Use of cyclones for removing dust from gas streams

Issued December 2005

EPA 602/05: This guideline aims to assist persons considering the use of a cyclone as a ‘dedusting’ device.

Introduction

Cyclones are relatively simple devices for removing particulate material from gas streams. Although they are commonly used, many operators do not understand the principles of their operation, or their limitations.

This guideline aims to assist operators in understanding how cyclones are selected and the information required for successful design.

When purchasing a new or second-hand cyclone, an operator is strongly advised to engage the services of an appropriately skilled consultant.

How does a cyclone work?

Cyclones use centrifugal force to remove particulate matter from a gas stream (refer diagram over the page).

A cyclone normally consists of a shell into which dusty gas is introduced through a tangential inlet.

The dusty gas spins in a vortex that results in dust particles being centrifuged towards the walls and moving down towards the conical base of the cyclone.

The ‘dedusted’ gas in the middle of the cyclone moves up towards the outlet at the top.

The collected dust must be removed from the cyclone without being picked up again (re-entrained). This is achieved by:

- discharging the dust into a separate hopper or silo
- ensuring an adequate dust collection rate to avoid accumulation and reduce the potential for blocking the cyclone
- using an air tight discharge device (such as a rotary valve) from the collection hopper.
What is cyclone efficiency?

Cyclones can generally remove any particles greater than 50 microns from a dusty gas stream; a more efficient cyclone can also remove particles smaller than 50 microns. Because the particles in a dusty gas stream are of different sizes, each cyclone design has a standard efficiency curve known as a ‘grade efficiency curve’.

The grade efficiency curve shows what percentage of each size range will be removed from the incoming dusty gas. These curves are prepared using a standard sand in air at 20°C; they need to be modified to suit the actual gas and solid.

Typical grade efficiency curves for a high and moderate efficiency cyclones are shown below.

![Grade Efficiency Curve](image)

In this case, the high efficiency cyclone would remove 90% of all 5 micron sand in the dust stream while the moderate efficiency cyclone would only remove 54% of all incoming 5 micron sand.

When selecting a cyclone, the standard grade efficiency curve must be modified to suit the particulate/gas system being dedusted.

What affects cyclone efficiency?

Cyclone efficiency is primarily driven by cone length—the longer the cone the more efficient the cyclone is at removing fine particles.

Cyclone efficiency is also affected by:

- the inlet velocity (V)
- the cyclone diameter (D)
- the diameter of the cleaned gas outlet relative to that of the cyclone (d/D)
- distortion of the outlet flow pattern by bends too close to the cleaned gas outlet
- damage to the cone section by external hammering
• a leaking seal or rotary valve at the base of the cone section.

Generally, the higher the cyclone efficiency, the higher the centrifugal forces that are exerted on the particulates and the higher the required pressure drop over the cyclone.

What information is needed to successfully design a cyclone?

There is a range of standard cyclone designs, each with its unique grade efficiency curve derived from sand in air. An operator needs to supply the following information to a cyclone designer.

Gas properties

• the flow rate or range of flow rates
• the density and viscosity of the gas.

Particle properties

• distribution of the 0-50 micron size range
• density
• shape factor
• solids loading.

The impacts of humidity, dewpoint and hydrophilic solids must also be considered in designing a cyclone system.

Reusing a second hand cyclone

An operator intending to purchase a second hand cyclone should obtain its design grade efficiency curve from the vendor. If this is not available it may be possible to identify the design by measuring the major dimensions.

If the grade efficiency curve is not available or cannot be identified, the purchaser carries the risk of the cyclone not working successfully in its new application.

Once the grade efficiency curve has been characterised the design procedure for a ’new’ cyclone can be followed.

The mechanical condition of the unit should be considered, especially joint integrity and evidence of hammer marks around the base of the conical section.

The ability of the existing solids discharge device to handle the new duty must also be considered before purchasing.
FURTHER INFORMATION

Legislation

Legislation may be viewed on the Internet at: www.parliament.sa.gov.au/dbsearch/legsearch.htm

Copies of legislation are available for purchase from:

Government Information Centre
101 Grenfell Street
Adelaide SA 5000

Telephone: 13 23 24
Internet: www.shop.service.sa.gov.au

For general information please contact:

Environment Protection Authority
GPO Box 2607
Adelaide SA 5001

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