Filter cleaning in hot gas applications

Overview

- The role of filter cleaning in hot gas filtration.
- Reverse pulse jet filter cleaning principles.
- Case study with ceramic filters.
- Cleaning system configuration considerations.

The role of filter cleaning

The two most common filtration methods for scrubbing high volume hot gas are

- dry electrostatic precipitation (ESP), and
- reverse pulse jet filtration (RPJ)

ESPs typically present a higher cost of acquisition and the collection efficiency is dependent on gas volume, load, and uniform particulate characteristics.

RPJ systems are typically tolerant of variations in gas flow rates, particulate properties and have lower acquisition costs.

ESP Systems

+	−
• No physical media • Low dPs	• Efficiency requires consistency • High cost of acquisition

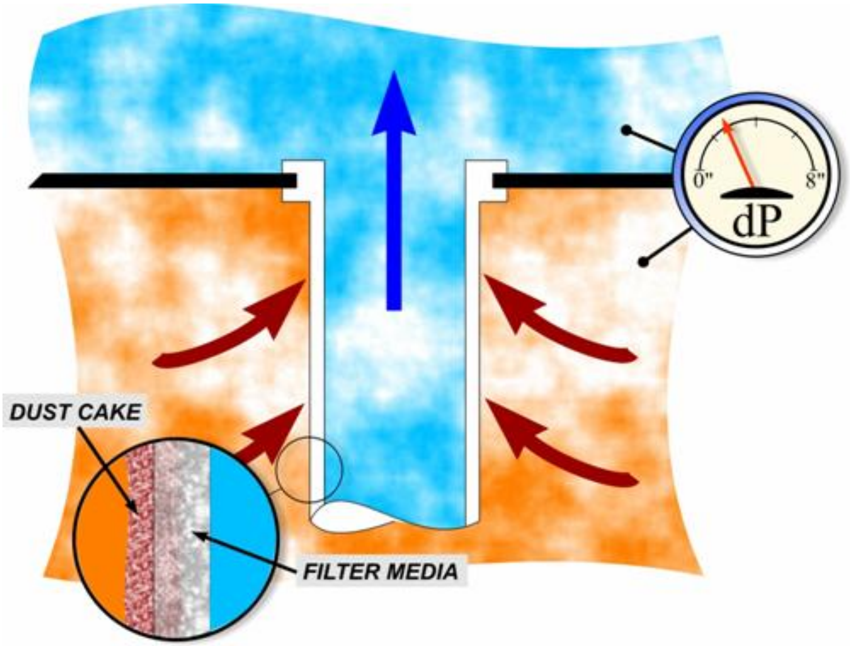
RPJ Systems

+	−
• Tolerant to changing conditions • Lower cost of acquisition	• Potential filter replacement costs

Today we are discussing RPJ applications in hot gas filtration

The role of filter cleaning

- Over time, as particulate collects onto the surface of the filter media and a dense layer of particulate forms – the dust cake.
- As the dust cake becomes bigger and more dense, the differential pressure (dP) increases.
- The dP is a critical measure of the dust cake density and therefore the filtration efficiency as well as the flow rate through the dust collector.



Normally, we rely on the dust cake to filter the the fine particulate. By maintaining dP at appropriate levels we manage the dust cake thickness for optimal filtration.

We rely on reverse pulse filter cleaning to maintain optimal dP.

The role of filter cleaning

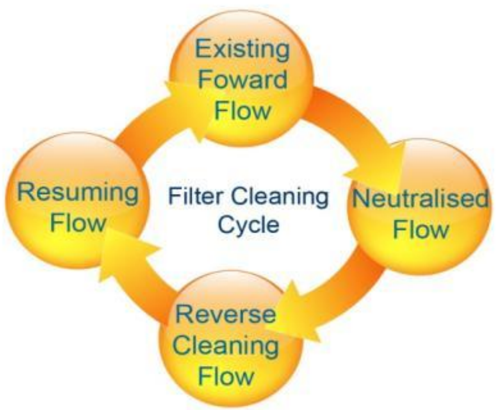
The design of the filter cleaning system is vital to the overall process.

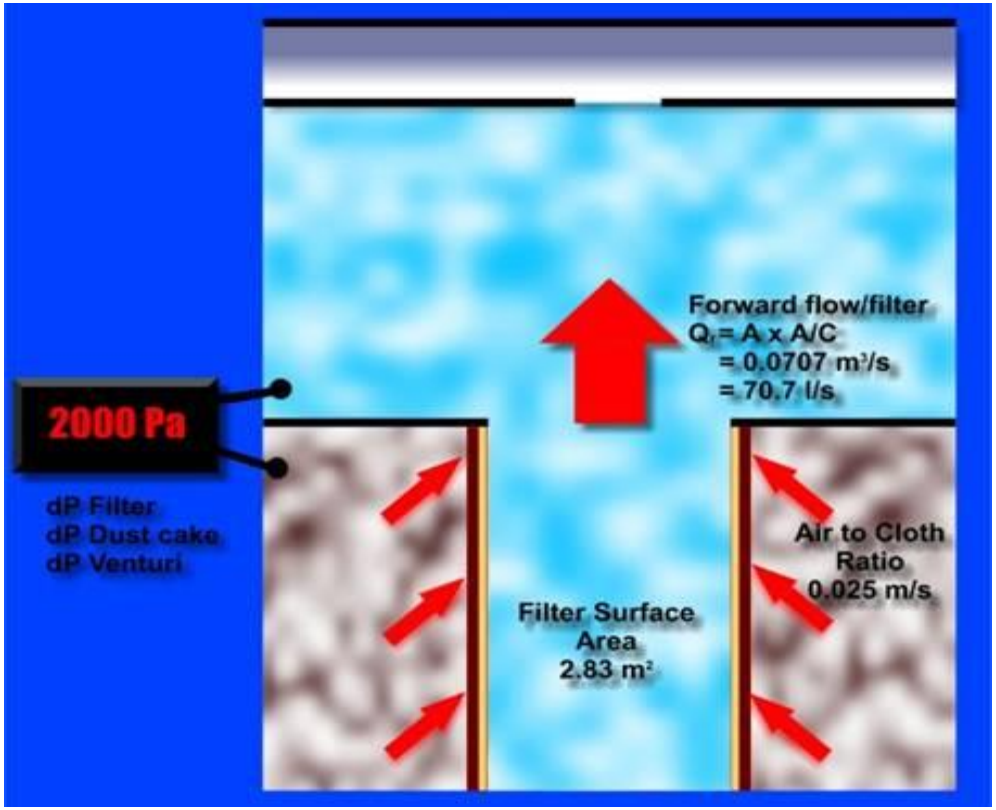
Principle of RPJ Filter Cleaning

Step 1

Existing Forward Flow

Flow is passing through the filters in the forward flow direction.



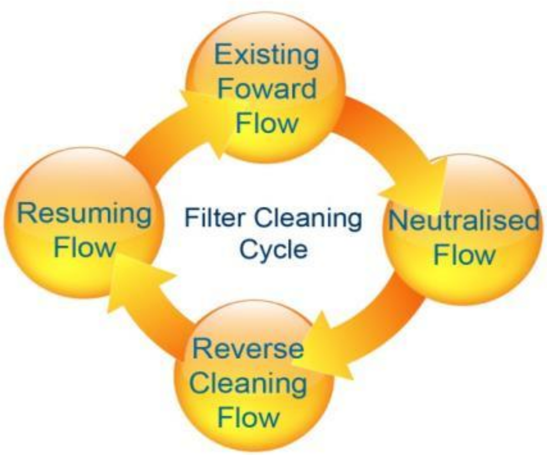


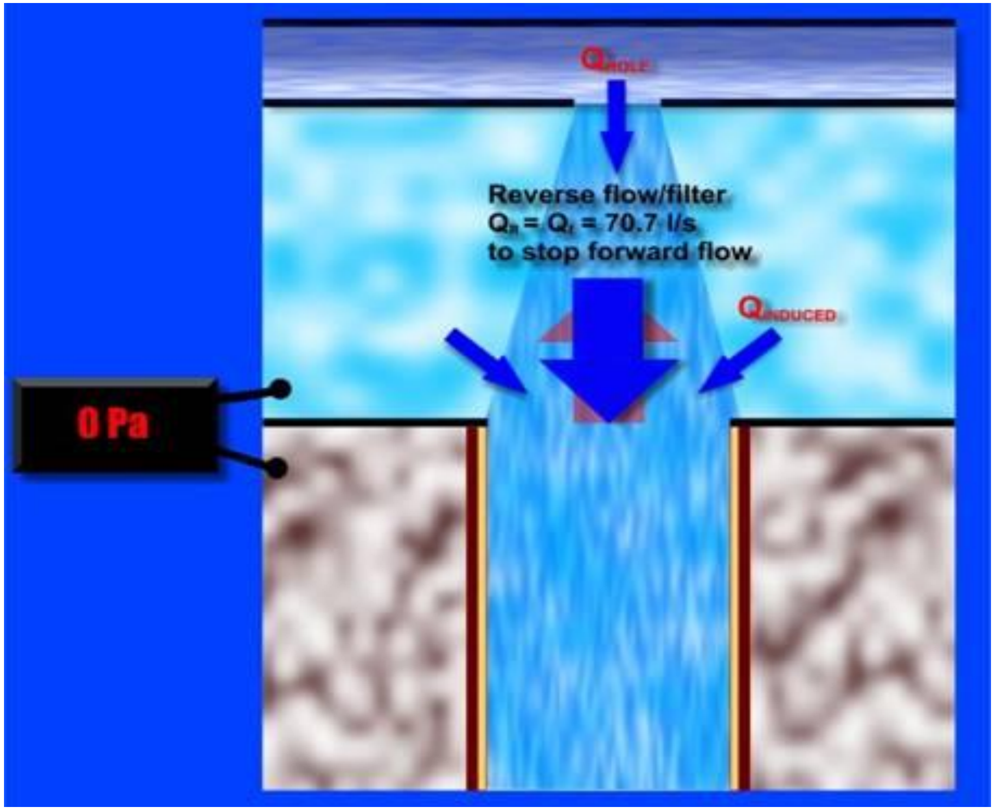
Principle of RPJ Filter Cleaning

Step 2

Neutralised Flow

A pulse of air in the reverse direction induces (entrains) *secondary air* from the clean air plenum and neutralises the forward flow. The dP across the filter element momentarily becomes zero.





Principle of RPJ Filter Cleaning

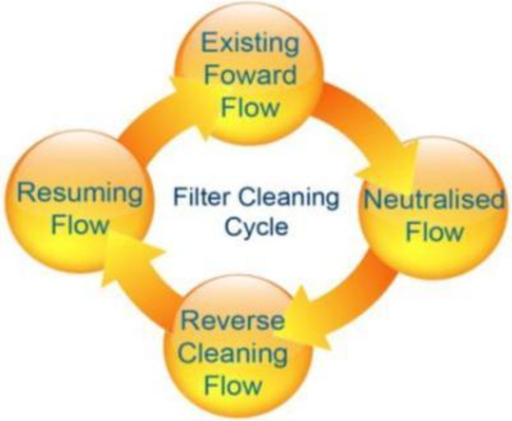
Step 3

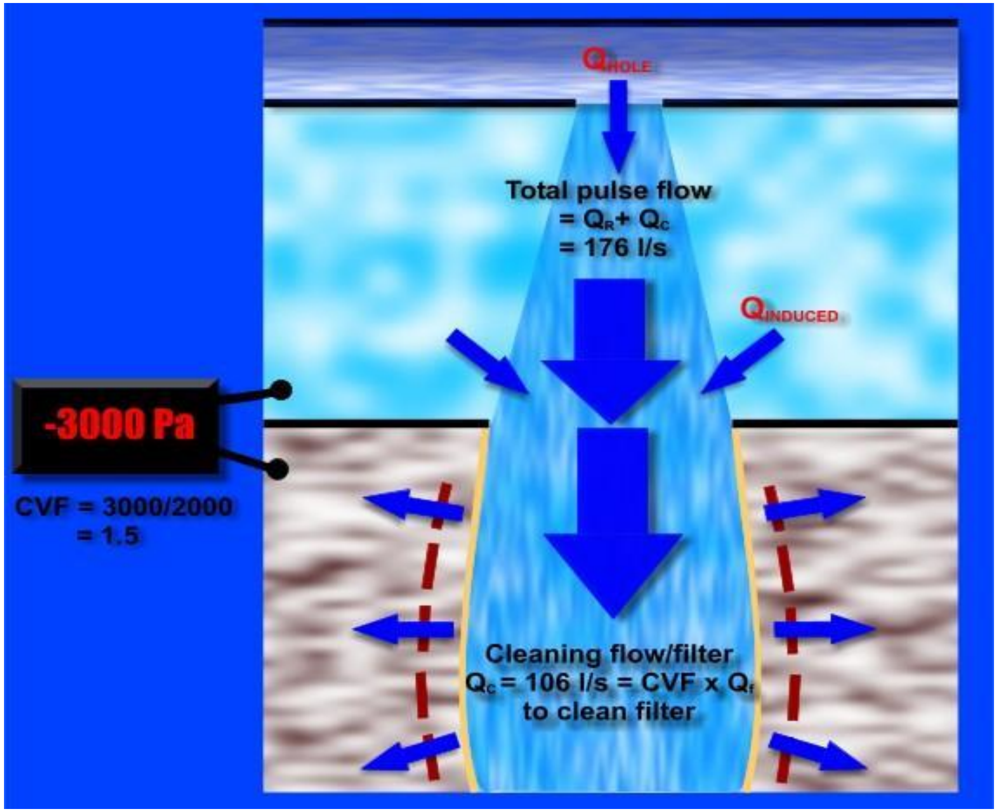
Reverse Cleaning Flow

During the same pulse, the air delivered *after* the forward flow has been neutralised causes a Cleaning Pressure (CP) to be developed inside the filters. This portion of the pulse is known as the Cleaning Flow.

Cleaning Factor = Cleaning Pressure / Differential Pressure

Bigger Cleaning Factor = stronger cleaning.





Appropriate cleaning factors are required to simultaneously ensure dP control and optimise filter life.

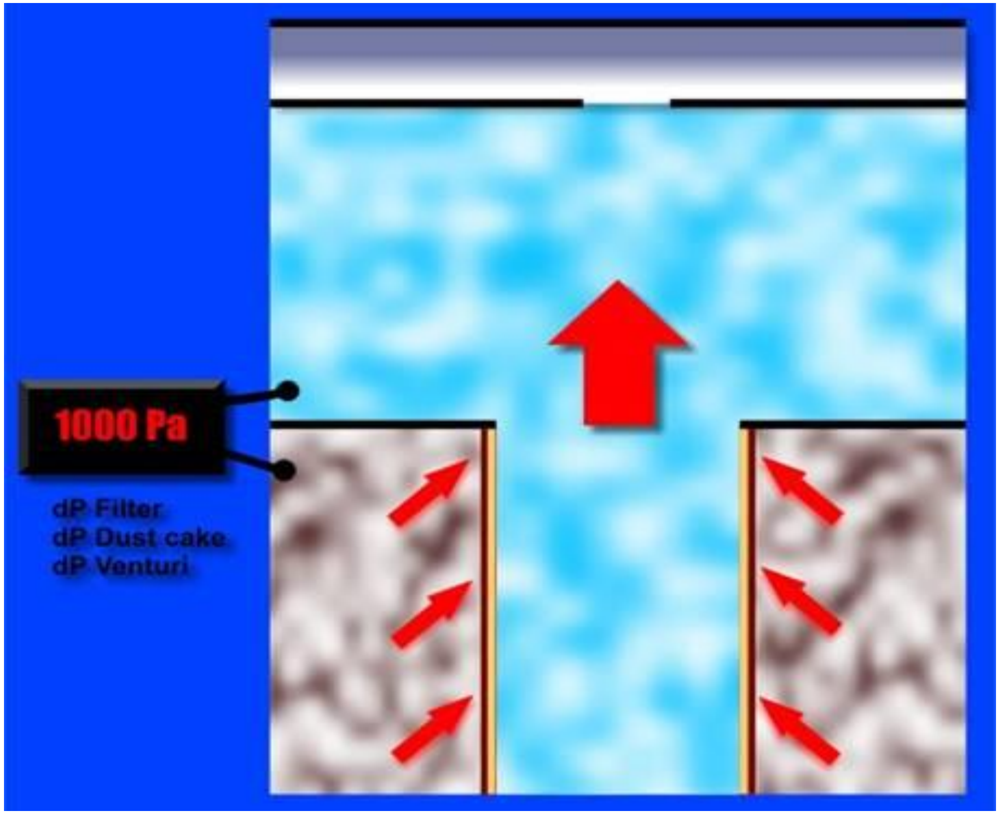
Principle of RPJ Filter Cleaning

Step 4

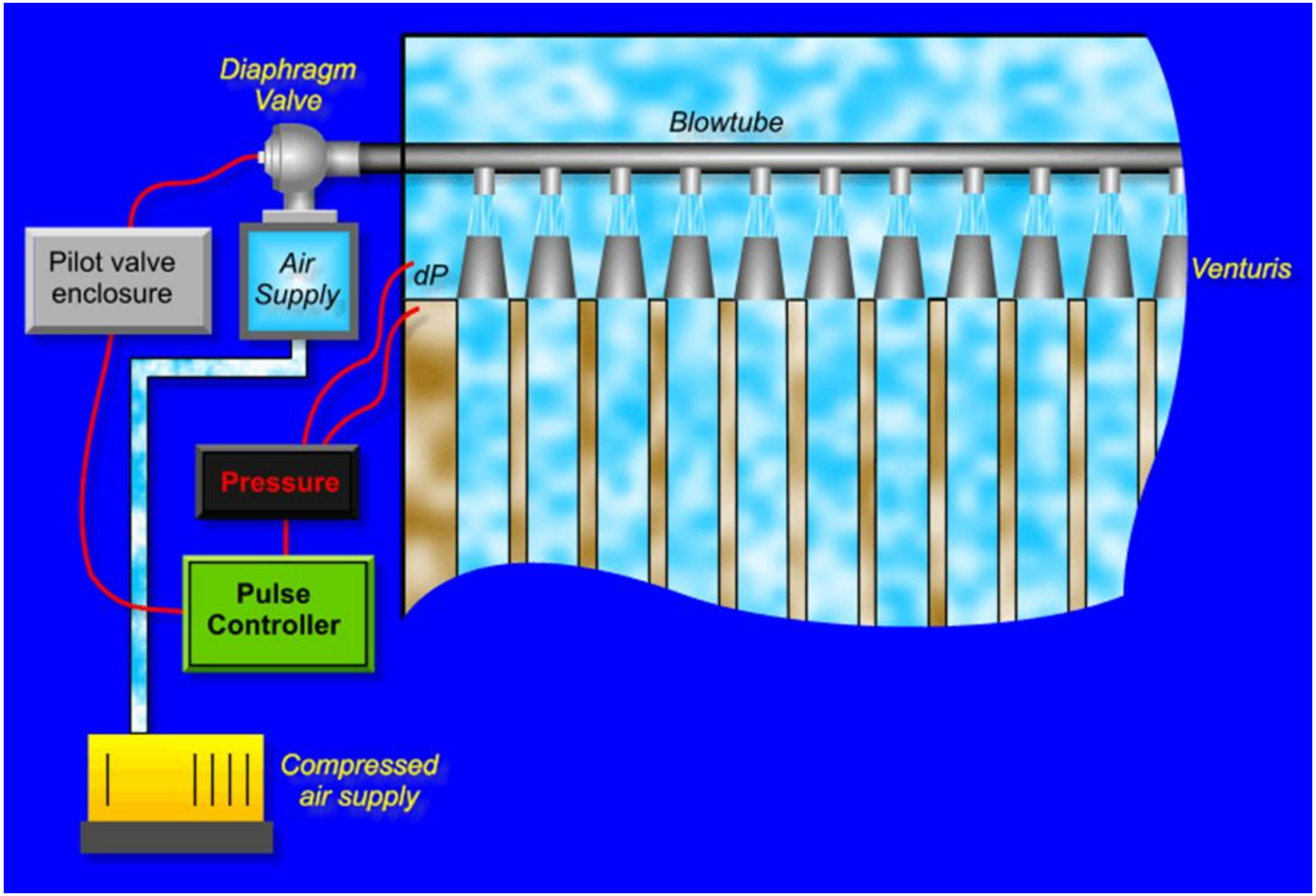
Resuming Flow

The reverse pulse ends and forward flow passes back through the filters again.

As the forward flow re-establishes through the filter elements, some of the released dust is pushed back onto the filter element. In a well designed system, the dust is allowed to fall some distance down the element before becoming attached to the filters again. Eventually the dust falls into the hopper.



Principle of RPJ Filter Cleaning



The configuration of the filter cleaning system is crucial to effective filter cleaning and dP control

Case Study: Australian Alumina Plant

APPLICATION

Process
Liquor burning process in alumina refinery

Temperatures
Process - 900°C (1652 °F)
Extraction – 200°C (392°F)

Particulate nature
Abrasive

Filter media
High temperature PTFE membrane bags

***Problem*:**
Filter life was below 6 months due to high abrasion on elements. Frequent filter failures led to emissions and action by local EPA + negative media.

Site chose to replace filter media with ceramic filter elements.

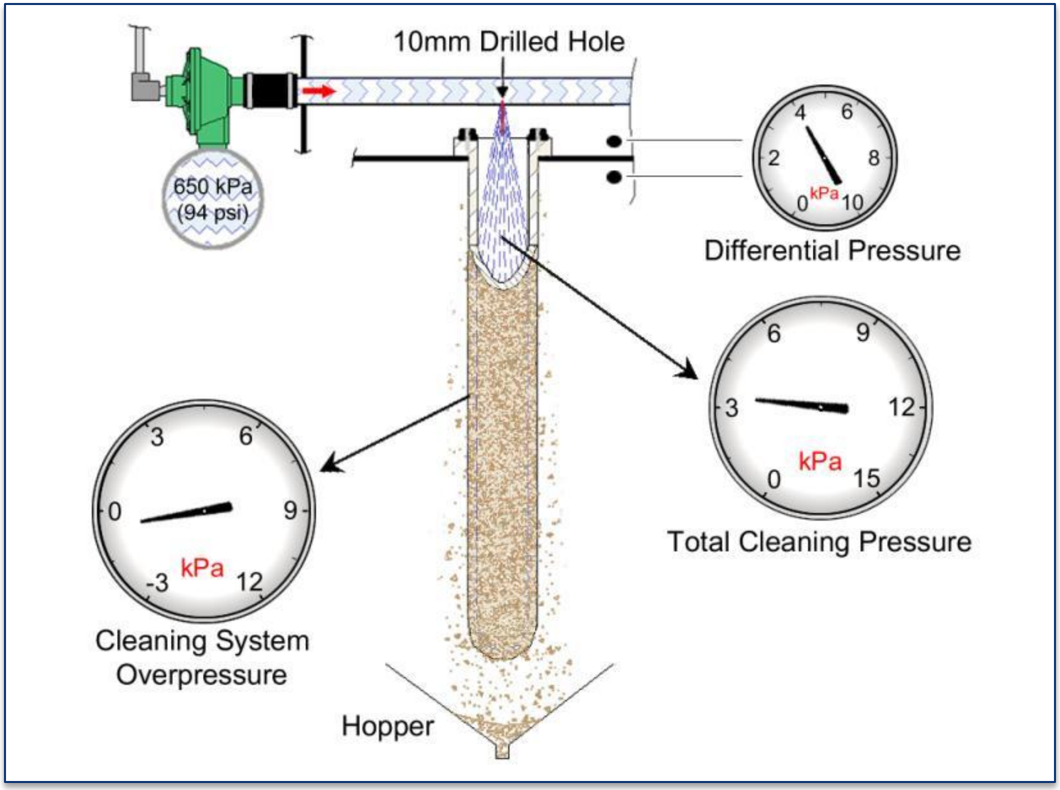
Case Study: Australian Alumina Plant

Replacement of media with ceramic filter elements was a large investment that led to a significant problem:

The filter cleaning system design was not considered when the media was changed.

The consequence of higher dP through the filter elements was that the filter flow rates could not be reversed, and no cleaning factor was generated. DP rose to over 4kPa (16 "WG)

Filters could only be cleaned off line, causing damage to the kiln, and a cost of over AU$30K each week.



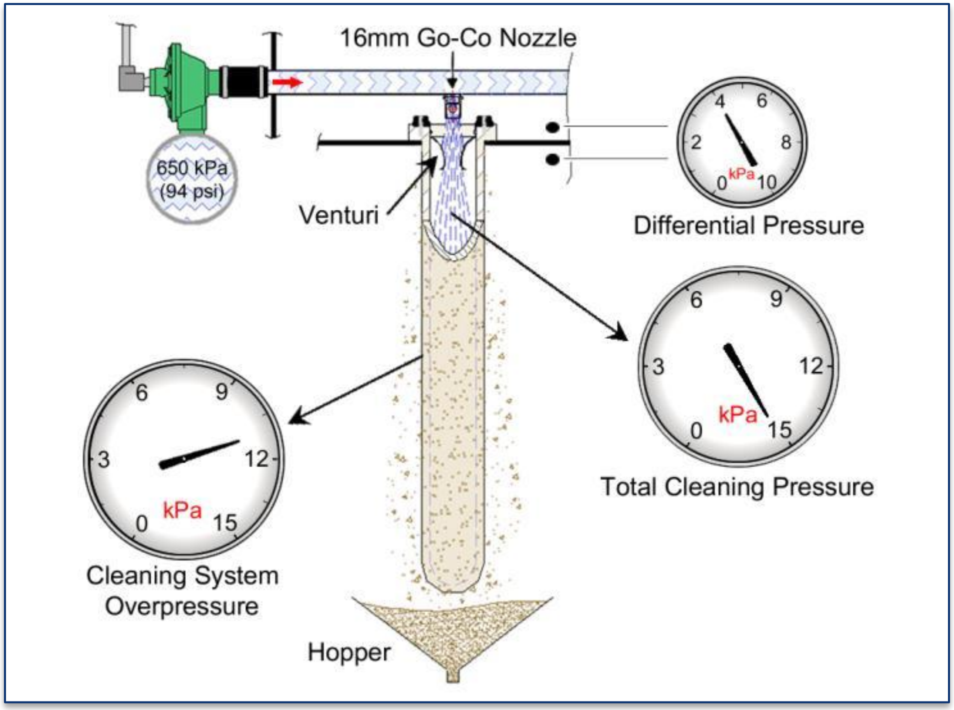
Poor cleaning system design = negative cleaning overpressure
NO CLEANING.

Case Study: Australian Alumina Plant

Cleaning system was modified:

Goyen evaluated several changes to improve the cleaning performance using the GOCO software, computational fluid dynamics, and the test facility. Testing and modelling showed that the combination of the GOCO nozzles and venturis increased the cleaning overpressure so significantly that the pulse cleaning system operating pressure could be reduced.

The plant was able to resolve the high dP problem and reduce the electricity consumption of the liquor burner (via fan power reduction and air compressor savings), and eliminate downtime.



Ample cleaning power, easily adjusted by compressed air pressure level.

Cleaning system design considerations for Hot Gas

Some key considerations when configuring cleaning systems for Hot Gas applications:

Pulse valve choice

- What is the temperature at the valve; will high temperature seals (eg Viton) be required?
- Are aggressive chemicals in contact with the valve?
- Do we need stainless steel components rather than cast aluminium (standard).

Media dP

- What will the filter media be? Can we expect higher than usual differential pressures?
- What is the dP required to maintain the dust cake at the appropriate levels?

Waste gas and dew point

- Does the waste gas contain contaminants that may turn to an acid when the system passes through the dew point (eg during shut down periods)?
- Acid condensation on pulse system components will considerably shorten the life of these.

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