Sargent & Lundy LLC
Comparison of Dry FGD Technologies

Paul S. Farber

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Overview

- Introduction
- Spray Dryer/Fabric Filter Overview
- Circulating Dry Scrubber/Fabric Filter Overview
- Design Emission Limits
- SO_2 Capture Capability
- Fuel Flexibility
- Load Flexibility
- Utilities Consumption
- Waste Production
- Summary

Selecting Between Similar Dry Scrubber Technologies

- Both Systems Lime Based
- Spray Dryer Based With Fabric Filter
- Circulating Dry Scrubber – Fluidized Bed Based With Fabric Filter

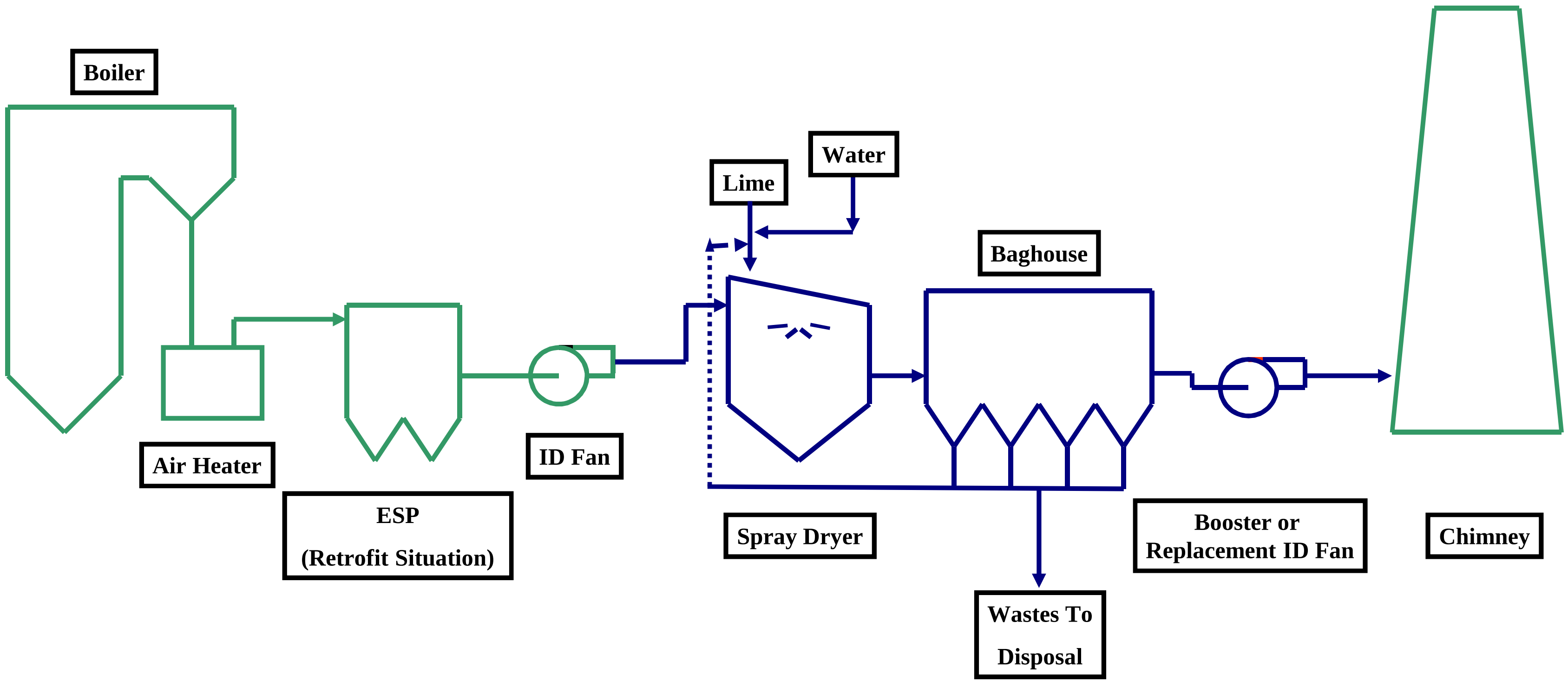
Spray Dryer/Fabric Filter Systems Have Been Operating On Coal Fired Power Plants Since The 1980's

Photo Courtesy of Babcock & Wilcox

Spray Dryer Overview

- Approximately 50 Spray Dryer/Fabric Filter systems in operation on coal-fired Utilities in the US
- Largest single module ~300 – 400 MW
- Reagent
  - Lime slurry
- Slurry atomized in spray dryer
- Fabric filter separates particulates
- Byproduct of reaction
  - Natural oxidation – predominantly calcium sulfite
- Temperature of “clean” flue gas
  - Approach to adiabatic saturation temperature

Spray Dryer Absorber (SDA) Retrofit



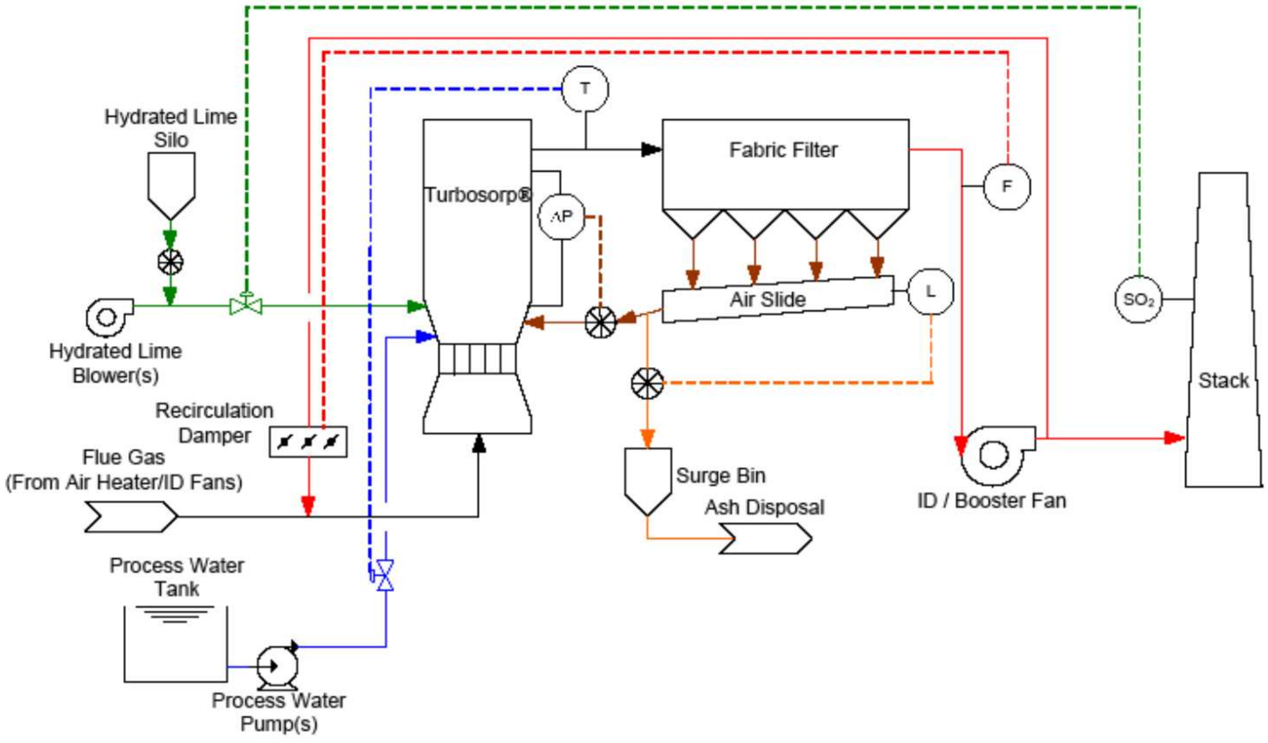
Circulating Dry Scrubbers Are Now Being Installed On Coal-Fired Power Plants

Photo Courtesy of Gainesville Regional Utilities

Circulating Dry Scrubber Overview

- Approximately 5 CDS/Fabric Filter systems in operation on coal-fired utilities in the US
- Largest single module (venturi) ~80 MW – may have several modules in a single vessel
- Reagent
  - Hydrated lime powder
- Hydrated lime and water injected separately into CDS
- Fabric filter separates particulates
- Byproduct of reaction
  - Natural oxidation – predominantly calcium sulfite
- Temperature of “clean” flue gas
  - Approach to gas saturation temperature

CDS Process Flow Diagram



Courtesy of Babcock Power

Major Items

- Reactor
- Process Water
- Lime Feed
- Fabric Filter
- Air Slide
- Booster Fan
- Flue Gas Dampers
- Ash System

Dry Scrubber Selection Criteria

- **Design Emission Limits**
- **SO_2 Capture Capability**
- **Fuel Flexibility**
- **Load Flexibility (i.e. Turndown)**
- **Utilities Consumption**
- **Waste Production**

Design Emission Limits

- Emission Limits for Criteria Air Pollutants
  - SO_2
  - VOC
  - PM
  - Hg
- Emissions Being Studied Under "Utility NESHAP" ICR
  - HCl, HF, HCN
  - Dioxins/Furans & Other Organics
  - Hg, Cr, Se, As, Co, Be, Cd, Pb, Mn, Ni
  - Radionuclides
- Both the SDA/FF and the CDS/FF should be able to reduce the emissions of present and future (possibly) regulated materials

SO_2 Capture Capability

- Spray Dryer/Fabric Filter
  - 0.05 lb/MMBtu
  - 95% Removal

- Circulating Dry Scrubber/Fabric Filter
  - 0.04 lb/MMBtu
  - 96% Removal

- The CDS/FF system has an advantage in SO_2 capture capability

Fuel Flexibility

- Both technologies limited by spray down ($T_{inlet} - T_{outlet}$) and by the approach to adiabatic saturation temperature

- Spray Dryer/Fabric Filter
  - Limited to ~2 – 3 lbs/MMBtu inlet SO_2 maximum
  - Limitations dependent upon removal required and inlet gas temperature

- Circulating Dry Scrubber/Fabric Filter
  - Limited to ~4 – 5 lbs/MMBtu inlet SO_2 maximum
  - Limitations dependent upon removal required and inlet gas temperature

- The CDS/FF system has an advantage in fuel flexibility

Load Flexibility

- Coal-fired utility boilers can operate at loads between 30% and 100% of MCR
- Spray Dryer/Fabric Filter systems can operate at turn-downs of ~3:1
  - Atomization of slurry into spray dryers is a function of load and inlet flue gas temperature
  - Longer residence times at low load improves drying
- Circulating Dry Scrubber/Fabric Filter systems can operate at turn-downs of ~2:1
  - The need to maintain a fluidized bed in the CDS sets the lower load/velocity in the reactor
  - Lower load operation is possible if a return flue gas duct is installed with dampers

- The Spray Dryer system has an advantage in load flexibility

Utilities Consumption

- Water consumption for both SDA/FF and CDS/FF systems are a function of the temperature approach and are approximately equal

- Due to the high internal recirculation rate in a CDS/FF system a noticeable amount of CO_2 is picked up by the lime
  - Lime consumption in CDS/FF systems will be higher than SDA/FF systems, especially at high removals
- Power consumption between SDA/FF and CDS/FF are approximately the same
  - SDA/FF power consumption is primarily the atomization power
  - CDS/FF power consumption is primarily due to the ID/booster fan power consumption

- The SDA/FF system has a slight advantage in utilities consumption

Waste Production

- Waste produced by CDS/FF systems is slightly more than wastes from SDA/FF systems due to CO_2 pickup by hydrated lime in the CDS
- The high pH in both SDA/FF and CDS/FF wastes helps immobilize mercury and other metals captured in the fabric filter.
- Wastes from both dry scrubber technologies will generally be disposed of in a landfill

- The Spray Dryer system has a slight advantage in wastes production

Selection of Dry Scrubber Techologies Summary

- The installed base of spray dryer/fabric filter systems is much larger than the present base of circulating dry scrubber/fabric filter systems
- CDS/FF systems have an advantage in SO_2 removal capability and fuel flexibility
- SDA/FF systems have an advantage in load flexibility, lime consumption, and an experience “base”
- Both systems have approximately the same water and power consumptions
- Overall selection between these 2 technologies will require an analysis guided by Utility priorities