Multicyclone Dust Collectors

Abrasión in Mechanical Dust Collectors

By Dave Sharpe
Boiler & Steam Systems LLC
Multicyclone Dust Collectors

Abrasión in Mechanical Dust Collectors

By Dave Sharpe
Boiler & Steam Systems LLC
Dave Sharpe
President of Boiler & Steam Systems LLC

- University of Washington (Engineering)
- 34 Years experience Boilers & Related Equipment
- Wood, Natural Gas and Oil fired boilers
- Multiclones, Baghouses, and Scrubbers
- Combustion and combustion control
- Low NOX emissions
- Economizers and heat recovery systems
- Industrial fans and blowers
- Steam and condensate return systems
Boiler & Steam System

- Supply castings and parts for Mechanical Dust Collectors
- Trouble shooting, audits—abrasion reduction, life expectancy of components, efficiency improvements
- Design & manufacture high efficiency collectors
  - Collectors custom designed for limited space
  - Custom designs for increase gas flow capacity
  - Reduced collector abrasion
- Design retrofit parts for faster collector rebuilds
- Supply help and guidance with combustion, emissions, ash, slag, or fuel related issues
Multicyclone Dust Collectors – Purpose

- Separate particulate from flue gas
- No longer sole air pollution control device on boilers
- Reduce plant emissions
  - Improve down stream pollution control equipment
- Protect down stream equipment
  - Induced Draft Fan (I D Fan)
  - Air heater
  - Economizer
  - Ducting
Multicyclones – How They Work

- I D Fan suction creates air velocity through cones that spins particulate to outside wall of the cone where ash spirals down the cone discharging through bottom outlet into hoppers.
- The particulate separates because it has higher specific gravity and its momentum drives it to the outside wall as the air turns. The viscosity of the air slows the smaller particles migration to the outside wall of the multiclone.
- Clean air spins up the outlet tube.
Mechanical collector.
Components

- Inlet plenum (dirty plenum)
- Outlet plenum (clean plenum)
- Hopper section
- Spinner
  - Integral
  - Separate
- Cone Casting
  - Tapered cone tip
  - Flat bottom
- Outlet tube
- Dirty air tube sheet (bottom - horizontal)
- Clean air tube sheet (top – sloped, stepped, or horizontal)
- Hopper outlet flange
- Airlock or seal valve
- Poke hole
- Manway
Multicyclone Dust Collectors

Abrasion

Multiclones are subject to high abrasion:

- High velocity gas flows
- High particulate loading (mass)
- High amounts of abrasive dust (Fly ash)
- High temperatures
- Chemical attack
Abrasion

- Third power relationship of velocity
  - Increase gas flow by 25% and abrasion can increase by a factor of ~2
- Requires particulate in the gas stream
- First power relationship of the mass
- Hard particles increase wear SiO2, TiO2, Al2O3, (all first class abrasives)
- Particle specific gravity and particle shape
- Under 7-10 microns abrasion goes down
- Abrasion is affected by angle of impact
Figure 9. Variation of erosion rate with impact velocity at room temperature and elevated temperatures at 573 K and 873 K (carbon steel).

Figure 10. Variation of erosion rate with impact velocity at room temperature, and elevated temperatures at 573 K and 873 K (1.25Cr-1Mo-V steel).
Figure 7. Variation of erosion rate with impingement angle at room temperature and elevated temperatures at 573 K and 873 K (carbon steel).

Figure 8. Variation of erosion rate with impingement angle at room temperature and elevated temperatures at 573 K and 873 K (1.25Cr-1Mo-V steel).
Abrasion Victims

- Cones (inlet tubes)
- Spinners
- Outlet Tubes
- Recovery Vanes
- I D Fan wheel and housing
- Lower Tube Sheet
- Collector Housing - inlet side
- Upper Tube Sheet
- Air heater – Economizer
Multicyclone Castings

- Many different designs
- Different diameter cones or inlet tubes (3”, 4”, 6”, 8”, 9”, 10”, 12”, 15”, 18”, 20”, 24”, 30” & 36”)
- Different angle spinners for different efficiency's
- Different capacities with the different spinners
- No significant design changes in 50 years
Casting Materials

Inlet tubes and spinners

- Mild steel--fabricated-- Brinell 200
- Ductile Iron--Cast-- Brinell 200
- White Iron--Cast--Brinell 400
- Ni Hard--Cast--Brinell 600
- High Chrome Alloy--Cast-- Brinell 450-600
- Ceramic--Cast
Outlet Tubes

- Mild steel
- Tubing - .095” .109” 11ga. 1/8”—soft steel
- Pipe -
  - Sch 10, .120”, .134”, .148”
  - Sch 40 .237”, .280”, .322”
- Stainless steel tubing .095” .125” (304, 316)
- Shields
  - Angle iron
  - Channel
  - Formed plate 170 degree
Reducing Velocity

- Reduce velocity thru the system
  - Boiler efficiency = lower gas flow
  - Lower excess air, lower oxygen in flue
  - Less moisture in fuel
  - Lower stack temperature
  - Reduce air infiltration, negative pressure leaks
  - Aggressive maintenance
Reducing Abrasives

Reduce abrasive in flue gas

Lower ash content fuel--fuel buyer--testing
Lower moisture in fuel--fuel buyer--testing
Mechanical carryover, underfire air
Char recycle system, screens,-- test ash
Air leaks generating bank, Airheater hoppers
Multiclone Airlock
Multiclone leaks, tube sheet, cones
Aggressive maintenance flue/ash pathway
Coded Note:
1. Economizer and or Air Heater
2. Coal Feeder

Single or Open Pass Boiler Section
1. 10% Recovery - Boiler Hopper Only
2. 30% Recovery - Boiler Hopper + Cinder Trap

Multiple Pass Boiler Section
1. 30% Recovery - Boiler Hopper Only
2. 50% Recovery - Boiler Hopper + Cinder Trap
3. 70% Recovery - Boiler Hopper + Cinder Trap + Mechanical Dust Collector

Typical Bark Boiler

Carbon Loss for Spreader Stoker Boiler
SINGLE AND MULTIPLE PASS BOILERS

Schmidt Associates, Inc.
7333 Fair Oaks Road
Cleveland, Ohio 44146-5968
Phone: (440) 439-7300
Fax: (440) 233-8939
E-mail: BME@BME.com

Sheet No. 1 of 1
Hog Fuel Ash

January 27, 2006

BOILER & STEAM SYSTEMS
4675 174TH COURT SE
BELLEVUE WA 98006

ATTN: DAVE SHARPE

Client Sample ID: Hog Fuel #2
Date Sampled: January 11, 2006
Date Received: Jan 23, 2006
Product Description: WOOD

Sample ID By
Sample Taken At
Sample Taken By
P. O. #

Boiler & Steam Systems
D. Sharpe
J-152-06

SGS Minerals Sample ID: 491-0606251-002

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<th>As Received</th>
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<th>MAF</th>
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<td>% Ash</td>
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<tr>
<td>Gross Calorific Value (Btu/lb)</td>
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<td>% Chlorine</td>
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FUSION TEMPERATURE OF ASH, REDUCING

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October 14, 2005

BOILER & STEAM SYSTEMS
4675 174TH COURT SE
BELLEVUE WA 98006

ATTN: DAVE SHARPE

Client Sample ID: #5 1/8 MinusFines Fir&Larch
Date Sampled: October 6, 2005
Date Received: Oct 10, 2005
Product Description: WOOD

Sample ID By
Sample Taken At
Sample Taken By
P. O. #

Boiler & Steam Systems
D. Sharpe
J-119-05

SGS Minerals Sample ID: 491-0503969-005

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<tr>
<td>Sulfate</td>
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<td><strong>Water Soluble Alkalies (%)</strong></td>
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<td>K20</td>
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Lb. Alkali/MM Btu = 20.22
Lb. Ash/MM Btu = 0.05
Lb. SO2/MM Btu = HGI = @ % Moisture
As Rec'd. Sp.Gr. = Free Swelling Index = F-Factor(dry) = DSCF/MM BTU = 10.104

Report Prepared By:

Gerald H. Cunningham
Fuels Laboratory Supervisor
March 12, 2004

BOILER & STEAM SYSTEMS, LLC.
4675 174th Court SE
Bellevue, WA 98006
Attn: Dave Sharpe

Sample identification by
Boiler & Steam Systems, LLC.

Kind of sample reported to us: Wood Ash

Sample taken at: [Redacted]
Sample taken by: [Redacted]

Date sampled: March 4, 2004
Date received: March 9, 2004

Sample ID: D.C. Ash 03/04/04
P.O. No. J-054

Analysis Report No. 71-228919

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<th>MINERAL ANALYSIS</th>
<th>Ignited Basis, % Weight</th>
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<td>Chloride</td>
<td>Dry Basis, % Wt.</td>
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<tr>
<td>Silica, SiO₂</td>
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<td>Alumina, Al₂O₃</td>
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<td>Iron oxide, Fe₂O₃</td>
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<tr>
<td>Magnesium oxide, MgO</td>
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<tr>
<td>Potassium oxide, K₂O</td>
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<td>Sodium oxide, Na₂O</td>
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<td>Sulfur trioxide, SO₃</td>
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<td>Phosphorus pentoxide, P₂O₅</td>
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<td>Barium oxide, BaO</td>
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<td>Undetermined</td>
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<tr>
<td>Loss on Ignition @ 950°C</td>
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Page 1 of 1
Benefits

- Reduced abrasion Boiler Tubes, Airheater, Economizer, Multiclone, ID Fan, Ductwork
- Reduced fan horsepower, ID Fan, FD fan
- Lower fuel requirements
- Less major maintenance, delayed maintenance
- Life cycle extended
- Additional boiler capacity (We just shot a hole in our foot!)
Things to not tell the Boss

- Rocks and sand have zero fuel value
- Equipment doesn’t heal or fix itself
- Water doesn’t burn
- During unplanned outages UPS only delivers non-critical parts
- We have no Standard Operating Procedure's because we have no standard operating days
- We did nothing different, but we will take full credit for the improvement