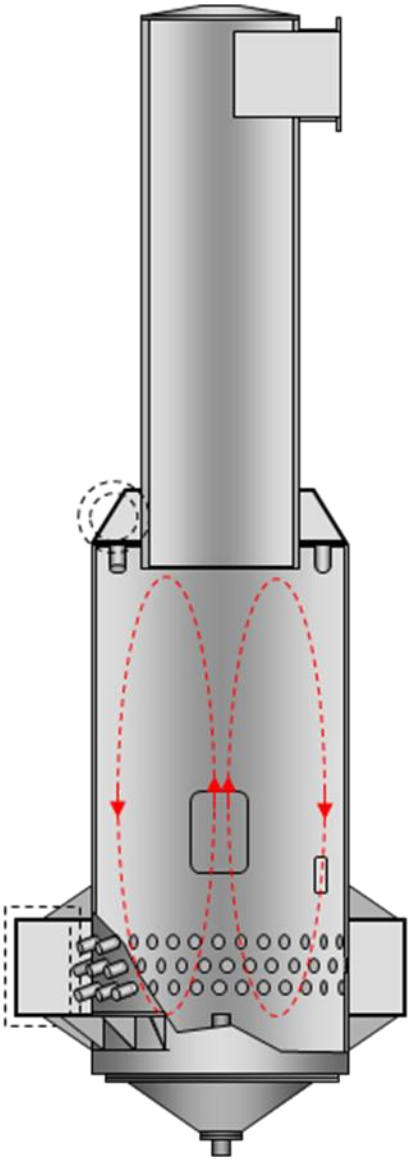
TORBED* Process Reactor Technology
Application Description

DRY GAS SCRUBBING

AN ADVANCED TECHNOLOGY FOR REMOVING POLLUTION FROM FLUE GASES

The TORBED Dry Scrubber is a Proven Technology that is capable of removing most pollutants from the exhaust gas of combustion devices burning waste materials. It has the following features:

- Fabricated from ferritic stainless steel to minimise wear and corrosion
- It incorporates a toroidal swirl to the flue gases ensuring excellent gas/solid mixing
- The flow pattern causes the particles to be retained in the chamber until the size reduces to allow the particles to escape
- Spent reagent particles are trapped in the bag filter with the ash particles
- It is economical with the reagent using less than other comparable systems to achieve world class performance
- Expected Removal Efficiency is
    - SO_2 - >90%
    - HCl - >95%
    - HF - >99%
    - Volatile Heavy metals - >99%
    - Dioxin and Furans - >99%



This level of performance is achieved with standard readily available lime hydrate reagents activated carbon.

The TORBED Dry Scrubber is offered as a suitable dry scrubbing plant for the adsorption of pollutants from boiler flue gases. The boilers may be fired by biomass, wastes including MSW, WDF and RDF fuels and is capable of removal efficiency as listed above.

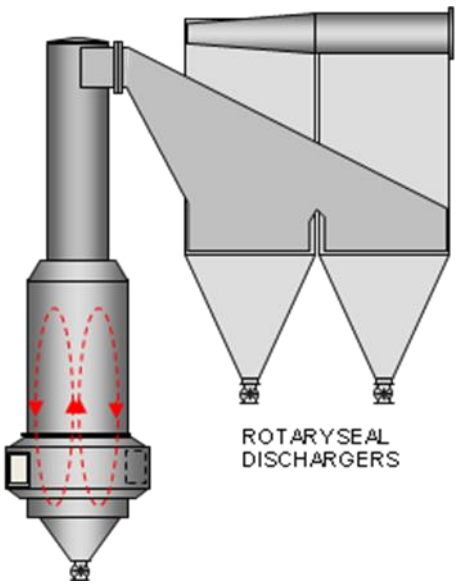
Usually operating with a fabric bag filter, this system provides high efficiency with low usage rates of sorbents, low residue disposal costs with no wet residue and thus no waste water treatment plants.

Advantages of the TORBED Dry Scrubber

The TORBED dry scrubber is most often matched against Circulating Fluidized Bed ('CFB') dry scrubber - the best known technology today. TORBED dry scrubbers have a significant advantage over the CFB Systems in that the material recovered from the bag filter is not recycled to the dry scrubber, as most CFB systems require, anything up to 20 times. This is necessary on the CFB systems in order to increase the contact time or residence time of the solid matter with the flue gases allowing the overall ratio of reagent to pollutant to be low enough to be acceptable to the user.

The TORBED scrubber recycles the reagent **internally** in the scrubber. The geometry and gas flow patterns of the TORBED reactor causes the material to remain in the scrubber until the particle size is reduced to a level where it can escape the Scrubber. This significant improvement over the CFB scrubbing systems helps to extend the bag filter life to is full expectancy and to reduce the usage of reagents in the scrubber.

Applications



Already in use on more than 150 installations worldwide, the TORBED process reactor has found many applications including biomass combustion for controlled burning of rice husk, gasification for biomass and waste fuels, catalyst regeneration and mineral processing.

The TORBED Dry Scrubber is the latest application of this process reactor technology which utilises its' well proven ability to mix solids and gases to effect the required change in one or both of the substances mixed in the scrubber. In this case, the usual solid substance is powdered lime hydrate and if necessary mixed with activated carbon.

The TORBED Dry Scrubber operates with a standard bag filter assembly to remove common pollutants from the flue gases of boilers or engines burning waste derived fuels using common reagents.

In most applications the reagents are recycled internally in the TORBED scrubber, shedding the reactive particle 'skin' as the reagent particles adsorb the pollutants. When size reduced to the level where the particle can escape the centrifugal forces in the scrubber, the spent particle passes into the bag filter where the remaining active reagent acts as a 'polish' on the adsorption reaction, before being discharged from the filters to be disposed of by the fly ash system.

Recycling the Particulate

Although not normally used, the technology retains the ability to recycle the spent reagent from the filter back to the Scrubber, *in extremis*, but this is minimised in order to preserve bag life in the filter.

Cooling water may also be injected into the Scrubber in order to adjust the operating temperature to the optimum condition. It has been found that the scrubber operates best when working close to the dew point.

Best Available Technology

In the period 1999 to 2002 Comalco invested in TORBED dry scrubbers for use on their alumina refineries in New Zealand and Tasmania. These were installed and exceeded all the client's requirements - it was recognised by Comalco and the regulatory authorities that the installation of the TORBED dry scrubbing had achieved world's best practice for their application.

The fume was HF, one of the regulated emissions in waste firing systems. HF and HCl, the 'halogens', are regulated tightly as they are recognised as precursors to dioxin and furan formation so these are considered amongst the most dangerous emissions.

The gas scrubber installation at Comalco Bell Bay Tasmania

The TORBED scrubbing technology was compared at the time with all other technologies for HF removal including other proponents of dry scrubbing with lime hydrate and activated carbon with fabric filtration, and due to the extended residence time in the TORBED reactor it was shown that only a single pass of the pollutant through the reactor was sufficient to adsorb the halogen to the required level.

This exceeded the technical capability of all other dry scrubber manufacturers at the time. HCL and HF are from the same family of elements and behave, chemically, in a virtually identically manner, except the adsorption happens more quickly with HCl.

SO_2 requires a longer contact time than the halogens and works better at elevated temperature so the main adsorption will occur in the boiler furnace and the lime hydrate injected at the dry scrubber will 'polish' the SO_2 to compliance levels.

Using both furnace injection of lime hydrate and lime injection into the dry scrubber provides adsorption capability of up to 98% of SO_2.

The unique and patented circulation patterns used in the TORBED dry scrubber cause intimate mixing between the solids and the gases. The contact with the other particles abrades the reacted surfaces, exposing fresh reagent surface to the pollutants, so recycling of the reagents through the main fabric filter, and using the filter cake on the filter bag surfaces as the main reaction area, is not required. Instead, the filter bags provide a reserve bed where the adsorption is 'polished' to ensure compliance.

In tests with the exhaust gas streams at the Comalco smelters, it was found that the TORBED reactors were more than three times as efficient as had been anticipated and with no requirement for particulate recycle (often up to 20 times with competing technology). As a result, 13 dry scrubbing units, each with a single stage TORBED reactor, were needed as part of the $NZ94 million (US$60m) gas emission project. Subsequently, Comalco also equipped their Bell Bay Smelter with a further 6 TORBED reactor units.

Each of these reactors treats a gas flow-rate of 380,000 m^3/h in a single pass system for both the gas stream and the alumina particles. The emission levels achieved for both gaseous hydrogen fluoride and particulates of approximately 1 mg/Nm^3 are comparable to the best performance figures for any dry gas scrubbing systems, anywhere in the world.

Despite the outstanding processing efficiency, no extra power was required as the TORBED reactor creates only a low pressure drop across the system. As a result, the dry scrubbing units could continue to use the six existing 1 MW exhaust fans, whereas the use of alternative systems would have meant upgrading existing fans.

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