:

Dust is very fluid when hot and dry. The dust is hydroscopic and becomes sticky when it cools down and has a propensity to hang up in hoppers and chutes. It sets hard when mixed with water. Further, the dust will densify if allowed to stand.

3.4 Bulk density of dust:

Because of the tendency to fluidise and densify, the bulk densities used in the design should be as follows:

Table 5 - Bulk Density of Dust

VOLUME CALCULATION	0.25 t/m^3
STRUCTURAL CALCULATION	0.8 t/m^3

5. GAS ANALYSIS

The combusted gases from the fumes are excessively diluted with ambient air and the furnace gas properties approximate to air.

Fluorspar is charged into the SiMn stirrer as a flux. The fluorspar contains 75% CaF_2 which in the smelting process will liberate fluorine. Because of the presence of trace amounts of fluorine, it is recommended that Nomex be used for the filter element material. Nomex has been found to work satisfactorily in similar installations in Japan.

The SO_2 is the main acid forming element in the off gas. It is estimated that 6.2 kg/h of sulphur will be present in the off gas.

6. DUCTING DESIGN

The ducting is designed such that atmospheric air is bled into the system through tapping and stirring zones during the fume capture.

If fume capture is not required, then these zones are closed down partially but still bring in enough dilution air to cool the furnace gases.

The ducting is made from CORTEN which provides a high emissivity prior to reaching the bag house.

7. SPARK ARRESTOR

A spark arrestor is installed some 100m from furnace fume extraction point which effectively eliminates any combustible volatiles, thus protecting the bag house from potential fire hazard.

8. BY-PASS DUCTING

Hot gas ducting by-passes the filter used during start up until gas stream is free of volatiles and tarry vapours which are generated during initial heat up of the furnace.

9. THE CHOICE OF FILTER

The difficult dust >50% SiO_2 with 50% <2 μ particle size, normally would result in the choice of a Reverse Air Filter operating at filter rate of 0.45 m/minute. However, Hosokawa has recent experience of installing two plants at Temco in Tasmania, where although the plant in this instance was a Ferro Manganese and there was only 12% SiO_2, there was still 44% of the fume generated at < 2 μ; therefore it was decided to install Mikro Pulsaire Pulse Jet cleaning technology. The filter has capital cost, running cost and maintenance advantages over the more conventional approach.

10. DESIGN PHILOSOPHY

The size of the installation and the need for an on-line maintenance facility dictates modular construction. Because of the high temperature, it is preferable to have the modules as stand alone units.

The modules offered have 440 filter bags, each 6.1 metres long.

In order to remain within a filtration rate of 15 mm/sec (0.9 m/min) with one module off-line, 6 modules were required.

By offering the Expandiffuse™ inlet arrangement, the filters can be operated at a higher filter rate for the periods during which one module is off line for maintenance.

The table below illustrates the various operating conditions:

Table 6 - Operating Conditions

			6 MODULE
Filter rate	- all on line	(m/m)	0.73
	- one off line	(m/m)	0,87

11. DESCRIPTION OF BAG FILTER

The "Walk-in" plenum type provides easy access to the filter bags for inspection and maintenance.

The collector employs cylindrical filter elements and is continuously cleaned on the reverse jet principle. Simplicity of design with no moving parts results in an extremely low maintenance filter.

Dust laden air enters the unit through a specially designed inlet section in the dust compartment. The patented Expandiffuse™ inlet takes the form of a two stage diffuser. The first stage is a plenum over the full length of the bag filter. This absorbs the impact of the high velocity dust particles and directs the dust laden air downward. Dust laden air now travels downward through the diffuser plates. Heavy and agglomerated particles drop directly into the hopper and lighter particles are distributed over the full filtration area of the unit. Remaining dust particles in the raw gas are entrained on the external surface of the filter bags.

Because of the downward flow pattern and even distribution of dust over the fabric, minimum dust re-entrainment occurs during pulsing.

Dust removal from the filter bags is achieved by the introduction of a momentary jet of compressed air to a row of filter bags. The required jet-pump cleaning action is achieved by a venturi which induces a secondary air flow. Reverse flow and a shock wave is generated, sufficient to clean the filter bags.

The cleaning cycle is regulated by an adjustable electronic sequential controller. As the row being pulsed is only isolated for a fraction of a second, constant air flow and pressure drop results.

12. FILTER CLEANING AND PROTECTION

12.1 As the dust builds up on the filter bag, the pressure drop (△P) across the bag filter plant will start to rise. Once this △P reaches a 'high' set point, 1,5 kPa, measured by the single 'Photohelic' unit, a signal is sent to a relay in each of the six pulse control panels. This will start the cleaning cycle from point no. 1 in each of the six modules. The Photohelic unit is a 220V powered instrument to which is connected pressure lines from the inlet manifold and the outlet manifold such that the differential pressure is indicated. Further, the unit has two switching points that can be set to give NO or NC contacts at high and low settings.

12.2 Each timer card has individual pulse duration (msec) and pulse frequency (sec) potentiometers which would be set on commissioning and would in general be the same settings on all six units.

12.3 Once the cleaning commences, the timer will signal each pulse valve solenoid to pulse in turn, thus sending a jet of compressed air via the blow tubes, down that row of filter bags. This shock wave will break off the coating of dust on the filter bags and will cause this dust to fall into the hoppers. After some time, as the bags become cleaner, the △P across the plant will drop and the Photohelic unit will sense a 'low △' reading and send a signal to each of the six pulse control units to stop cleaning.

The △P will again rise and the Photohelic unit will once again signal for cleaning to commence. At this point the six pulse timer cards will restart at the point at which the cleaning was stopped.

12.4 In the event that no cleaning is demanded, after two hours an entire cleaning cycle will take place. This will repeat every two hours until the power is disconnected or cleaning on demand commences.

12.5 Each filter module is fitted with a Magnahelic unit. This instrument has pressure line connection from two points either side of the tube plates that will give an analogue readout of the tube plate pressure drop (ΔP across the bags).

This unit is mounted in the cabinet with the timer cards such that the reading will be visible.

12.6 A temperature probe is supplied to be fitted in the client's inlet ducting upstream of the bag filter. This thermocouple will give a signal should the temperature exceed the safe operating temperature, at which point the fan dampers should be shut down.

12.7 The lower 2 m of the hoppers are trace heated and individually thermostatically controlled to maintain the hopper lower portion at an elevated temperature above dew point.

13. GUARANTEES

A particulate emission of 50 mg/Nm^3 of gas up the stack is guaranteed. At the time of writing, no test results had been obtained, but the stack has no visible emission. Permanent on-line particle emission monitoring results will be given monthly to C.A.P.C.O. Initial tests indicate an emissio level of less than 18mg/am^3

The ΔP across the whole system is guaranteed at 2 kPa and is currently operating at 1,5 kPa.

Intitial tests indicate an outlet concentration of less than 18mg/m^3.