

REINHOLD ENVIRONMENTAL Ltd.



2010 APC Round Table & Expo Presentation

July 18-20, 2010, in Concord, NC / Hosted by Duke Energy

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Fabric Filter O&M

Reinhold APC Round Table July 2010

Mikael Fredriksson

POWER

ALSTOM

Presentation

FF Start Up Practise

FF Shut down Practise

FF Operation

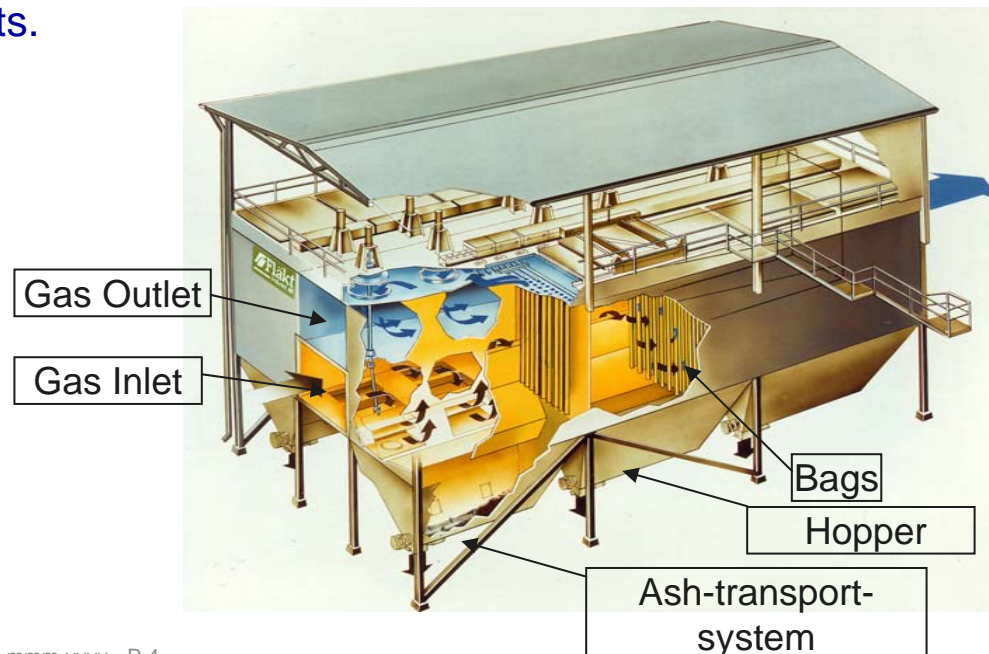
FF Trouble Shooting

FF Bad bag detection and bag monitoring system

- Mikael Fredriksson
 - ALSTOM Thermal Service
Global Product Manager Fabric Filter
 - Employed 1995
 - ESP's
 - Fabric Filters
 - Power
 - Waste
 - Pulp and Paper
 - I&S
 - LSC Sales/Tendering/Execution
 - Business Manager Environmental Iberia
 - Global Product Manager FF

15 year in ALSTOM AQCS

- Well designed FFs will normally retain 99.9 % or more of the inlet particulate matter. Dust emissions in the range of 10 mg/Nm^3 or lower are most often achieved, and levels down to 0.1 mg/Nm^3 are occasionally found. There are specially designed FF that has successfully met a dust emission warranty of 0.4 mg/Nm^3 with a special low emission design.
- FFs combine a moderate technical complexity with high availability and an inherently high collection efficiency, also for sub-micron-sized particles, and have the dual capacity of particulate control device and highly efficient chemical reactor for absorption of gaseous components.



- **Boilers: FBC, PC, Stoker**
- **Cement: Kilns, Mills, Coolers**
- **Metallurgical Processes: Melt Shops**
- **Coke Pushing: Trav-L-Vent**
- **Aluminium Pot Lines: Furnaces, Alumina Injection**
- **Incineration: Dry Lime, Milk of Lime Injection**

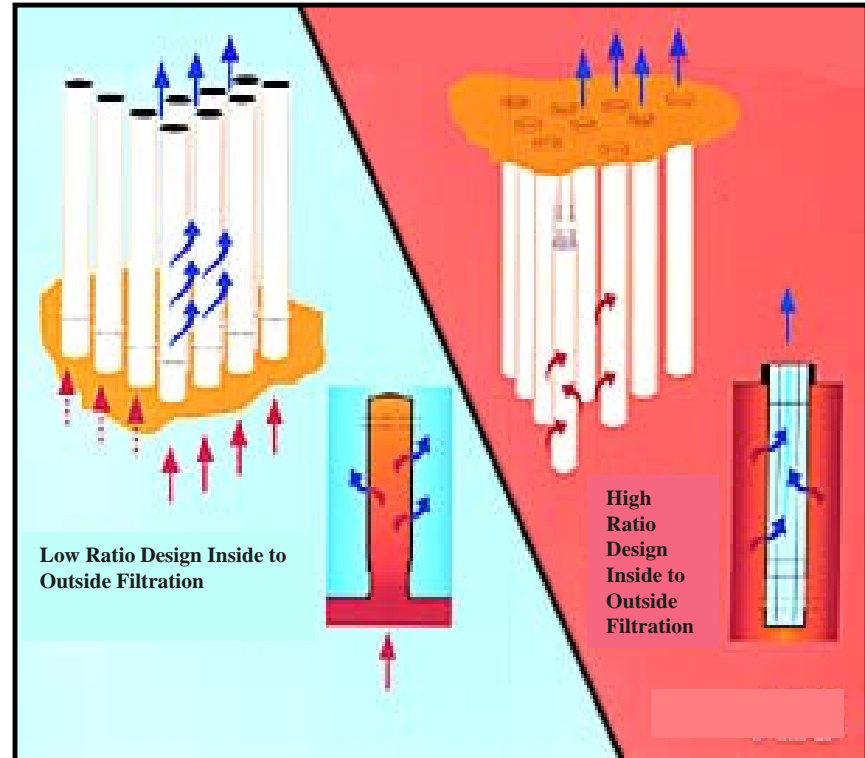


**Ogden Energy
Fairfax Units 1-4
4 @ 750 TPD
Fairfax, VA**

Where do we have Bag Houses?

Bag House System

- **Collects dust particles in the flue gas stream**
- **Fabric and dust layer act as filter**
- **Low Ratio/High Ratio**
- **<10% Opacity**
- **<0.005 gr/ACF Emissions**
- **Pressure Loss 4-8" H₂O**



General Facts

- **Filter Bag Material**
- **Fabric Filter Type and Size**
- **Bag Geometry**
- **On-Line Maintenance**
- **Inlet/Outlet Plenums**
- **Compartment Dampers**



**US Generation
Logan Unit 1 - 230 MW
Philadelphia, PA**

Bag House Determination

- **Hopper/Dust Discharge**
- **Maintenance Access**
- **By-pass (High Temperature)**
- **Thermal Expansion**
- **Controls**
- **Monitoring System ΔP & Opacity**



**Constellation Power, Inc.
Roanoke Valley Unit 1 - 150 MW
Roanoke, NC**

Bag House Determination

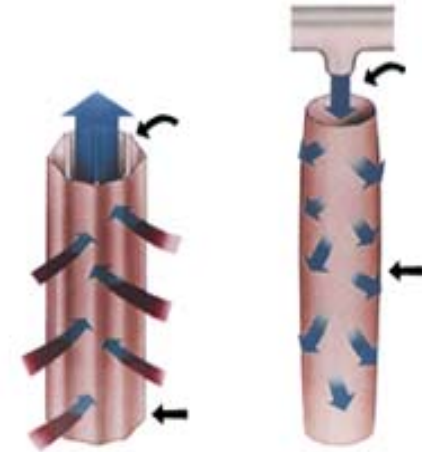
- **Filter Speed**
- **Fabric Type**
- **Gas Distribution**
- **Bag Geometry**
- **Flue Gas Temp & Density**
- **Inlet Ash Concentration**
- **Ash Particle Density**
- **Ash Particle Shape & Structure**
- **Ash Particle Size**



AES Corporation
Units 1 & 2 - 2 @ 90 MW
Kapolei, Hawaii

Gas Composition

- **Nature of Ash**
- **Agglomeration Factors**
- **Cleaning Intensity**
- **Cleaning Duration**
- **Damper, Plenum and Box Gas Velocities**
- **Fabrication and Erection Quality**
- **Operation and Maintenance**



Collection of
Dust Cake on
Fabric



Cleaning Dust
Cake off Fabric

Ash Composition & Bag House Design

Presentation

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- **Start Up**

- To protect bags from damage during start-up, be sure all flue gas controls and monitoring equipment are fully functional before pre-coating of bags begins.
- Failure to pre-coat bags before startup or high temperature operation will damage the filter bags.
- Check tank pressure
- Inspect the fabric filter inlet and outlet dampers. Manually operate each damper to verify that they seat properly and operate full stroke.
- Inspect all filter bags for proper installation.
- Check that the compartments are clean of tools or debris.

- **General Start Up Procedure**

- Inspect all hoppers, plenums and ductwork in the gas path to insure all debris has been removed. After inspection, verify that all doors have been closed and sealed.
- Verify instrument set-points and switch settings.
- Verify FF hopper heaters are energized at least 24 hours before putting the Boiler in operation.

- **Start Up Procedure**

- The following is a typical startup condition. Each AQCS System is different and should be thoroughly evaluated for its optimum startup procedure. Cooperation between the startup personnel and the AQCS startup personnel is a must.

- At some point in time during startup, the fabric filter temperature will pass through both the water vapor and acid gas dew-points. These conditions should be passed as quickly as possible to minimize condensate deposits on the filter bags and metal surfaces. During startup, the highest operating temperature and load should be pursued as quickly as possible.

- Frequently lowering the flue gas temperature through the dewpoints or continuous operation at the acid dew-points will decrease bag life and increase fabric filter pressure loss.

- **Fabric Pre-Coat**

- Pre-coat materials should be lightweight particles of aluminum silicate, agriculture limestone, hydrated lime, or fly-ash. Pre-coat material should have a particle size of 50% less than 200 mesh.

- **CAUTION:**

- DO NOT USE CALCIUM OXIDE – CAO**

- Approximately 1 pound of pre-coat is required for each square yard of fabric. It is imperative that the pre-coat is apportioned equally to all compartments.

- Approximate additional 20 % needs to be added, as some dropout in the hoppers will occur. Periodically check hoppers for pre-coat fallout. Re-inject and increase flow as required.

- It is essential to pre-coat all new fabric prior to initial introduction of flue gas and ash to ensure maximum bag life and minimum pressure loss. Pre-coating should be done as close to start-up as possible.

- Subsequent start-ups do not require fabric pre-coating if sufficient residual ash is retained on the fabric surfaces at shutdown.

- No flue gas is present during this procedure.

•Fabric Pre-Coat

- Turn on hopper heaters at least twenty-four (24) hours prior to pre-coating.
- Ensure all compartment inlet and outlet dampers are open. Turn off pulse jet air to the pulse manifolds.
- Start the I.D. Fan in accordance with the manufacturer's recommendations. Once the bags are pre-coated, it is beneficial to keep the I.D. fan in operation until the boiler is on-line. If the fan shuts off, some pre-coating material will fall off the bags
- Close inlet and outlet damper on about half the compartments.
- Pre-coat all compartments using as much air as can be obtained at low temperatures. I.D. fans are usually sized for hot gas and the only thing that can be done is load them up as high as possible for the pre-coating operation. Close more compartments to get as much air volume as possible, if necessary. Higher air velocity is more efficient at pulling the pre-coat material into the compartments.
- Coat the inlet side compartments first and then open up the outlet side compartments after about half of the material has been injected.

•Fabric Pre-Coat

- Inject the material into the Fabric Filter inlet duct from a self-unloading bulk truck equipped with a blower. The injection port should be at least mid-way up the duct if not on top. The optimum point is the injection port on top of the SDA outlet/PJFF inlet duct.
- To avoid fallout on inlet duct floor, feed material at a slow rate. A feed rate of one ton in 15 minutes is acceptable.
- Do not try to use the compartment ΔP gauges to determine coating as there is usually only a slight increase caused by the pre-coating. Dusting at the stack may be seen during this operation.
- Minimize the amount of time that oil is being fired (if used) and the fabric filter is on-line.
- After start-up allow a good ash coating, around 8 inches on the compartment differential pressure gauges, to build up before going through the first cleaning cycle.
- Turn on the pulse jet air to the pulse manifolds and set the pressure at minimum required to energize pulse valves (10-20 psig)
- Try to make sure the boiler is burning correct intended fuel when cleaning is initiated. Pulsing too soon will blow the pre-coating off the bags.

- **Start Up Procedure**

- Activate the pulsejet cleaning system by the fabric filter ΔP sensor. Fabric filter should not require cleaning for several hours.
- Once the designed fuel is being fired, request the fabric filter to be placed in the **ONLINE** mode.
- After placing the fabric filter in **ONLINE** cleaning mode, the pulsejet cleaning system will be activated by high differential pressure across the fabric filter. Fabric filter should not require cleaning for several hours.
- After the fabric filter has been on-stream for approximately twenty-four (24) hours, sequentially isolate each compartment one at a time and inspect for condensate deposits or leaking filter bags.

•Re-Start After Boiler Outage

- If necessary, pre-coat the bags
- Turn off the compressed air to the pulse manifolds.
- Ramp the boiler up to full load and leave it there for at least a day.
- When the FF ΔP reaches 8 inches, clean one compartment at a time by isolating it for 5 minutes and putting it back on-line. Do not use pulse air yet.
- After some number of days pulse air will be required for bag cleaning. Use the minimum amount necessary to control pressure drop.
- This procedure should provide the most protection against dewpoint and fine ash blinding of the fabric.

Presentation

FF Start Up Practise

FF Shut Down Practise

FF Operation

FF Trouble Shooting

FF Bad bag detection and bag monitoring system

•**CAUTION:**

PURGING IS IMPORTANT TO BAG LIFE AND FAILURE TO PROPERLY PURGE THE SYSTEM WILL VOID THE BAG LIFE AND POTENTIALLY THE PRESSURE DROP.

•**Shut Down**

- Purge by pulling air through the fabric filter for one (1) hour.
- Initiate manual cleaning cycle of fabric filter.
 - During the shutdown allow the cleaning cycle to remain on until each compartment has been cleaned, then turn off cleaning cycle.
 - The hoppers should be completely emptied of all particulate while the surfaces are still warm, to minimize any crusted buildup. (Hoppers should not be used for storage).
 - As time allows, other routine maintenance procedures should be carried out as convenient. These would include bag inspection and maintenance of all dampers, fans, hopper auxiliary equipment, etc.
 - The only time the fabric filter should be shutdown is when the boiler is shutdown.
- When the fabric filter has to be shutdown it is extremely important that the proper procedures are followed. Failure to do so could result in damage to the bags, which may require that they be replaced.
- Operate the I.D./F.D. fans through the fabric filter for one additional hour.
- Shut down the I.D. Fan.
- Ash removal equipment may be stopped after all hoppers are completely empty.
- Hopper heaters should remain on to protect the bags.

- **Emergency Shutdown**

- Emergency shutdown creates potentially adverse conditions for the AQCS System gas envelope and bags. Condensation of corrosive elements can occur which can cause metal corrosion and permanently damage the bag fabric. The system must be purged of corrosive gases to prevent these conditions from occurring. Bag life and pressure drop guarantees and material warranties can be affected and potentially be voided.

- All lines should be flushed and drained immediately to prevent pluggage.

Presentation

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- The AQCS System is designed to operate continuously and automatically without operator intervention. The operator should still remain alert for possible problems. The control system will normally alarm many serious malfunctions when they occur but keeping control of the most important parameters will keep the FF in optimized performance.
- The DCS control Screens should be monitored at all times for system conditions and alarms.

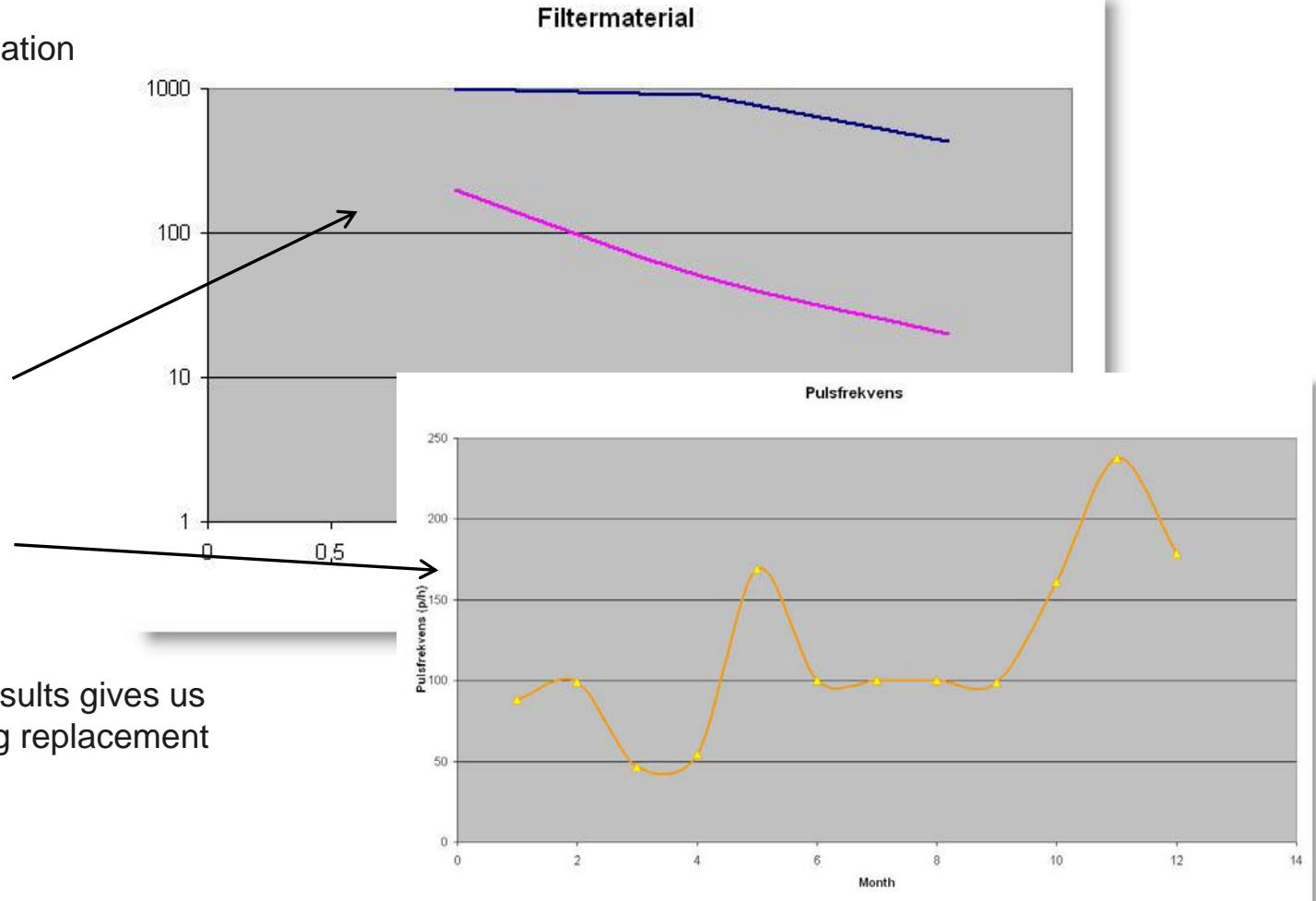
NID signaler					
Rökgas		Mixer			
SO2 in	1,50	mg/Nm3	Kalk	80,00	Hz
HCl in	1250,37	mg/Nm3	Vatten	262,72	l/h
H2O in	22,09	%	Kol	11,74	Hz
Temp in	160,07	C	Recirkulation	41,50	Hz
SO2 ut	1,50	mg/Nm3	Difstryck Reaktor	0,79	Pa
HCl ut	0,00	mg/Nm3	Mixerström	100,00	A
H2O ut	13,64	%	Silo		
Temp ut	142,96	C	Kalknivå	84,76	%
O2 ut	5,63	%	Kolnivå	65,04	%
Opacitet 11%	0,70	mg/Nm3			
Gas flöde	37,09	kNm3/h			
Gas flöde2	0,00	kNm3/h			
Varvtal fläkt	0,00	Hz			
Difstryck Slangfilter	1,37	kPa			
Tryckluft					
Transportluft	0,00	Pa			
Fluidluft	7,15	MPa			
Transporttemp	0,00	C			
Fluidtemp	81,09	C			

Bag condition is best monitored by a combination of lab tests and online measurements and calculations.

Lab test results.

Calculated performance data.

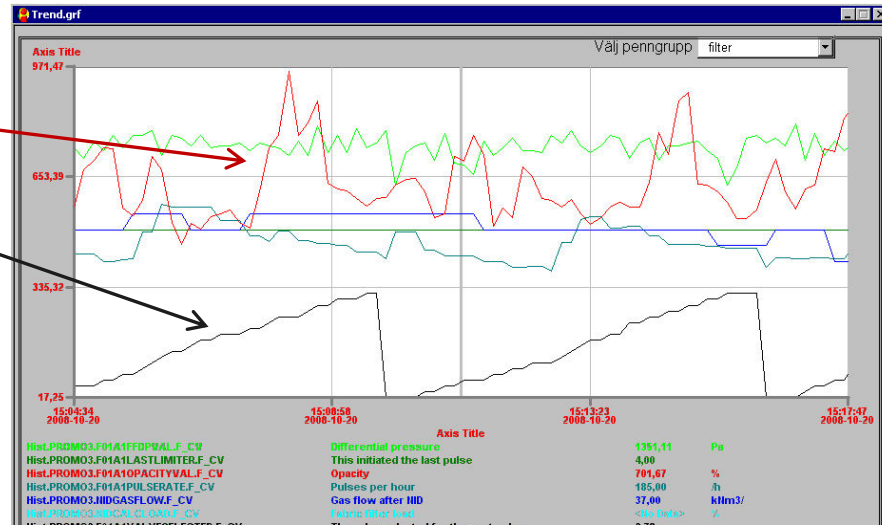
Combining these results gives us the tools to plan bag replacement or cleaning.



FF Operation

High emission detected

Evaluate trend, check relation seqnr vs opacity



Block valve causing high emission

Stega till ventil 19

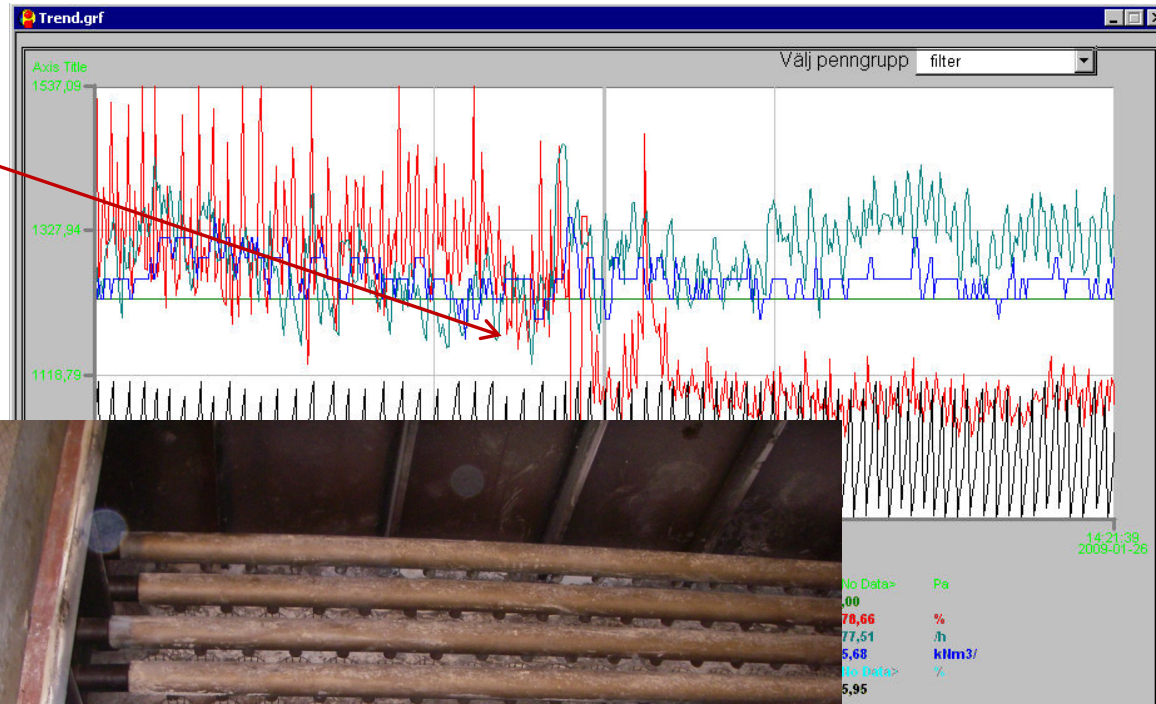
Nästa ventil 19 Puts

EFFIC F01A1 Antal ventiler 20 = Aktiv = Blockerad

Ventilnr	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Utgång	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Elfel																				
Pulsfel																				
Slangfel																				

Fysisk position	Utgång
Tank1Ventil1	-> 0
Tank2Ventil1	-> 1
Tank1Ventil3	-> 2
Tank2Ventil3	-> 3
Tank1Ventil5	-> 4
Tank2Ventil5	-> 5
Tank1Ventil7	-> 6
Tank2Ventil7	-> 7
...	->
Tank1Ventil2	-> 10
Tank2Ventil2	-> 11
Tank1Ventil4	-> 12
Tank2Ventil4	-> 13

Confirm reduced emission



Wait until next planned outage before locating and plugging leaking bag.



Presentation

FF Start Up Practise

FF Shut down Practise

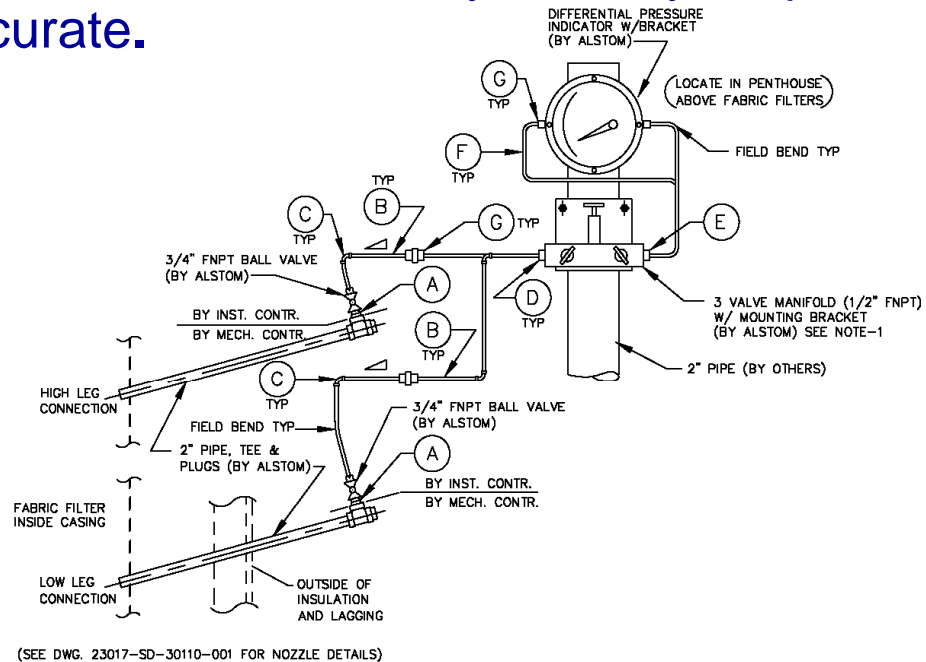
FF Operation

FF Troubleshooting

FF Bad bag detection and bag monitoring system

• Excessive Fabric Filter Differential Pressure Drop

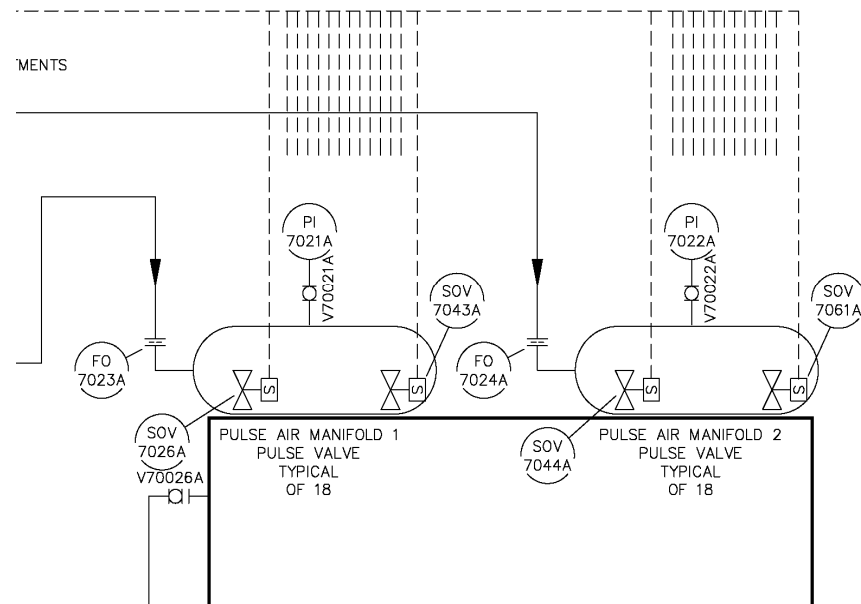
- Insure compartment inlet and outlet dampers are **FULLY OPEN**.
- Thoroughly clean out differential pressure gauge lines by disconnecting both ends of the line and blowing compressed air through them. Examine; clean if necessary, all dirty air pick-up points. Verify readings are accurate.



REMOTE MOUNT DIFFERENTIAL PRESSURE INDICATING TRANSMITTER
LOW PRESSURE GAS SERVICE
FABRIC FILTER COMPARTMENTS

- **Excessive Fabric Filter Differential Pressure Drop**

- Insure Inspect controls to make certain they function properly and that timer values are on accurate settings.
- Observe that air pressure in manifolds is maintained throughout the entire cleaning cycle. Examine manifolds for possibility of air leaks through the pulse valves. If this is occurring, the air pressure in the manifolds is probably low and the valves are prevented from seating.



- **Excessive Fabric Filter Differential Pressure Drop**

- Inspect compressed air lines for moisture. Check upper part of filter bags for dampness or caking of material.

- Check water dew-point of ash-laden Flue Gas. This can be done by inserting a portable thermocouple, covered with a wet sock, into the flue gas stream. If fabric filter is at or below water dew-point, it is necessary to increase inlet temperature to fabric filter by adjusting system-operating conditions. (Care must be taken to have air remain at least 25°F above the dew-point).

- If the differential pressure of the fabric filter is too high, increase **ON TIME** and/or decrease **OFF TIME** on pulse timer to change cycle. Caution should be taken when adjusting the **ON TIME**. If the **ON TIME** is increased too far, then the amount of air consumed in the collector can be greater than the amount the compressor and air lines can supply. If the above methods of altering the pulse cycle fail in reducing the differential pressure, it may be necessary to increase the cleaning pressure at the fabric filter by adjusting the pressure setting at the air supply point.

- **Excessive Fabric Filter Differential Pressure Drop**

- If the readings do not drop but remain high, then there is a good indication that the filter bags are either:

- Blinded with too much ash
 - Caked with moisture-laden ash

- If the differential pressure drops appreciably (below six (6) inches for example), then bring ash load back into the system. The differential pressure should climb but maintain an equilibrium of three (3) to six (6) inches.

- **Note:**

- IF THE DIFFERENTIAL PRESSURE RISES ABOVE THE ACCEPTABLE LEVEL FOR DESIGN CONDITIONS, EVEN THOUGH IT DROPPED INITIALLY, THE FILTER BAGS ARE PROBABLY BLINDED. NON-STANDARD CLEANING CYCLES MAY CORRECT THE PROBLEM.**

- Check main air flow volume with pitot tube or equivalent measuring equipment and compare with original air volume for which the unit was designed. Fabric filter could be overloaded with too high of an airflow.

- **Excessive Fabric Filter Differential Pressure Drop**

- Check particle size and ash loading in air stream and compare to design specification. Particle sizes below ten (10) microns have greatest effect on pressure drop.
- Check hopper for overloading.
 - Observe ash discharge equipment for proper operation and capacity; correct if necessary. Leaky flange connections can cause inward air leakage, prevent ash discharge, and permit excessive accumulation in the collector. Do not use the hopper for storage of material.
 - Check for material bridging across hopper or sticking to hopper.

- **Extremely Low Pressure Drop**

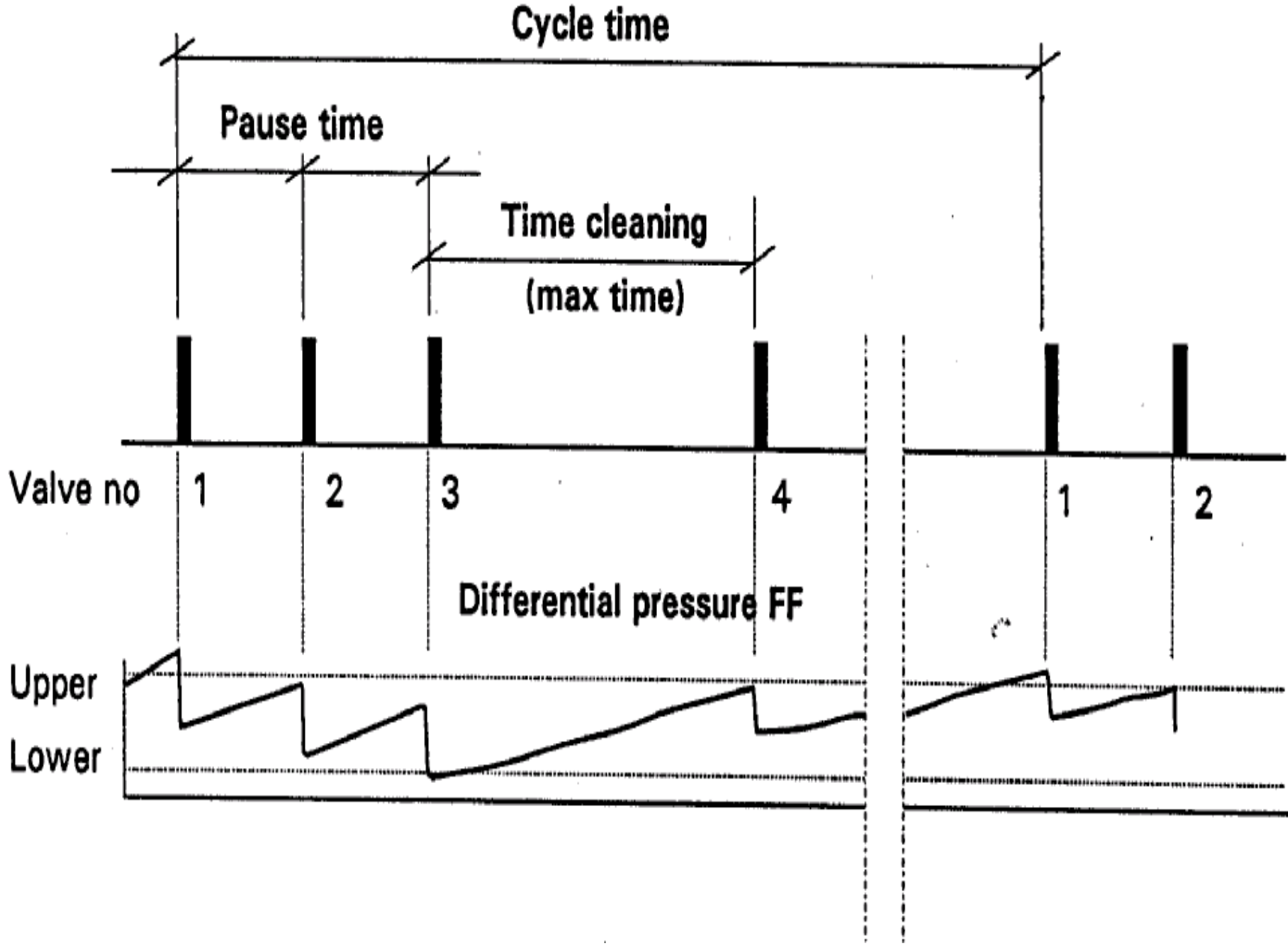
- Clean out differential pressure gauge line by disconnecting both ends of the line and blowing air through them. If a dial gauge manometer is used, re-adjust it to zero point. Examine, clean if necessary, all dirty air pick-up points.

- Check for filter bags with holes in them or worn filter bags; replace if necessary.

- Check to make sure filter bags are installed properly.

- Adjust **ON TIME** and **OFF TIME** on pulse timer to change cleaning cycle. If the differential pressure at the fabric filter is too low, then increase the **OFF TIME** and/or decrease the **ON TIME** on the pulse timer to adjust the cleaning cycle. If the above methods of altering the timer fail in increasing the differential pressure, it may be necessary to decrease the cleaning pressure at the fabric filter by adjusting the pressure setting, at the source, for cleaning air pressure.

FF Trouble Shooting Pulse Time Defenition



- **Primary and Secondary Dusting (Dirty Exhaust Air)**

- Primary dusting occurs on startup and is due to small ash particles passing through the clean filter fabric. Under normal conditions after a few hours of operation, the dusting will stop as the filter fabric is conditioned.

- Secondary dusting can occur from either of two (2) sources. One source could be leaks in filter bags and/or the grid sheet. A close inspection of the filter bags and grid sheet may reveal holes where particulate laden air may pass, especially when the compressed air from the pulse valves creates a high turbulence in the fabric filter. If holes are found, repair at once to stop the leaks.

- The second source for secondary dusting can occur when the filter bags have insufficient ashcake. A filter bag depends on ashcake as well as the fabric to produce a highly efficient operation.

- A plume of ash leaving the stack is an indication that insufficient ashcake exists. This plume may be a result of cleaning the filter bags too efficiently. To control secondary dusting, adjust **ON** and **OFF** time settings. Either of these adjustments (or both coordinated together) can prevent “over cleaning” of the filter bags. Over cleaning lowers the ability of the filter bags to resist the passage of ash

- **Primary and Secondary Dusting (Dirty Exhaust Air)**

- Allow a unit to run at least forty-eight (48) to ninety-six (96) hours after initial installation of filter bags before performing tests. This running time allows filter bags to reach their operating efficiency and dusting may stop.

- Check filter bags for holes and wearing; replace if necessary.

- Check for moisture and acid dewpoint in the unit. High moisture can cause filter materials to harden and shorten filter bag life.

- Check for corrosion on cages. Rough surfaces will cause excess filter bag wear.

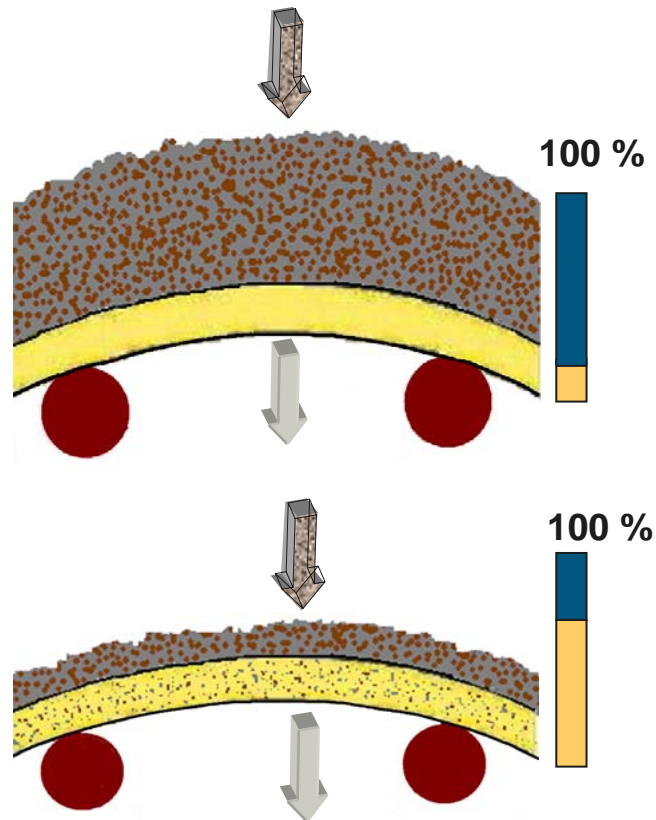
- Check flex of filter bags. Filter bags that are too loose cause excessive wear.

- Check for excessive pulsing or over-cleaning which can cause excessive wear.

- **Note:**
SINCE A PROPERLY APPLIED FABRIC FILTER OPERATES AT EFFICIENCIES OVER 99%, THE EXHAUST SHOULD ALWAYS BE “CLEAN” TO THE EYE, EXCLUSIVE OF WATER VAPOR OR OTHER CONDENSATES. VISIBLE SEEPAGE OR A “PLUME” OF ASH IN THE EXHAUST MEANS THAT A PORTION OF THE MEDIA OR A MECHANICAL JOINT IS LEAKING

- **Primary and Secondary Dusting (Dirty Exhaust Air)**

- Check for excessive pulsing and high emission can indicate worn bags with high resistance (clogged).



•Poppet Dampers – Outlet

- Poppet dampers normally make a positive seal. However, ash buildup due to leaking filter bags, or warping caused by excessive temperatures, may result in leaks.
- Clean area around poppet seat.
- Loosen actuator and gland slightly to permit free movement.
- Cycle poppet damper several times to gain optimum alignment.
- Shim actuator as necessary and tighten; re-tighten gland.
- Re-check poppet damper closing. If damper still does not seat, actuate poppet to the open position and, using locking nuts, move damper blade down on shaft slightly. Poppet plate should show a slight concave deflection all around damper seat when in closed position.
- If damper will not seat or operate properly, check the shafts for corrosion or a buildup in the packing gland area. Remove old packing material and clean the shaft using emery cloth. Loosen the packing gland and ensure that it will move freely up and down the shaft. Coat the shaft with a dry lubricant (Teflon spray or mold release), re-mount the packing gland and install new packing.
- The poppets remain in position for extended periods of time during normal operation. These dampers should be inspected; shafts cleaned and stroked several times during any outage.

•Note:

DO NOT COAT THE FABRIC FILTER OUTLET DAMPER SHAFT WITH OIL BASED LUBRICANT.

•Poor Bag Life

- Check operating temperature to see that it is within limits of filter bag material. High temperature operation over long periods of time will shorten filter bag life.
- Check gas-to-cloth ratio vs. original specifications. Excessively high ratio will shorten filter bag life.
- Check for moisture and dew-point in unit. Flue gas condensation may damage the fabric and shorten filter bag life.
- Check installation of filter bags. Filter bags that are too loose cause excessive wear.

Presentation

FF Start Up Practise

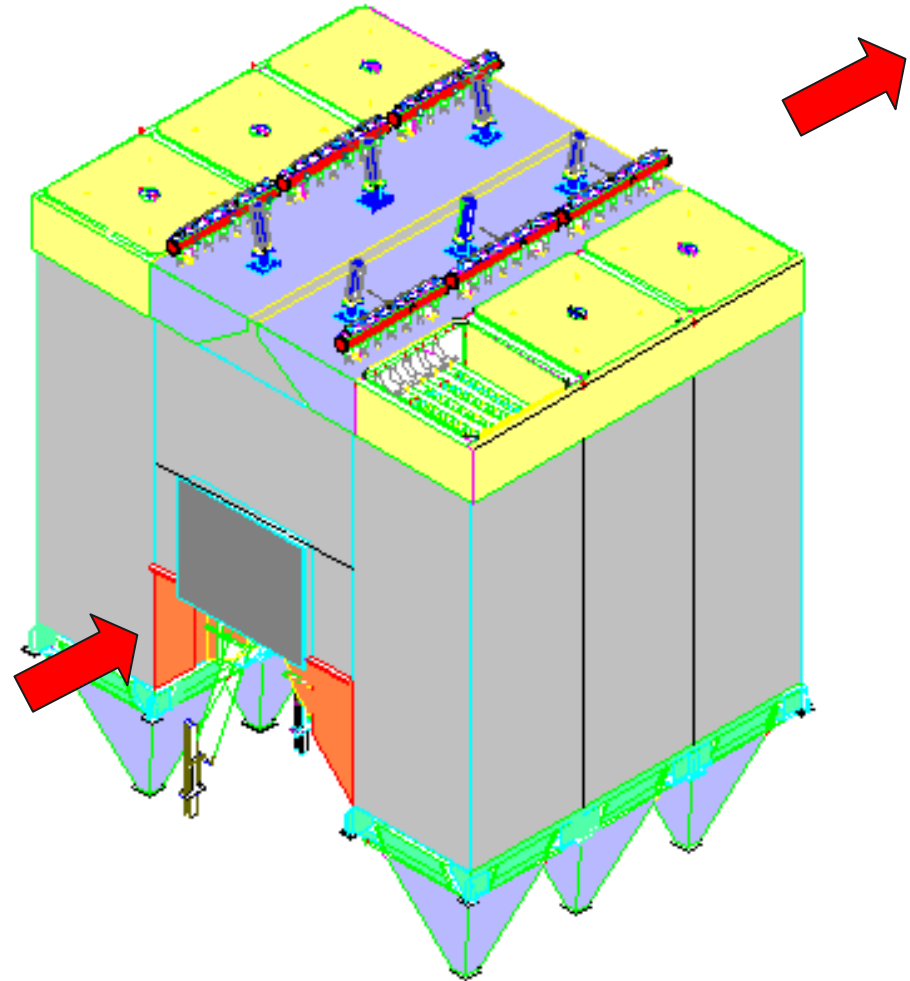
FF Shut down Practise

FF Operation

FF Trouble Shooting

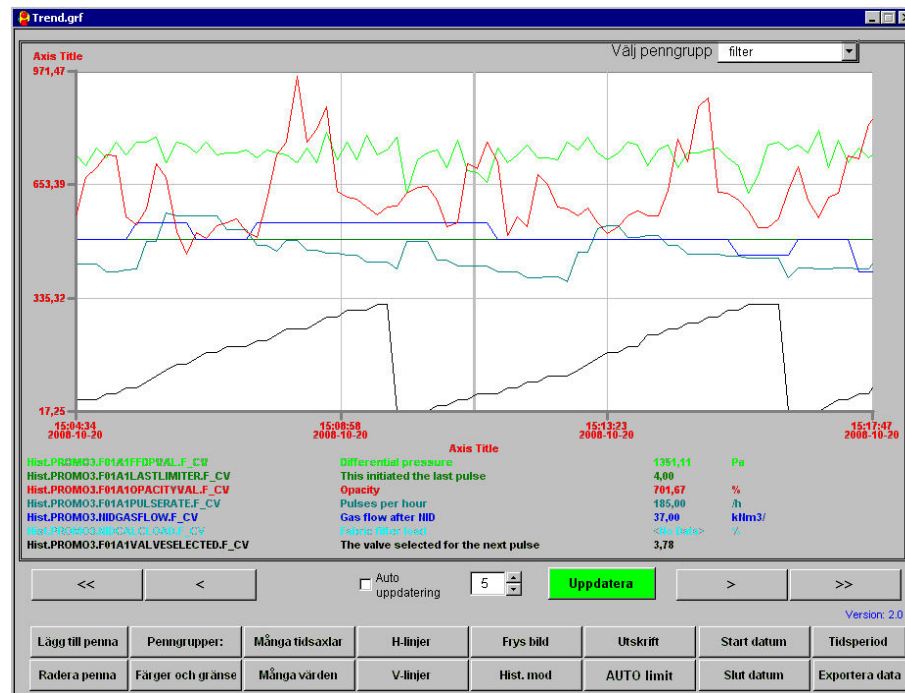
FF Bad Bag Detection and Bag Status Monitoring

- **How can a broken bag be detected?**
 1. The common way is to shutdown compartments and then wait to evaluate if the emission goes down.
 2. There are monitoring system that will with the right evaluation inform where the broken bag is.
 3. There is also intelligent systems that can give information about the status of bags and necessary actions can be taken before any high emissions occurs.



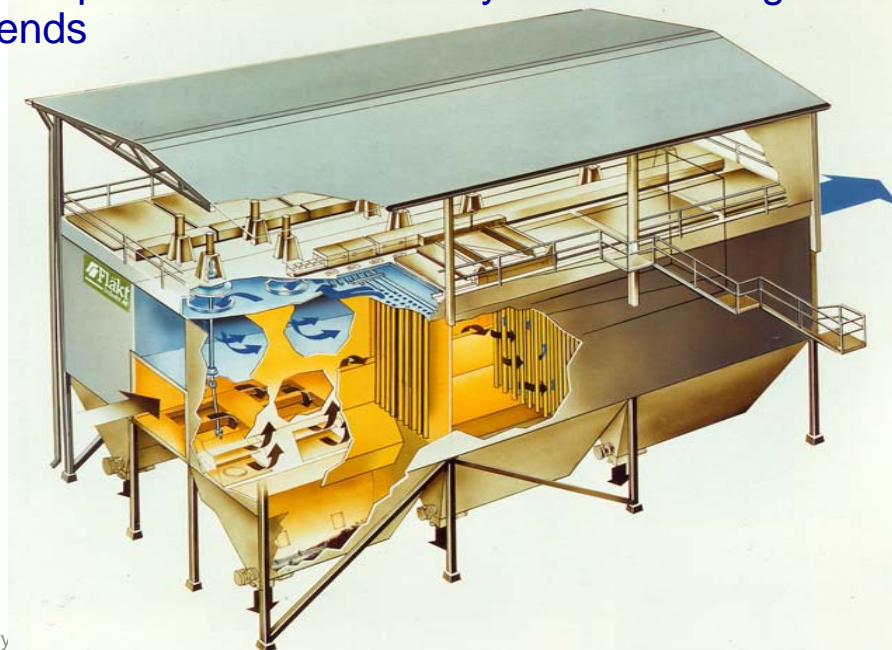
• Detecting broken bag manually.

- High emissions is detected from the DCS system and the only way without monitoring system is to take out single compartments and wait to see if the emissions drops.
- When the compartment is detected the compartment has to be open and examined for the broken bag.
- This is time consuming and costly procedure.



- **Detecting broken bag with emission monitoring system.**

- High emissions is detected from the DCS system and then the emission monitoring system is evaluated for detecting the compartment with the broken bag.
- To have a complete system minimum 1 emission sensor is needed after each compartment.
- The emission peaks that gives the higher emissions has to be compared with valve pulses.
- This gives a faster and controlled system but increased emissions are not entirely eliminated.
- System can be build up inside the DCS system to will give automated alarm of increased emission trends



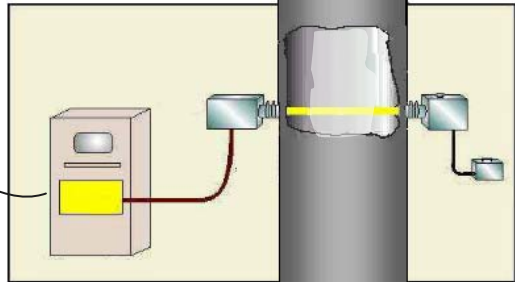
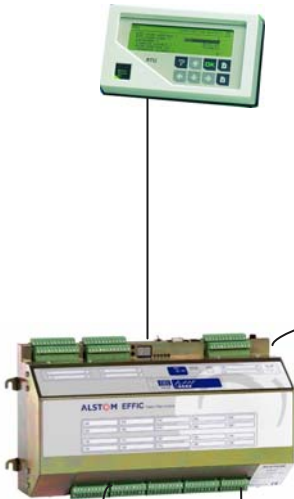
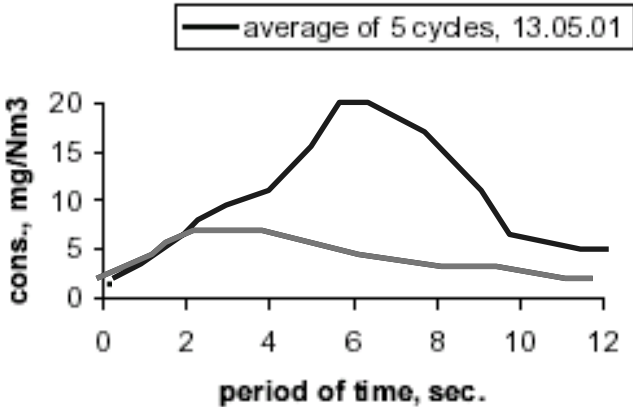
- **Detecting broken bag with Bag Status Monitoring system.**

- Emissions peaks are detected before they are seen in the normal emission measurement system.
- 1 emission sensor is needed in outlet from the Fabric Filter.
- The status monitoring system compares with valve pulses and gives indication to where the worn bag is located.
- This gives total controlled FF and all forced outages is eliminated and a planned maintenance with out impact on production or labour work.
- Information from the monitoring system can be sent to the DCS system in a easy way.

- **How do the intelligent monitoring system work?**
 - When a pulse is sent through a bag a peak can be seen if a fast sensor is used.
 - These pulses are evaluated and any increased peaks are detected-
 - The peaks are different depending on the age of the bags so the differences in the peaks are constantly evaluated.

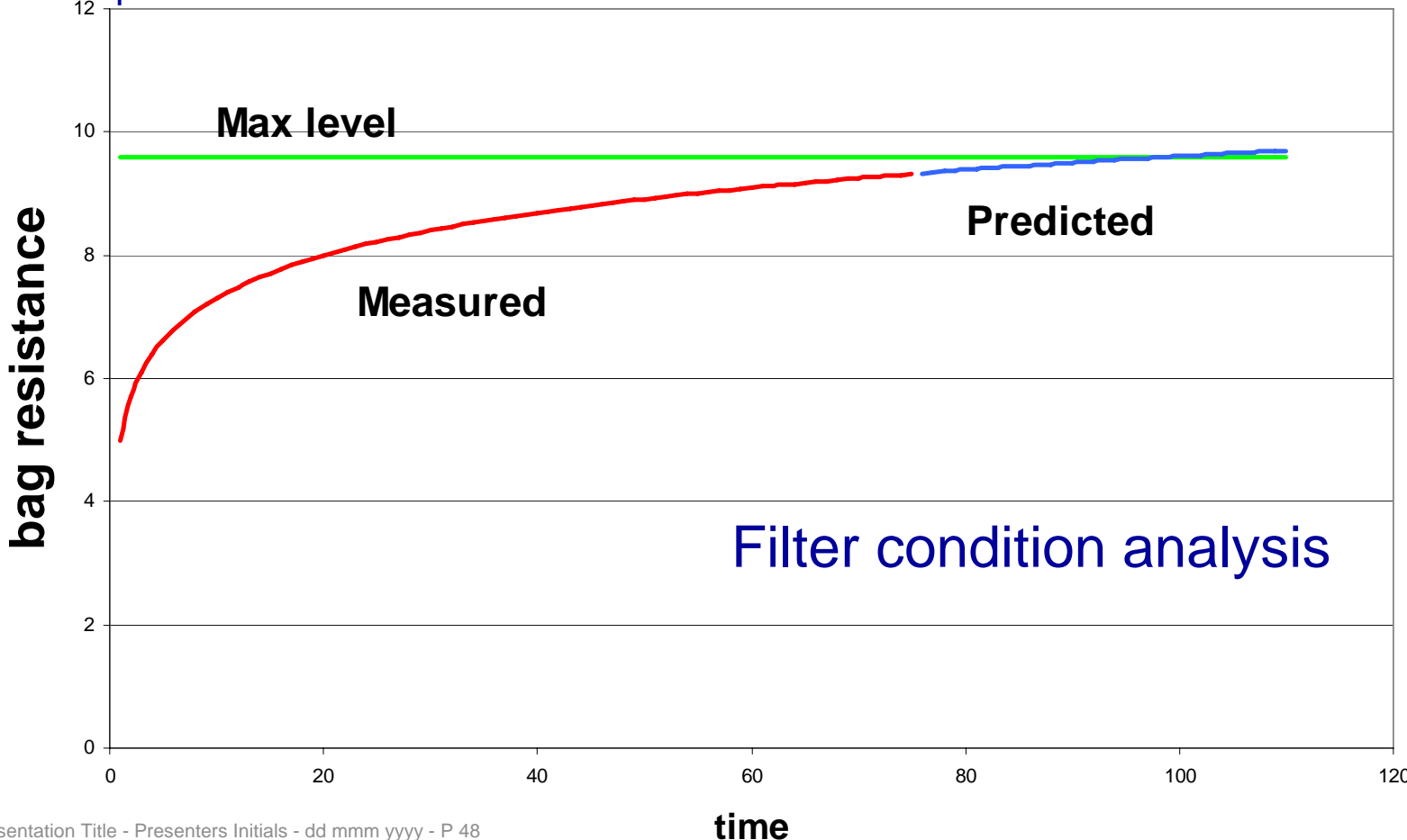


FF Bad Bag Detection and Bag Status Monitoring

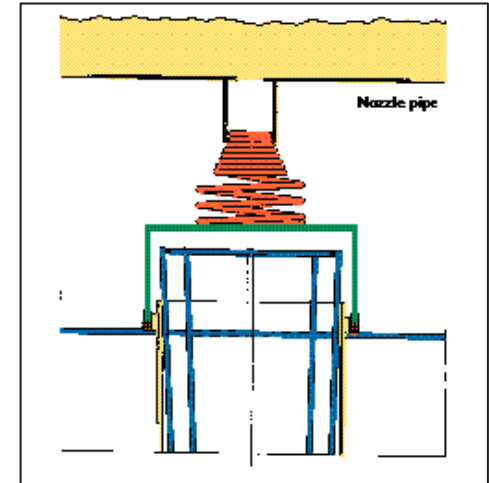


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- **The status of the bags can be monitored.**
 - The bags has a maximum resistance value.
 - To be able to set the status of the bags an prediction of the future lifetime is possible.



- **When a worn bag is detected it can easily be capped (if the nozzle pipe design allows it) to eliminate future emission problem and the rest of the bags can be in operation.**
- Shut-off of a single bag done easy and fast
 - single bags can be capped using an optional bag cap
 - filter can be taken into operation immediately
 - replacement of damaged bags postponed to planned maintenance shut-down
 - up to 10% of the bags can be capped



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