

ELECTROSTATIC DUST PRECIPITATOR FOR SULPHURIC ACID PLANT INSTALLED AT THE TOHOKU FERTILIZER CO.

The sulphuric acid dust cottrel equipment installed recently at the Tohoku Fertilizer Co. involves some new designs which are based on various working data of many previous installations as well as those of recent experiment made on the electric source using selenium. The electrostatic precipitator has been more efficient than other types but it has some difficulties in its handling and maintenance. This is because that in the electrostatic precipitator, the d-c high voltage power source is supplied from the mechanical spark rectifier which is easy to lead to troubles and hard to maintain stable operation. It is absolutely important as a dust collecting equipment to work always with stability. For instance, the collector efficiency should be determined from the combined efficiency, that is the rate of dust collection multiplied by the rate of operation.

To increase the combined efficiency of the equipment, the stability of operation and the maintenance of the highest efficiency of the dust collection are the important factors. In order to have the equipment applied with a possible maximum voltage within which the equipment is assured of stable operation, the following three methods are adopted.

1. The electric stability of precipitation is improved. This is done by means of using a selenium rectifier which can raise effective and maximum permissible voltage of operation but allows no abnormal high voltage of high frequency as in the case of ordinary rectifier. There can be no incidental sparks, and as a result, the stability of continued operation can be assured even if the high voltage is applied.

2. The mechanical reliability of dust collection is improved. This is done by keeping electrodes

which operate under high temperature in a correct pitch. The flat electrodes are selected and the surface of the whole dust collecting electrode is thoroughly rapped so that sparking voltages rise up evenly on the surface.

3. The stable operation of all auxiliary machines is assured. This is accomplished by safety operation and no break-down of the rapping device and the dust conveyer, all of which are remotely controlled from a switchboard for the convenience of maintenance. As a result, the applied voltage can be raised and the corona discharge current can be increased and yet safety and continued operation is made possible. The size of precipitating chamber has been reduced to approximately 2/3 of the ordinary installation while the combined efficiency has been improved shown in the following table.

The outline of the installation is introduced hereunder.

I. SPECIFICATION AND FEATURES

The purpose of the dust cottrel system for sulphuric acid plant is to eliminate dust from sulphur dioxide gas that comes out of pyrite roasting where the gas temperature is high and the gas is corrosive. The subject equipment was installed at the Matsuo mine roasting plant where the produced gas was said to be extra-ordinary hard to collect dusts. Unlike other dust collecting plant used for prevention of air pollution, the subject equipment is to be installed among the acid production line as a part of the plant, and the continued operation or non break down at least more than one year is a positive requirement.

	Precipitating time	Discharge current density	Dust collecting efficiency	Remarks
Tohoku Fertilizer Co.	6 sec.	2-4 $\mu\text{A}/\text{cm}$	98%	Selen used
Plant A	9 sec.	0.5-1 $\mu\text{A}/\text{cm}$	97%	Mechanical rectifier used average value at Matsuo mine
Plant B	6 sec.	0.5-1 $\mu\text{A}/\text{cm}$	95%	

The specification of this equipment is shown below :

1. Type : SDC 142, Parallel separable system with horizontal gas flow and net electrode
2. Gas : Furnace gas produced from roasting 80% Matsuo mine ore plus 20% pyrite
3. Gas volume : $2 \times 4,000 \text{ Nm}^3/\text{h}$
4. Gas temperature : At inlet 400–550°C
At exit 300–450°C
5. Gas composition : SO_2 12% N_2 82–85% etc.
6. Amount of dust : 5–13 gr/ Nm^3
7. Precipitation efficiency : 98% or more
8. Electric source : One selen 3-phase full-wave rectifier 20 kVA

Fuji Electric Mfg. Co. make

The principal features of this equipment are :

1. A selenium 3-phase full-wave rectifier is used as an electric source. The dust collecting electrodes are selected specifically not to have any projection, which makes it possible to have higher applied voltage and increased discharge current. As a result, the size of the dust precipitating chamber is reduced to 2/3 of the ordinary chamber.

2. Though the gas temperature is higher and the amount of dust quantity is larger than the others, being unfavorable as a dust precipitator, the dust collecting efficiency of more than 98% is available.

3. The equipment is perfectly separable and arranged in two parallel systems which assures easy maintenance and convenient handling.

4. The precipitation chamber housing is a brick structure covered with a steel frame and steel sheets. The whole house is made rugged—no gas leakage, no outside air comes in to reduce SO_2 density or to lower gas temperature.

5. The electric source of the selenium rectifier is of good efficiency and of easy maintenance. It gives out no noise, no ozone gas and no interference on radio and television.

II. CONSTRUCTION OF DUST PRECIPITATOR

Each system of the perfectly separable type equipment consists of two electrode chambers and each of which constitutes eight ducts. The collecting electrodes are made of 3.2 mm dia. wire net of 1" mesh hanged in a frame of 1.5 m wide and 3 m high. The whole construction is proved no strain to wire net under heat expansion although no angle reinforcement is used. 192 pieces of discharging electrode wire are made of 2 mm dia. special stainless steel and are acid-proof and temperature-resistant.

In the electrostatic precipitator, it may well be said that the various dimensions of electrodes, especially the accuracy of pitch between current discharging electrodes and collecting electrodes determine

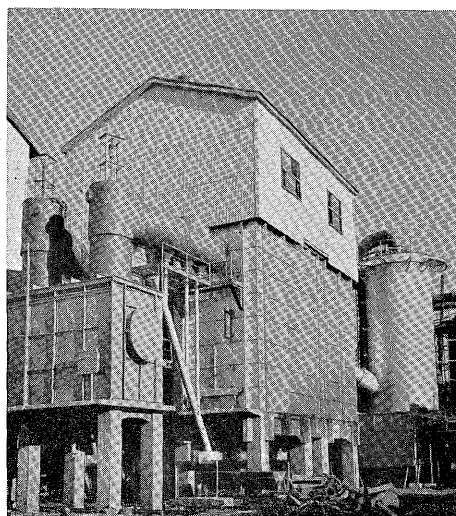


Fig. 1. Outer view of housing

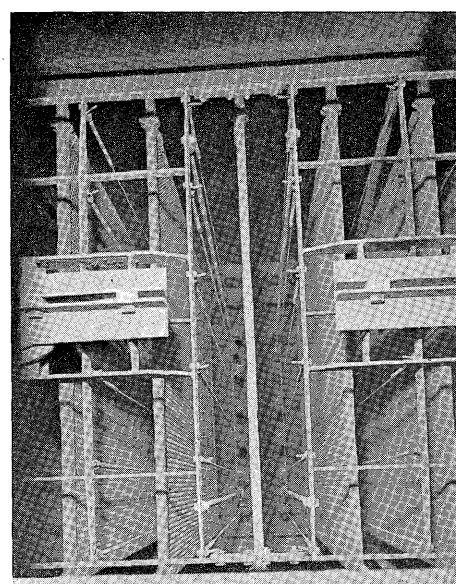


Fig. 2. Construction of dust collecting electrodes

the efficiency of precipitator. In the high temperature of 550°C as in the case of this equipment, it sometime gives problem even to the creep strength of ordinary steel material, and the heat expansion alone makes thermal expansion up to several centimeters. Therefore, how to get rid of strain due to manufacture is the vital importance of keeping the accuracy of pitch. Special consideration is given to the design to keep accurate dimensions while working under extraordinary high temperature. The sparking voltage during operation is proved to be much higher than that of ordinary equipment.

The dust precipitation chamber housing is built on the heat and acid resisting concrete base and hopper, having brick construction as a main body. It is reinforced by steel frames to have strength against heat expansions under the high temperature 550°C. The outside of the housing is covered by steel sheets

to avoid gas leakage. The header plates and others in the ordinary case are usually heat insulated by sand, but in this equipment, special insulating materials are used. It assures gas tightness and also greatly reduces temperature drop of the gas. It will certainly increase heat economy when the exhaust heat boiler or else is installed there.

III. EQUIPMENT OF ELECTRIC SOURCE

As an electric source to supply d-c high voltage to the dust collector, a selenium 3-phase full-wave rectifier that is the standard product of the Fuji Electric Mfg. Co. is used, displacing an ordinary mechanical rectifier.

The equipment consists of a high voltage transformer and selenium rectifier which are placed in a same tank as shown in Fig. 3. It requires only one bushing which saves not only the cost of equipment but makes it easy for inspection and decreasing places of causing troubles. The equipment is particularly profitable when used in a chemical plant where a big quantity of dust is present from the viewpoint of easy maintenance. The following is the specification :—

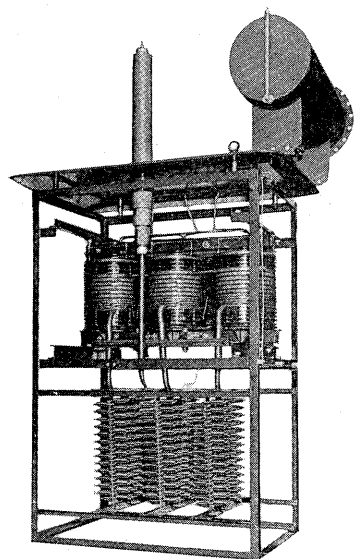


Fig. 3. Inner part of selenium rectifier for precipitator use

High voltage transformer

Type KOP 145/55

Rating a-c 267 V/55,000 V 3 ph. 50 cycles

Capacity 20 kVA continuous

Selenium rectifier

Type Gdh 65,000/0.25

Output d-c 65,000 V 250 mA

In the conventional mechanical rectifier, it often occurs that the rotating arm gives out sparks, and the shoe quickly wears, causing difficulties to the maintenance of equipment. Added to that, the spark causes the generation of ozone and disturbs radios and televisions. These may be counted, as the defects of ordinary mechanical rectifier. The use of the selenium rectifier eliminates all these defects; and brings about easy maintenance. Furthermore, as described before, the great improvements of rectifying wave forms improves dust collecting efficiency, which has popularized the use of selenium rectifying equipment of late.

IV. DUST COLLECTING EFFICIENCY

The dust collecting efficiency tests of this equipment have been conducted several times through a long period since the commencement of the plant operation. All tests proved satisfactory and further, showing no decline of efficiency after 8 months operation as shown in the following table :

	Treated gas volume	Gas temp. at entrance	Collecting efficiency
After 2 months cont. operation	8,039 Nm ³ /h	420°C	99.1%
After 8 months cont. operation	8,900 Nm ³ /h	490°C	98.5%

For this particular installation, the remodeled electrodes and selenium rectifier proved the possibility of reducing sizes of precipitation chamber by approximately 30 %, provided the efficiency remain the same. At present however, there is produced a special saturable reactor with which a new method of voltage control has been completed. This enables the apparatus to thoroughly control sparks in the precipitating chamber even if they grow in it and assure stable operation. It will give the precipitator more stability, and permit application of higher voltage, and if conditions allow, the size of precipitating chamber may be reduced to a half.

(By Shigemitsu Komiji, Design and research Div.)

Outline of Our Products

(I) Heavy Current Equipment

- a) Generators :
Synchronous generators up to 100,000 kVA.
Direct current generators up to 5,000 kW.
Other all kinds of generator.
- b) Condenser :
Synchronous condenser up to 50,000 kVA.
Static Condenser up to 200 kVA.
- c) Motors :
3-phase synchronous motors up to 10,000 HP,
3-phase induction motors up to 10,000 HP.
3-phase commutator motors up to 200 HP.
Direct current motors up to 10,000 HP.
Other all kinds of motor.
- d) Standard motors (for general use):
3-phase induction motors from $\frac{1}{2}$ HP to 100 HP.
Squirrel cage motors from $\frac{1}{2}$ HP to 100 HP.
Split phase start 1-phase ind. motors 100 & 200 W.
Repulsion start 1-phase ind. motors for 200 & 750 W.
- e) Special motors:
Loom, card, mule, ring-motor and pot-motor for textile industries.
All other kinds of special use motor.
- f) Rotary converters with transformer up to 3,000 kW, 1,500 V.
- g) Transformers :
Power transformers up to 200 MVA, 287 kV.
Furnace transformers with on-load tap changer up to 50 MVA, 140 kV.
Measuring transformers up to 287 kV.
Other all kinds of transformer.
- h) Standard transformers (for general use):
1-phase & 3-phase distribution transformers from 3 kVA to 200 kVA.
- i) Induction voltage regulators up to 1,000 kVA.
- j) Iron vessel mercury arc rectifiers :
Single node or multianode type, water cool or air cool type and with pump or without pump type up to 6,000 A, 100 kV.
- k) Contact converters up to 12,000 A, 500 V.
- l) Selenium rectifiers up to 10,000 A, 100 kV.
- m) Regulating apparatus :
Motor starters, controllers, speed regulators, voltage regulators and other regulating apparatus for all kinds of service.
- n) Circuit breakers :
Expansion circuit breakers from 60 kV up to 287 kV.
Oil circuit breakers up to 70 kV.
Air circuit breakers up to 3,000 V.
High speed air circuit breakers up to 3,000 V.
- o) Switch equipment :
Disconnecting switches up to 287 kV.
Knife switches, magnetic switches and other all kinds of switch equipment.
- p) Switchboards :
Sheet iron made switchboard for all kinds of service.
- q) Relays :
All kinds of relays for power and industry use.

(II) Machines

- a) Water turbines :
Francis type, Pelton type and Kaplan type turbines up to 100,000 HP completed with necessary regulating accessories.
- b) Steam turbines up to 50,000 kW.
- c) Gas turbines :
Closed circuit type up to 30,000 HP.
- d) Water pumps :
Turbine pumps up to 1,000 HP.
Centrifugal pumps from 2".
- e) Fans :
Propeller fans.
Centrifugal (Sirocco) fans.
- f) Mine hoists :
Cage or skip type shaft winder.

(III) Railway and Ship Equipment

- a) Traction motors of all kinds.
- b) Mine locomotives of all kinds with electric equipment.
- c) Cargo winches for 3 tons and 5 tons with electric equipment.
- d) Steering engines of all kinds with electric equipment.

(IV) Weak Current Equipment

- a) Integrating watt-meters (watt-hour meters):
1-phase W.H.M. for low tension circuit use.
3-phase W.H.M. for low tension and high tension circuit use.
- b) Electric measuring instruments :
Switchboard meters, portable type meters, precision meters, recording meters, insulation testers, tele-metering equipment.
- c) Industrial measuring instruments :
Electric thermometers, pyrometers, psychrometer, flow meters for water, steam, gas and air.
Gas analyser, pressure gauges, vacuum meters pH meters, level meters, electronic recorders, salinometer.
- d) Automatic controlling equipment :
Automatic combustion controlling equipment for steam boilers and various furnaces.
Pneumatic controllers for temperature, pressure, flow and liquid level.
Ratio controllers for gas and liquid mixing.
rollers, electrical indicating controllers with on-off contacts.

(V) Domestic Equipment

- a) Electric table fans of, 8" 12" and 16".
Electric pedestal fans of 16".
- b) Electric room heaters.
- c) Electric washers for $\frac{1}{4}$ HP.
- d) Electric refrigerators for $\frac{1}{4}$ HP.
- e) Razor blade sharpener (for double edge).
- f) Dry battery & flash light.
- g) Juicer, electric clock.
- h) Electric iron.
- i) Toaster.
- j) Centrifugal dehydrating machine.
- k) Electric bulbs & Fluorescent lamp & illuminating app.