Report on Dust Suppression for Unit 3 Drying Plant Ronphos
Short /Medium and Long Term Goals

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Contents

Acronyms

Ronphos	Republic of Nauru Phosphate Corporation
NRC	Nauru Rehabilitation Corporation
GoN	Government of Nauru
AusAID	Australian Agency for International Development

Introduction

This section provides a summary of why there is a need for dust suppression for the Ronphos Unit 3 Drying Plant situated in the Aiwo District Republic of Nauru.

Over the past several years and zero funds to carry out the maintenance on the precipitator it became blocked, electrodes corroded out, the drying shed became full of holes that disturbed the air flow, with the rains over the past this has caused extensive rusting in this unit, it has become extensively decayed and unusable.

This has lead to a major dust problem from unit 3 (approx 29 meters above sea level) when light winds are blowing from an easterly direction over command ridge towards Aiwo from the Tennis court to the North of unit 3 (N: 0712724 E: 9941102) to the Civic Center to the South of unit 3 (N: 0712725 E: 9940409) (Elevation approximately 7 meters) and approximately 693 lineal meters, this is the area of the greatest dust settlement. The Aiwo district has a lower elevation than some of the surrounding areas (0.7 meter) causing a funnel type effect that draws the dust into it. Geographically Aiwo is in the wrong place.

Another factor in the increased dust problem within this area is the very dry period that Nauru is currently experiencing, with the lack of rain the oceans and the earth here on Nauru is gaining temperature, this is causing periods of warm to hot air streams from the east to gain temperature as they move over the island allowing the dust to migrate towards the ground as they move over unit 3 and the Aiwo area instigating the dramatic increase of dust particles to drop to the ground and causing a public nuisance, particles are in the range of 0.23 to 11.44 grams per cubic meter of air and the particle size varies from 0.5 to 100um or 1.5 tons of dust every 24 hours that the drying plant is in operation. This is also greatly increased by the dryness of the raw feed arriving at the drying plant.

Over the past several months a study of what is major areas that are causing the dust in the unit 3 drying plant has been undertaken and the findings will be explained over the next pages along with recommendations for the immediate short term strategy to midterm solutions and the ultimate long term solutions and along with recommendations on how to recover this dust and combine it with the dried phosphate for export.

Dust Suppression Methods;

There are five principle types of industrial dust collectors that need to be looked at prior to determining the method that would be suitable for the type of drying application and material that is being dried and the changes in the moisture content of the raw material.

- Inertial separators
- Fabric filters
- Wet scrubbers
- Electrostatic precipitators
- Unit collectors

Internal Separators

Inertial separators separate dust from gas streams using a combination of forces, such as centrifugal, gravitational, and inertial. These forces move the dust to an area where the forces exerted by the gas stream are minimal. The separated dust is moved by gravity into a hopper, where it is temporarily stored.

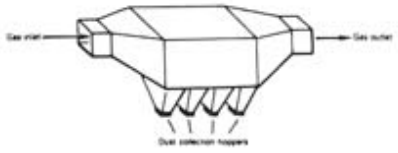
The three primary types of inertial separators are:

- Settling chambers
- Baffle chambers
- Centrifugal collectors

Neither settling chambers nor baffle chambers are commonly used in the minerals processing industry. However, their principles of operations are often incorporated into the design of more efficient dust collectors.

Settling chamber

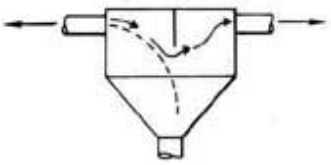
A settling chamber consists of a large box installed in the duct work.



Settling Chamber

The sudden expansion of size at the chamber reduces the speed of the dust-filled airstream and heavier particles settle out.
Settling chamber is simple in design and can be manufactured from almost any material. However, they are seldom used as primary dust collectors because of their large space requirements and low efficiency. A practical use is as pre-cleaners for more efficient cleaners.

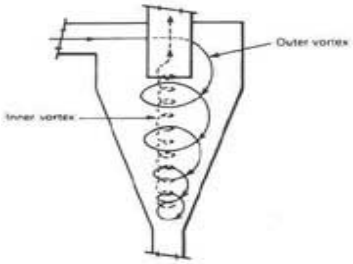
Baffle chamber



Baffle Chamber

Baffle chambers use a fixed baffle plate that causes the conveying gas
Stream to make a sudden change of direction. Large diameter particles do
Not follow the gas stream but continue into a dead air space and settle.
Baffle chambers are used as pre-cleaners.

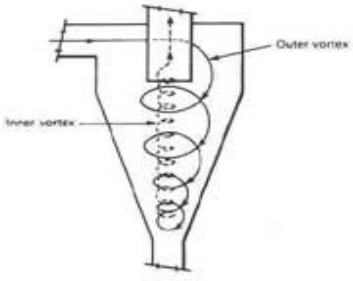
Centrifugal collectors



Cyclone

Centrifugal collectors use cyclonic action to separate dust particles from the gas stream. In a typical cyclone, the dust gas stream enters at an angle and is spun rapidly. The centrifugal force created by the circular flow throws the dust particles toward the wall of the cyclone. After striking the wall, these particles fall into a hopper or conveyor belt located underneath.
The most common types of centrifugal, or inertial, collectors in use today are:

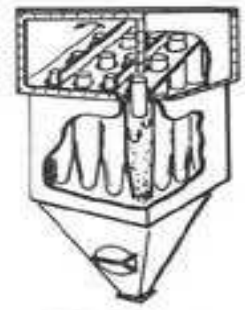
Single – cyclone separators



Cyclone

They create a dual vortex to separate coarse from fine dust. The main vortex spirals downward and carries most of the coarser dust particles. The inner vortex created near the bottom of the cyclone, spirals upwards and carries finer dust particles.

Multi – cyclone separators

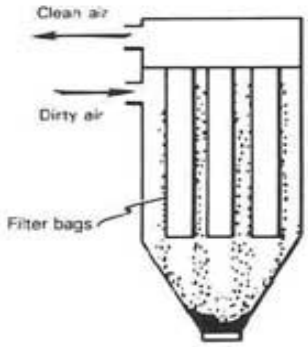


Multiclone

Also known as multi-clones, consist of a number of small – diameter cyclones, operating in parallel and having a common gas inlet and outlet, as shown in the figure above. Multi-clones operate on the same principle as cyclones creating a main downward vortex and an ascending inner vortex.

Multi-clones are more efficient than single cyclones because they are longer and smaller in diameter. The longer length provides longer residence time while the smaller diameter creates greater centrifugal force. These two factors result in better separation of the dust particulates. The pressure drop of multi-clones collectors is higher than that of single cyclone separators. This is the same way the Dyson vacuum works.

Fabric filters



Baghouse

Commonly known as bag-houses, fabric collectors use filtration to separate to separate dust particles from dusty gases. They are one of the most efficient and cost effective types of dust collectors available and can achieve a collection efficiency of more than 99% for very fine particulates.

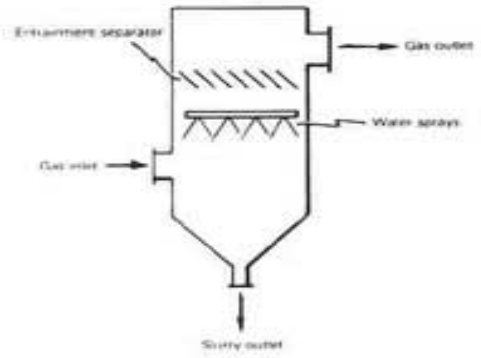
Dust laden gases enter the bag-house and pass through fabric bags that act as filters. The bags can be of woven or felted cotton, synthetic, or glass fiber material in either a tube or envelope shape.

The high efficiency of these collectors is due to the dust cake formed on the surfaces of the bags. The fabric primarily provides a surface on which dust particulates collect through the following four mechanisms:

- Inertial collection – Dust particles strike the fibers placed perpendicular to the gas flow direction instead of changing direction with the gas stream.
- Interception – particles that do not cross the fluid streamlines come into contact with fibers because of the fiber size.
- Brownian movement – Sub-micrometer particles are diffused, increasing the probability of contact between the particles and collecting surfaces.
- Electrostatic forces – The presence of an electrostatic charge on the particles and the fiber can increase dust capture. A combination of these mechanisms results in formation of the dust cake on the filter, which eventually increase the resistance to gas flow. The filter must be cleaned periodically.

There are many types of bag-house dust collectors with numerous applications that are not completely viable for the type of dust collection that Ronphos requires.

Wet scrubbers

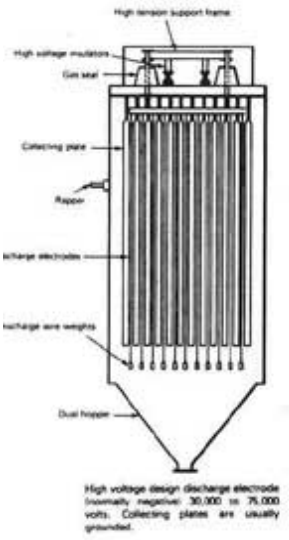


Wet Scrubber

Dust collectors that use liquid are commonly known as wet scrubbers. In these systems, the scrubbing liquid (usually water) comes into contact with a gas stream containing dust particles. The greater the contact of the gas and liquid streams, the higher the dust removal efficiency.

The cleaned gases are normally passed through a mist eliminator (demister pads) to remove water droplets from the gas stream. The dirty water from the scrubber system is either cleaned and discharged or recycled to the scrubber. Dust is removed from the scrubber in a clarification unit or a drag chain tank. In both systems solid material settles to the bottom of the tank. A drag chain system removes the sludge and deposits in into a dumpster or stockpile.

Electrostatic precipitators (ESP)

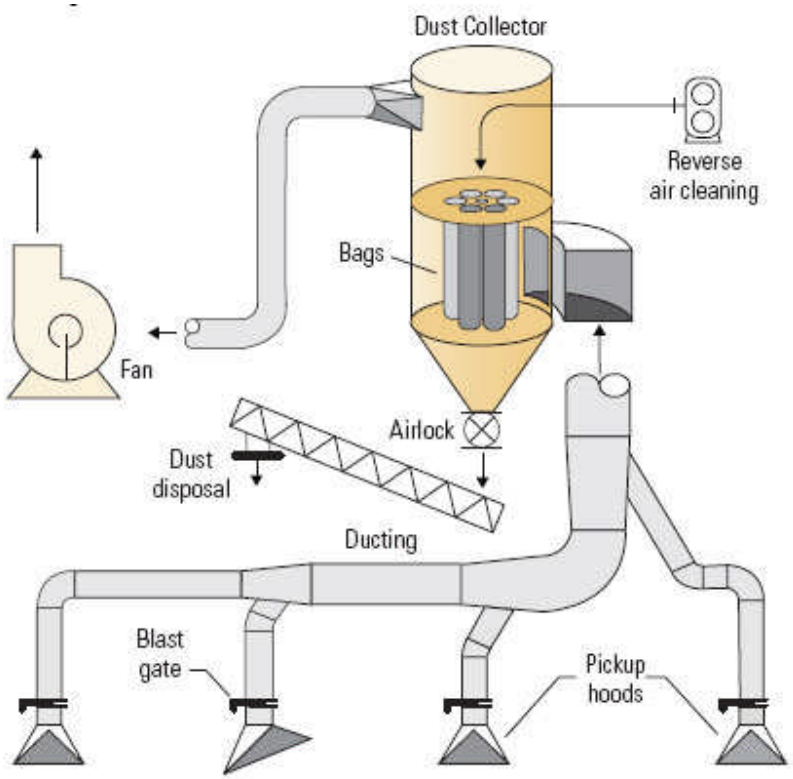


Electrostatic Precipitator

Electrostatic precipitators use electrostatic forces to separate dust particles from exhaust gases. A number of high – voltage, direct – current discharge electrodes are placed between grounded collecting electrodes.

The airborne particles receive a negative charge as they pass the ionized field between the electrodes. These charged particles are then attracted to a ground or positively charged electrode and adhere to it.

The collected material on the electrodes is removed by rapping or vibrating the collecting electrodes either continuously or at predetermined intervals. Cleaning a precipitator can usually be done without interrupting the airflow.



Dust Collection Example

Four main points to be considered in both short and long term solutions

1) Moisture content of the raw material being received at the drying plant.
2) Moisture content of the finished product to meet the client's requirements.
3) Grinding method of the dried product to the final specifications.
4) The acceptable atmosphere and environmental dust emissions. (Target 99%)

The moisture content of the raw feed plays a large role in the selection of both short and long term solution to reduce the total amount of dust emissions into the atmosphere, along with feed rates of raw feed to the dryers and the amount of liters of Fuel Oil used to dry each ton of product, and the amount of flame per hour used.

Table of Feed rates to Kilns

Moisture % in	Liters per ton	Feed Rate tons per hour	Flame per hour	Moisture dried %		Cut off point %
12	7 liters	62 tons per hour	Constant	3.5 % dried		4.2 %
11	6.5 liters	70 tons per hour	Constant	3.5 % dried		4.2 %
10	6 liters	72 tons per hour	Constant	3.5 % dried		4.2 %
9	5.5 liters	74 tons per hour	Constant	3.5 % dried		4.2 %
8	5 liters	76 tons per hour	Constant	3.5 % dried		4.2 %
7	4.5 liters	82 tons per hour	Constant	3.5 % dried		4.2 %
6	4 liters	88 tons per hour	50 minutes per hr	3.5 % dried		4.2 %
5	3.5 liters	90 tons per hour	45 minutes per hr	3.5 % dried		4.2 %
4	2 liters	97 tons per hour	30 minutes per hr	3 % dried		4.2 %
3	1 liter	100 tons per hour	15 minutes per hr	2.5 % Dried		4.2 %

Weight scales have been fitted to conveyor feed belts so the tons per hour can be adjusted to suite the above table.

New fuel meters with digital read outs have been installed on the delivery lines to the pumps to assist with the liters per ton settings.
There is still a need to fit another set of fuel meters in the lines to the heating lances; this should be done as soon as possible so the event of over drying is eliminated as much as possible.

New Fuel Meter

2.1 Short Term