**Introduction**
The following is a description of how the Powdered Activated Carbon (PAC) dosing system operates. Firstly an overview of how the Semi Dry Reactor and the purpose of carbon injection is described. Following this the process of unloading the PAC into the PAC silo and the transfer of PAC from the silo to the Semi Dry Reactor is discussed. Finally the process of residue recirculation from the baghouse filter back to the Semi Dry Reactor is noted.

**Purpose of the Semi Dry Reactor**
The Semi Dry reactor is a reaction container for the sorption of acids to calcium hydroxide as well as the sorption of heavy metals, dioxins and furans to PAC.

**Sorption**
Sorption is a fixation of a material by absorption (chemical) and/or adsorption (physical).

**Absorption**
Absorption is the process of gas bonding chemically with liquids or solid materials (calcium hydroxide is used to neutralize acids). In the absorption process, substances from a gas or a liquid are absorbed by a solid material. They penetrate inside the solid material.

**Adsorption**
Adsorption refers to a physical process in which substances from a gas or a liquid attach to the surface of solid material and accumulate on that surface. The larger the surface of the solid material, the more adsorption takes place. The forces that cause these substances to deposit on the surface are physical forces rather than forces based on chemical bonding.

**Powdered Activated Carbon (PAC)**
The base material for the production of PAC consists of raw materials containing carbon such as brown coal and black coal. Powdered Activated Carbon particles are porous carbon particles with a large internal surface (300 to 2000 square meters per gram) which is formed by macro, transitional and micro-pores (Figure 1).

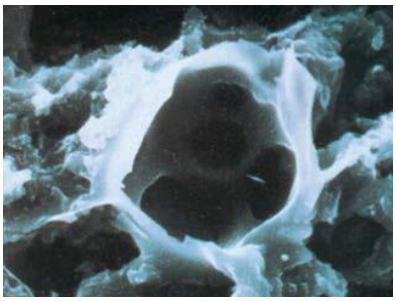

**Figure 1 Enlargement of Powdered Activated Carbon by microscope.**

**Physical reaction**
Powdered Activated Carbon reacts with organic pollutants and heavy metals such as furans, dioxins and mercury, which are absorbed.

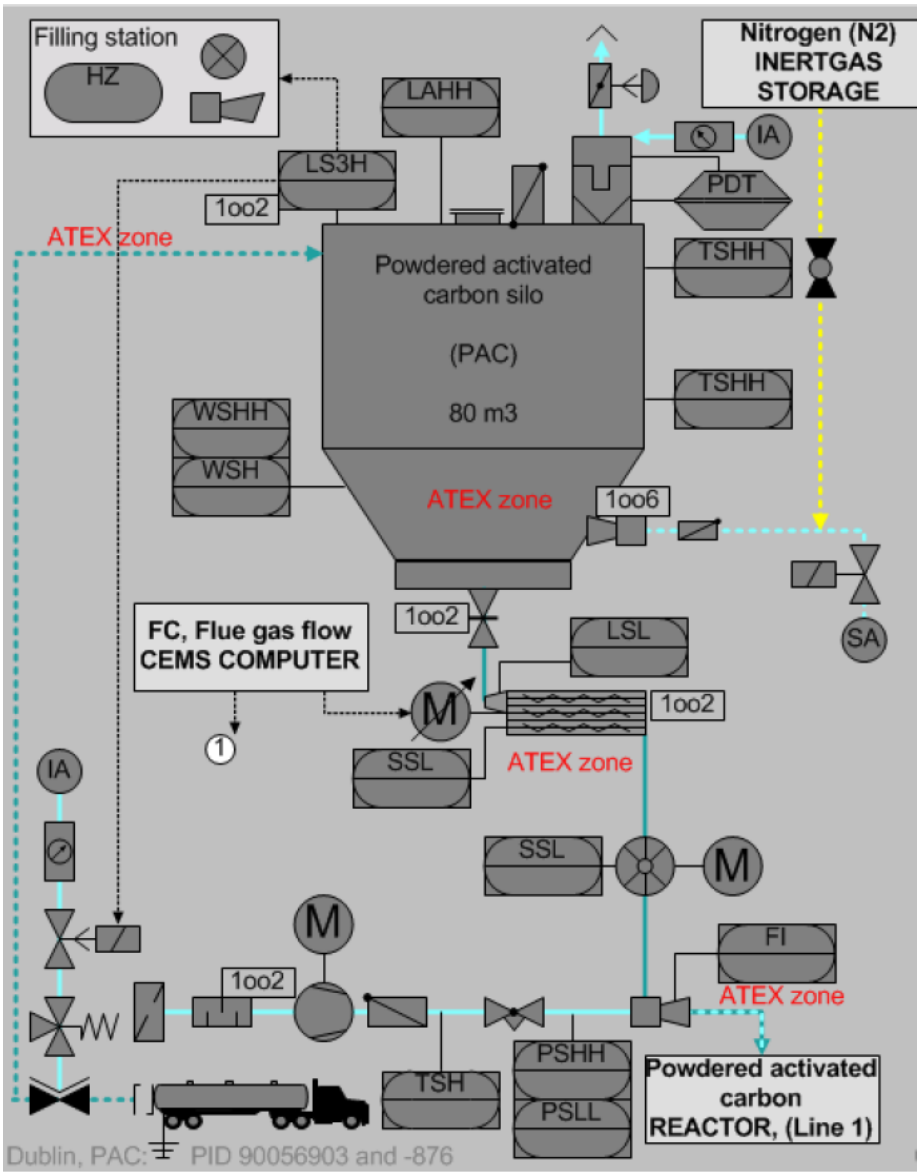


**Figure 2 PAC Silo**

**Overview of the PAC path**

The PAC is delivered by truck (Figure 2). The unloading process is carried out pneumatically using the conveying air created by the trucks on board compressor. The fluidization in the conical section of the silo supports the discharge of PAC from the silo into the metering and conveying system.

A metering screw with variable frequency drive meters the PAC. The metering is determined using feedback from the flue gas flow.

The rotary valve ensures that a seal is achieved from the silo to the conveying system.

The PAC mixes with the conveying air in the injector and is subsequently blown into the reactor and becomes a part of the flue gas.

**Breather valve**

The silo is fitted with a breather valve to prevent over and negative pressurization.

**Level measurement**
The level measurement indicates the current level in the silo. A radar measurement device, installed on the silo roof, measures the distance from the reference point (flange gauge on the silo roof) to the product surface (PAC). The radar pulses are sent from the antenna in the instrument, reflected by the product surface and received again by the radar system.

**Overfill protection measurement**
The overfill protection measurement is a limit circuit which is independent of the level measurement. It secures the silo from overfill. The measurement device is installed on the silo roof. The system is equipped with a vibration limit switch. The limit switch is fitted with a fork which looks into the silo. The fork oscillates with a certain frequency. When the vibrating fork is covered with PAC, the vibration is damped and the frequency changes.

**Weighing cells**
Weighing cells are fitted into the base of the silo.

**Metering screw**
The metering screw is a volumetric multi-shaft screw meter. It is fitted with 5 metering screws (Figure 3, item 2), an empty level sensor (Figure 3, item 1) and drive motor standstill monitor (Figure 3, item 3).
The level sensor detects the formation of bridges.
The metering screws rotate in opposite direction forming a blocking zone. This prevents the solid material from rotating synchronously and ensures a high degree of self-cleaning.
The discharge curve is linear. It is continuously adjusted to feed requirements via the frequency converter.

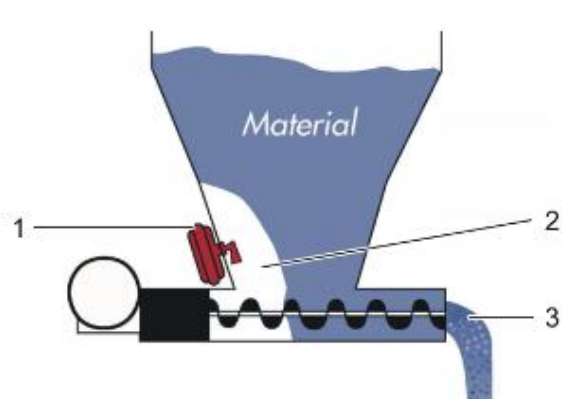


**Figure 3 Metering Screw**

The maximum quantities discharged by the PAC metering screws are about 20 kg/h.

**Metering PAC**
The metering of PAC corresponds to 40 - 100 mg/Nm$^3$ flue gas. The frequency of the metering screws depends on the flue gas flow.

**Rotary valve for PAC**
The rotary valve seals the area between the silo and the delivery pipe.

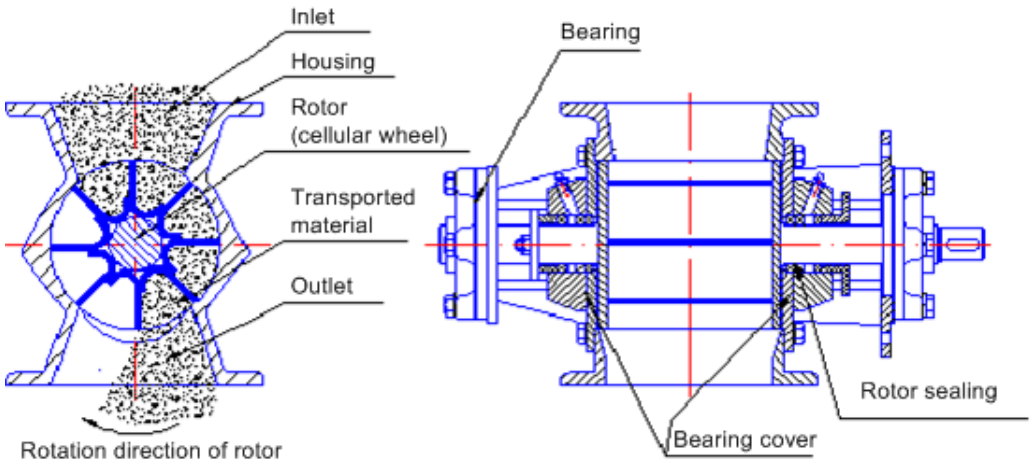


**Figure 4 Rotary Valve**

The rotary valve (Figure 4) consists of a rotor with blades turning in a tightly fitting housing. Each rotor cell takes up feed material from the inlet opening and drops it at the valve outlet. This ensures a continuous feed.

**Semi Dry Reactor**
The Semi Dry Reactor (Figure 5) is a standing cylindrical container. Lines for the hydrated lime and PAC, the recirculation channels and the water lances enter the bottom of the Semi Dry Reactor.
The raw gas flows from the bottom of the reactor to the top where it leaves as a solid material / gas mixture through the reactor head. From there it enters the fabric bag filter.

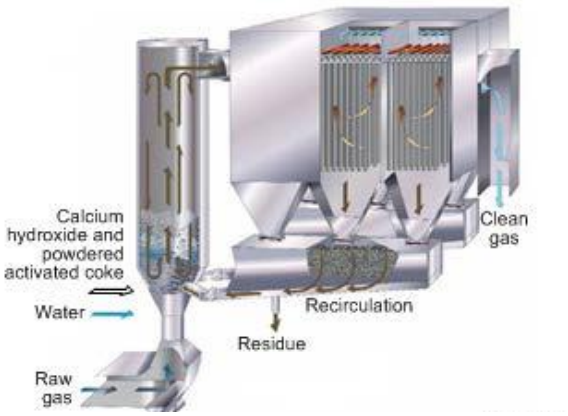


**Figure 5 Semi Dry Reactor**

**Recirculation of Solid Material**

To better use unreacted hydrated lime and PAC, the separated solid material below the fabric bag filter chambers are primarily conveyed back to the reactor. This conveying occurs with two pneumatic conveyor channels. The conveying and fluidizing air on the different areas of the pneumatic conveying channels can be set and measured with local flow measurements. The conveying/fluidizing air is generated with two conveyor fans. One fan supplies each recirculation channel. There is one redundant air blower which can supply either of the two channels.

Safety valves protect the system against excess pressure.

The recirculation is constantly kept in motion (flowing bed) through the air injection into the lower part of the fluidization channels. The material is fed into the reactor through the gradient of the channel.

Each recirculation channel contains a pneumatically actuated metering rotary valve and a pneumatic shut-off gate valve.

Whenever the recirculation of material is stopped, the fluidization of the two channels continues with one blower to keep the material in motion and prevent clogging.

**Differential pressure control of the material bed in the Semi Dry Reactor**

The differential pressure of the fluidized material bed in the Semi Dry Reactor is regulated by the recirculation of discharged solid matter from the fabric bag filter. The discharged solid matter is recirculated by one metering rotary valve per channel interface.