Reinhold Environmental Ltd.

2007 NOx Round Table & Expo Presentation

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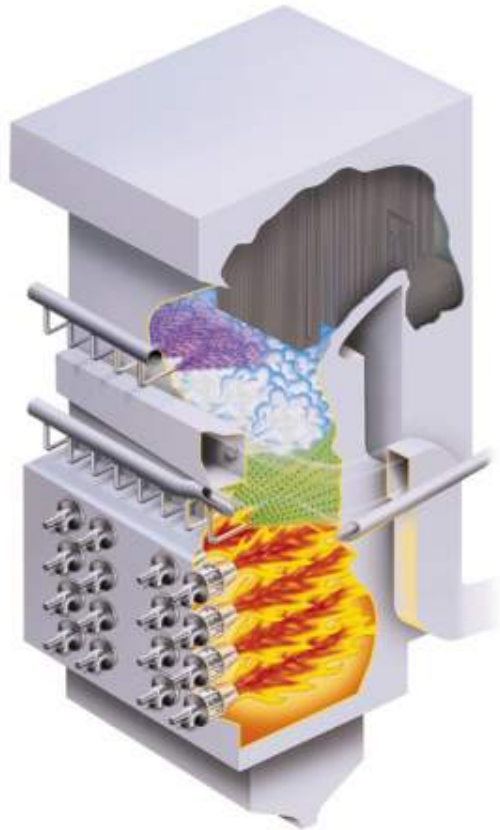
GE Environmental Services

Reinhold Seminar

Impact of SCR on Fabric Filter Operation



Bob Taylor
February 2007

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Impact of SCR on Fabric Filter Operation

Background:

- In the US, NOx regulations were not in place during construction of many coal fired utility boilers currently in operation.
- Initial retrofit NOx reduction efforts concentrated on low NOx burners and combustion modifications.
- Implementation of Selective Catalytic Reduction SCR became common as NOx emission limits were reduced.
- In the US, the majority of SCR installations are associated with electrostatic precipitator particulate collection equipment.
- Most new coal fired utility boiler installations and some retrofits utilize a combination of SCR and fabric filters.

Impact of SCR on Fabric Filter Operation

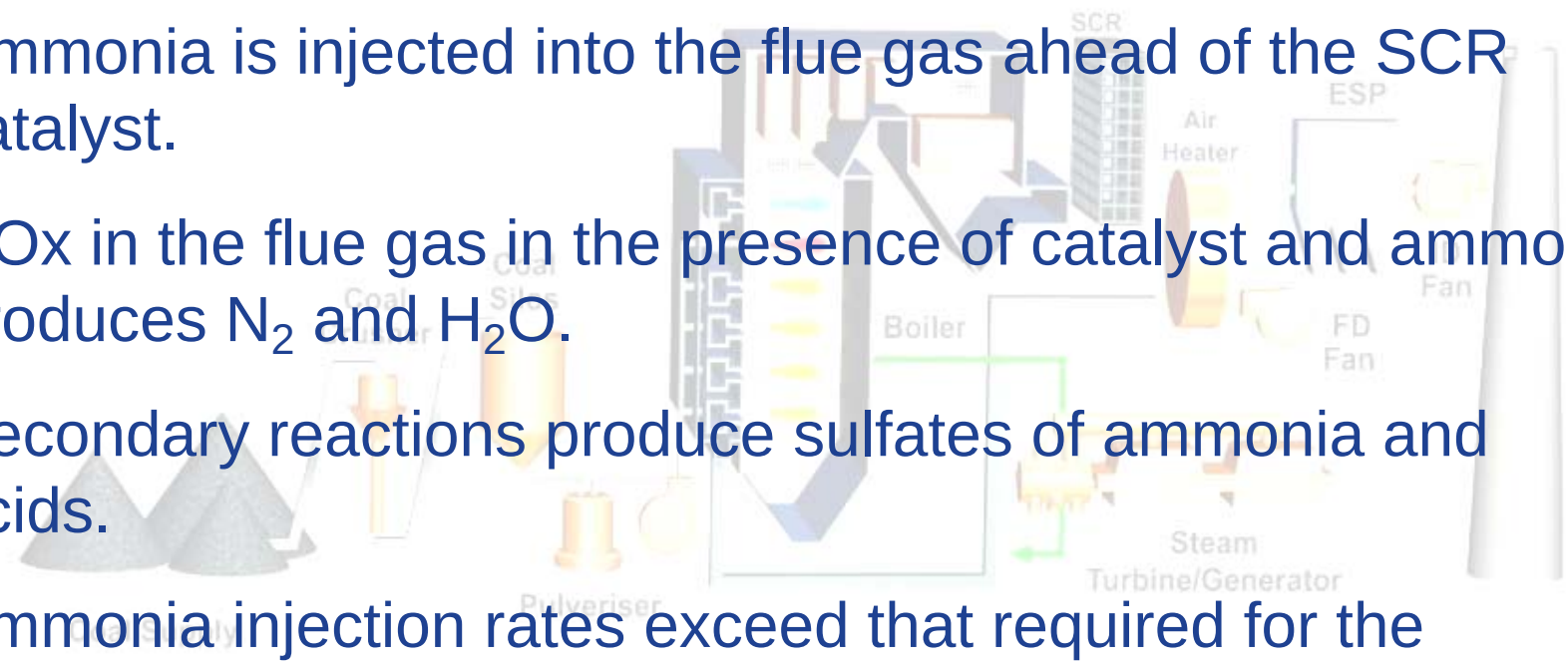
Background:

- Most of the initial SCR installations occurred on boilers using electrostatic precipitators for PM collection.
- In general, electrostatic precipitator performance was not adversely affected by installation of an SCR.
  - Ammonia slip had the impact of agglomerating particles.
  - More negative operating pressure increased air in-leakage
- In the US, more SCR's are coming on line operating in combination with fabric filters used for PM collection.
- The impact of SCR on fabric filter operation is not yet clear.

Impact of SCR on Fabric Filter Operation

How Does SCR Work:

- SCR is typically located between the economizer and air pre-heater where gas temperature is between 600°F and 800°F.
- Ammonia is injected into the flue gas ahead of the SCR catalyst.
- NOx in the flue gas in the presence of catalyst and ammonia produces N_2 and H_2O.
- Secondary reactions produce sulfates of ammonia and acids.
- Ammonia injection rates exceed that required for the reaction causing excess ammonia to pass through the SCR.
- This excess ammonia is characterized as ammonia slip.



SCR Reactions

Ammonia injected into the flue gas in combination with the catalyst reacts as follows:

In the presence of the catalyst:

$$4NO + 4NH_3 + O_2 \longrightarrow 4N_2 + 6H_2O$$

$$2NO_2 + 4NH_3 + O_2 \longrightarrow 3N_2 + 6H_2O$$

Sulfate and Bisulfate compounds:

$$SO_3 + 2NH_3 + H2O \longrightarrow (NH_4)SO_4$$

$$SO_3 + NH_3 + H2O \longrightarrow NH_4HSO_4$$

Sulfur Dioxide to Sulfur Trioxide Conversion:

$$2SO_2 + O_2 \longrightarrow 2SO_3$$

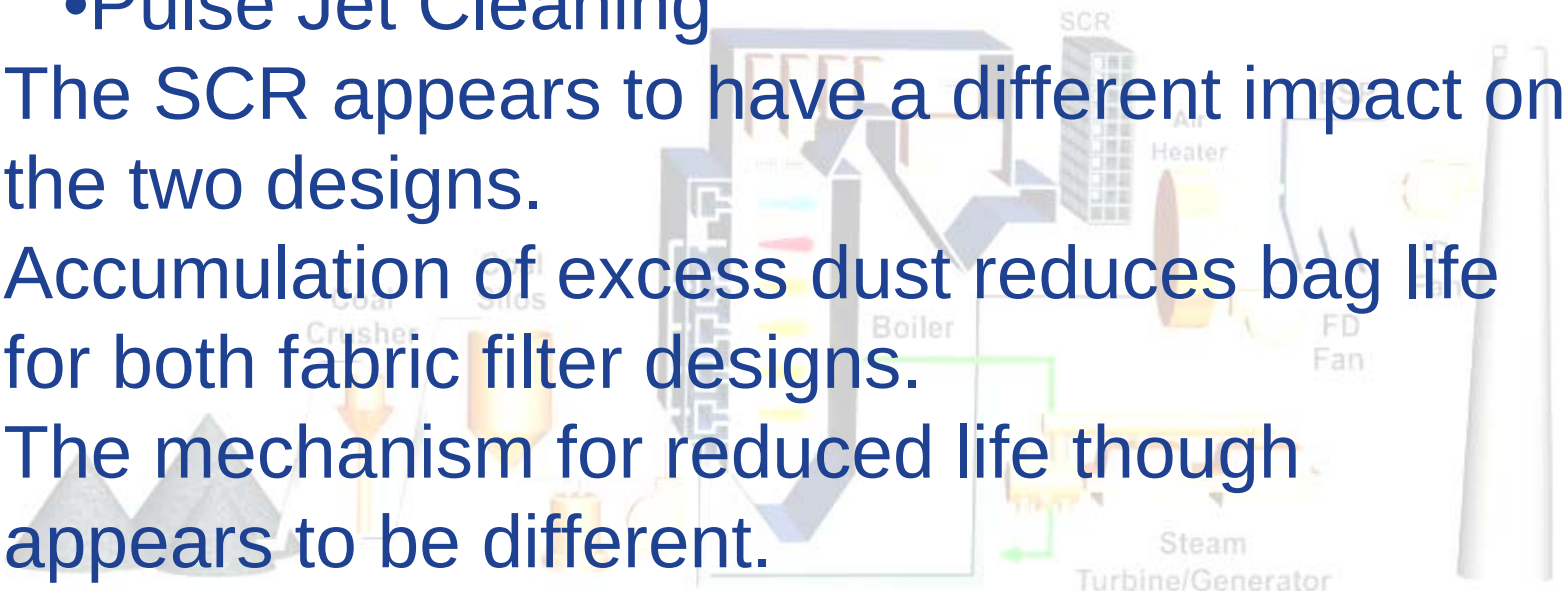
Impact of SCR on Fabric Filter Operation

How does an SCR impact fabric filters:

- The SCR based de-NOx process, produces ammonium sulfate and bisulfate as well as increased quantities of sulfur trioxide.
- Ammonium Bisulfate, a sticky yellow solid, dominates the reaction.
- Excess sulfur trioxide readily forms sulfuric acid which can condense at fabric filter temperatures as a brown sticky paste.
- Both compounds can condense at typical filter bag operating temperatures.
- The sticky accumulation causes dust to adhere to the filter media rather than release during cleaning cycle.

Impact of SCR on Fabric Filter Operation

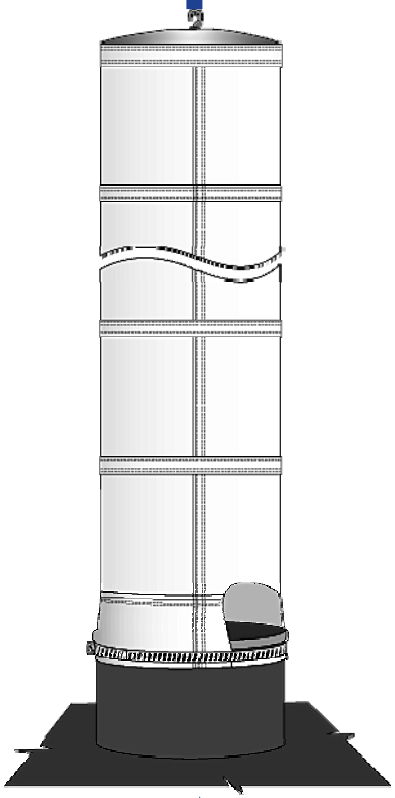
- There are two basic fabric filter designs used on utility boiler applications:
  - Reverse Gas Cleaning
  - Pulse Jet Cleaning
- The SCR appears to have a different impact on the two designs.
- Accumulation of excess dust reduces bag life for both fabric filter designs.
- The mechanism for reduced life though appears to be different.
- A discussion of the two mechanisms follows:

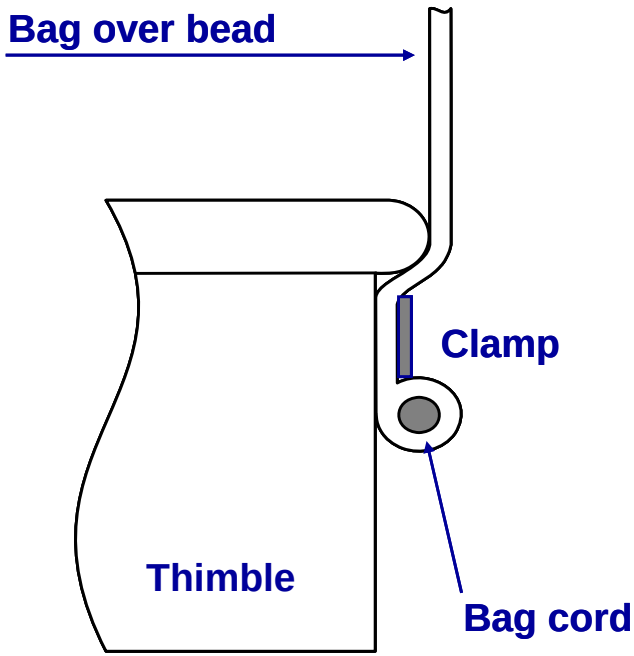


Impact of SCR on Fabric Filter Operation

Reverse Gas Cleaning Bag house:

Tensioning assembly

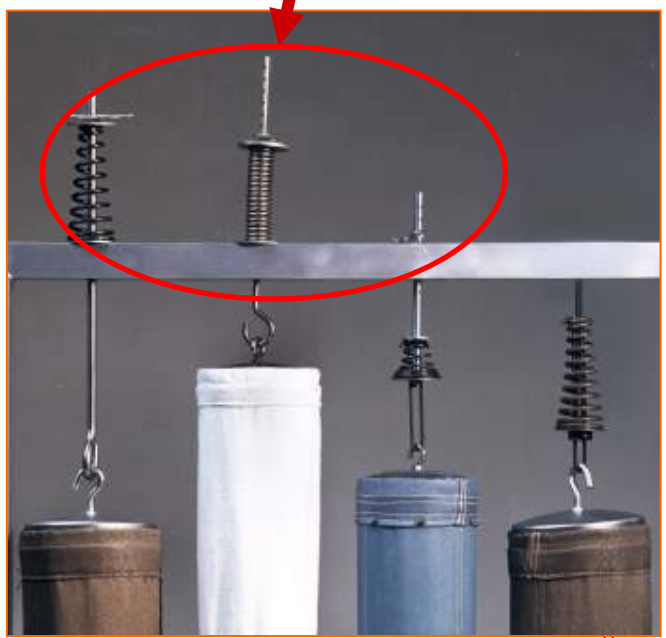




Dirty gas

In a reverse gas cleaning bag house, dirty gas enters below the tube sheet forcing dust to collect on the inside of the filter bag.

Tensioning Assemblies



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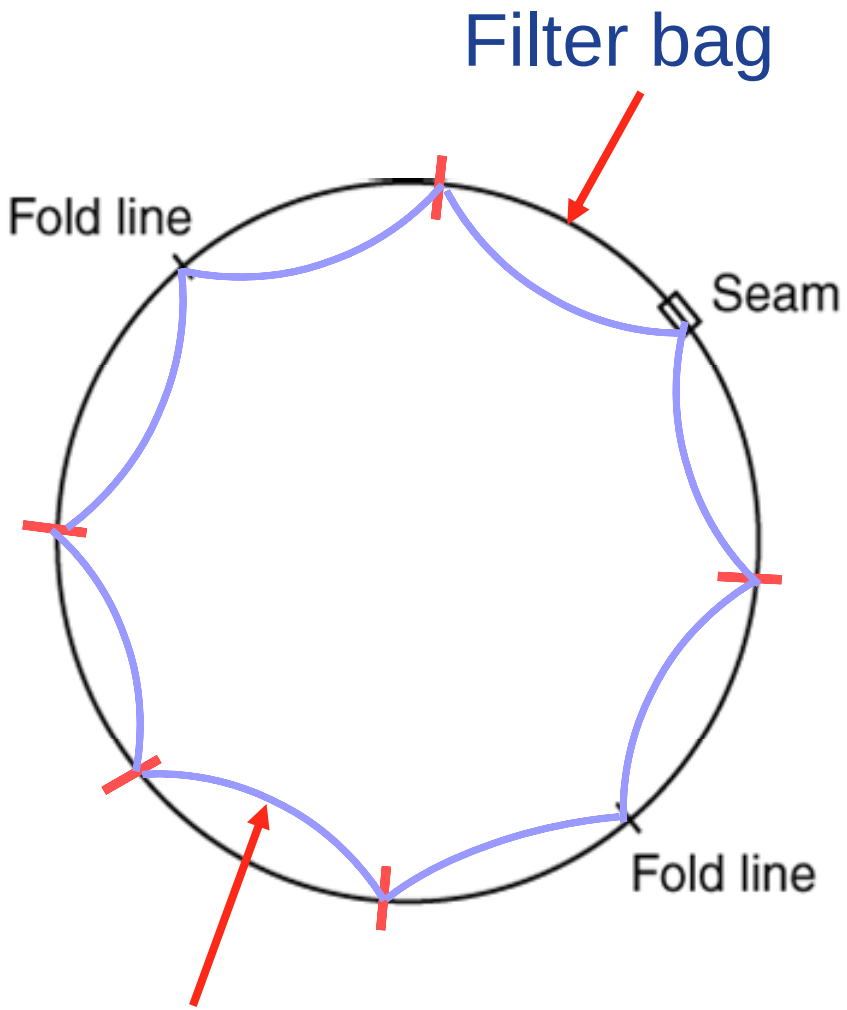
Impact of SCR on Fabric Filter Operation

- Increased weight of filter bags resulting from ammonium bisulfate and sulfur trioxide accumulation cause bags to be improperly tensioned.
- Reverse cleaning of improperly tensioned bags causes flexing at a consistent “fold” line.
- The result is premature fatigue failure of the fabric along the fold lines.
- Media fatigue, not excessive pressure drop is the primary cause for bag replacement.



Filter bag during cleaning

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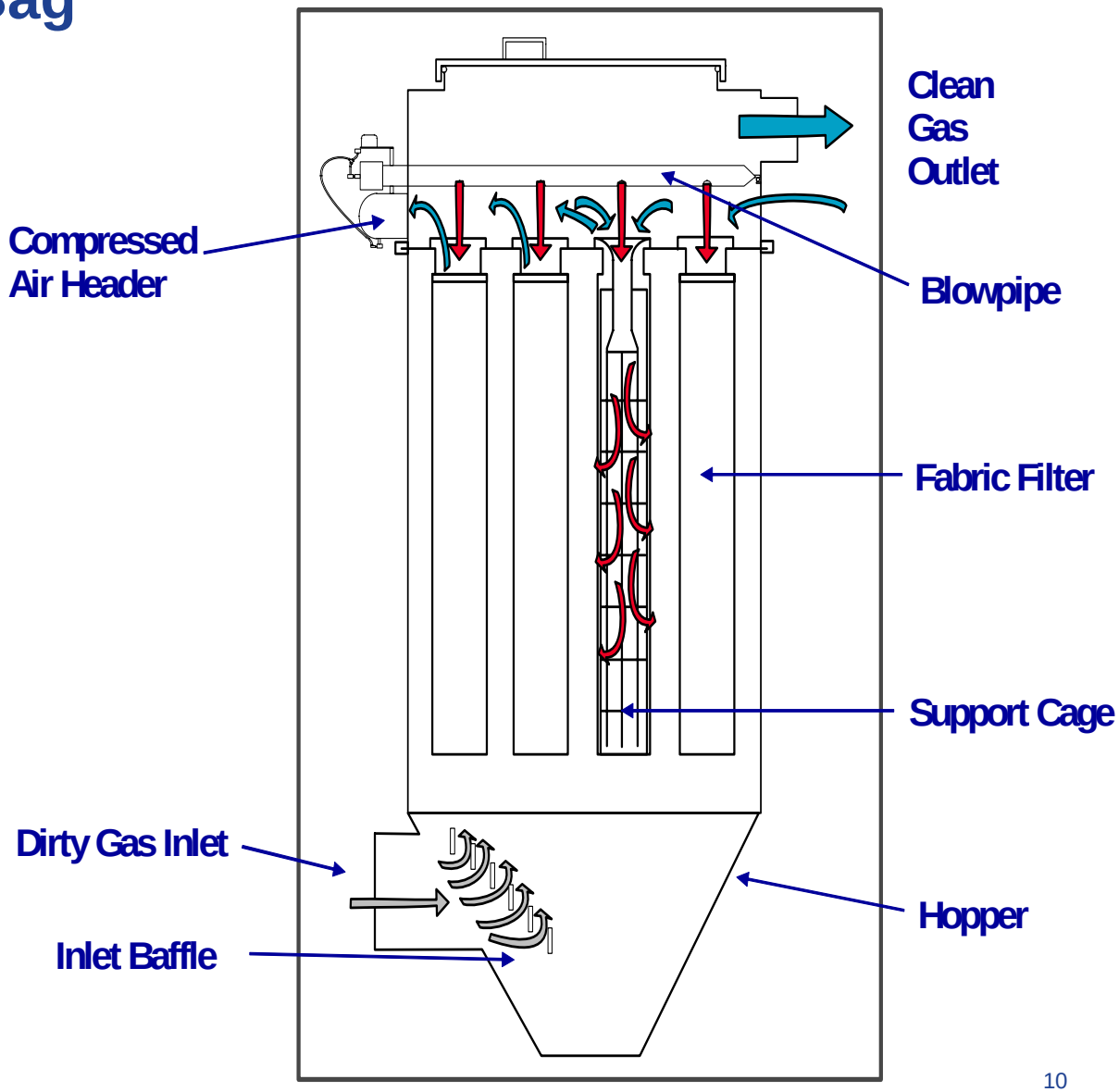
Impact of SCR on Fabric Filter Operation

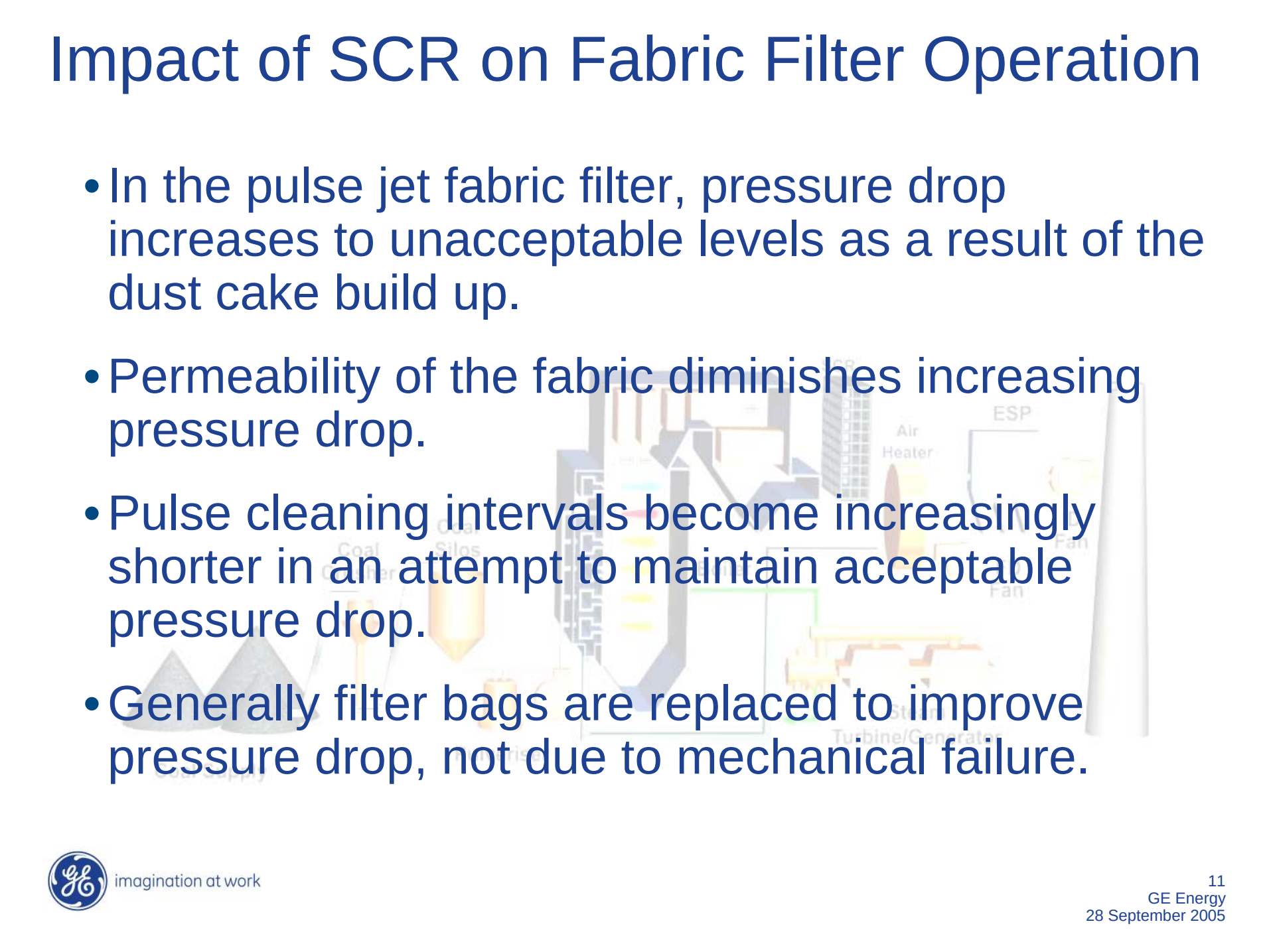
Pulse Jet Cleaning Bag houses:

- In a pulse jet bag house, dirty gas enters at the bottom of the collector forcing dust to collect on the outside of the filter bag.
- Pulses of compressed air are introduced at the filter bag throat to remove dust cake.
- When dust layer thickness and tenacity increases, more frequent cleaning is necessary to maintain acceptable pressure drop.



Impact of SCR on Fabric Filter Operation

- In the pulse jet fabric filter, pressure drop increases to unacceptable levels as a result of the dust cake build up.
- Permeability of the fabric diminishes increasing pressure drop.
- Pulse cleaning intervals become increasingly shorter in an attempt to maintain acceptable pressure drop.
- Generally filter bags are replaced to improve pressure drop, not due to mechanical failure.



Impact of SCR on Fabric Filter Operation

How do we address SCR and Fabric Filter operation?

As additional operating data is gathered, more definitive guidance can be offered. In the meantime:

- Minimize ammonia slip, less than 2 ppm desirable.
- Minimize sulfur content, quantity is critical in ammonium bisulfate production.
- Monitor coal alkali content, low coal alkali content exacerbates the impact of sulfur content.
- Monitor SO_2 to SO_3 conversion of catalyst, lower SO_3 reduces build up problems.
- Minimize air in-leakage in and ahead of fabric filter.
- Consider alternative filter media.

Impact of SCR on Fabric Filter Operation

- **Filter bags can be weighed to quantify the level of build up experienced operating downstream from an SCR.**
- **The data below was taken from a reverse gas fabric filter using glass bags.**
- **Similar results are observed in a pulse jet fabric filter**

Reverse gas fiberglass filter bag 12" diameter x 35' long	Filter Weight, lbs.
SCR turned on	55-100
SCR turned off	35- 45
Membrane filter bag (SCR on or off)	20 - 25
New filter bag	16 - 20

Data shows that the fabric filter with a membrane lamination maintains a lower weight compared to a non membrane filter bag.

This indicates that dust cake is released more readily with membrane.

Impact of SCR on Fabric Filter Operation

Summary:

- A fabric filter operating downstream from an SCR will experience thicker and more tenacious dust cake.
- As a result, the average weight of the filter bag increases.
- Depending on the type of bag house considered, this will have the affect of reducing bag life due to loss of permeability or mechanical failure.
- Data is gathered from a small base of installed units.
- Changes in fuel, catalyst, operating temperature, and filter media can provide improved operation.

Impact of SCR on Fabric Filter Operation

SNCR Impact on Fabric Filter Operation

- Paper has discussed the impact of SCR on fabric filter operation.
- NOx control using Selective Non Catalytic Reduction, SNCR, can have similar impact.
- Ammonia slip is generally higher in SNCR compared to SCR.
- SO3 levels are not increased by SNCR.
- As a result, the impact of SNCR appears to be related largely to ammonium bisulfate accumulation on filter bags.

Thank You