# Multicyclone Dust Collectors

## Abrasion in Mechanical Dust Collectors

By Dave Sharpe
Boiler & Steam Systems LLC

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# 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 out side wall as the air turns. The viscosity of the air slows the smaller particles migration to the out side wall of the multiclone.
- Clean air spins up the outlet tube


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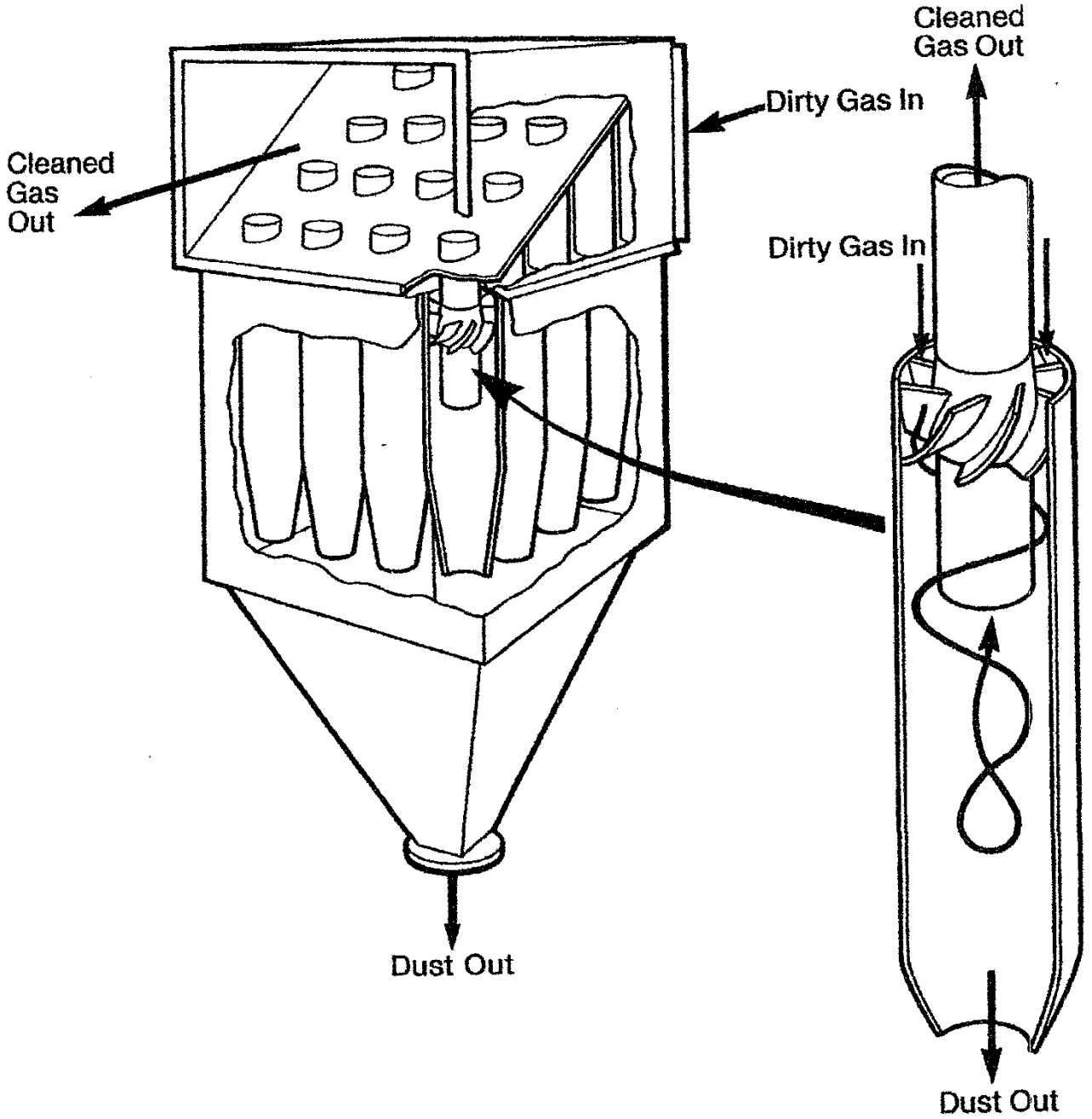
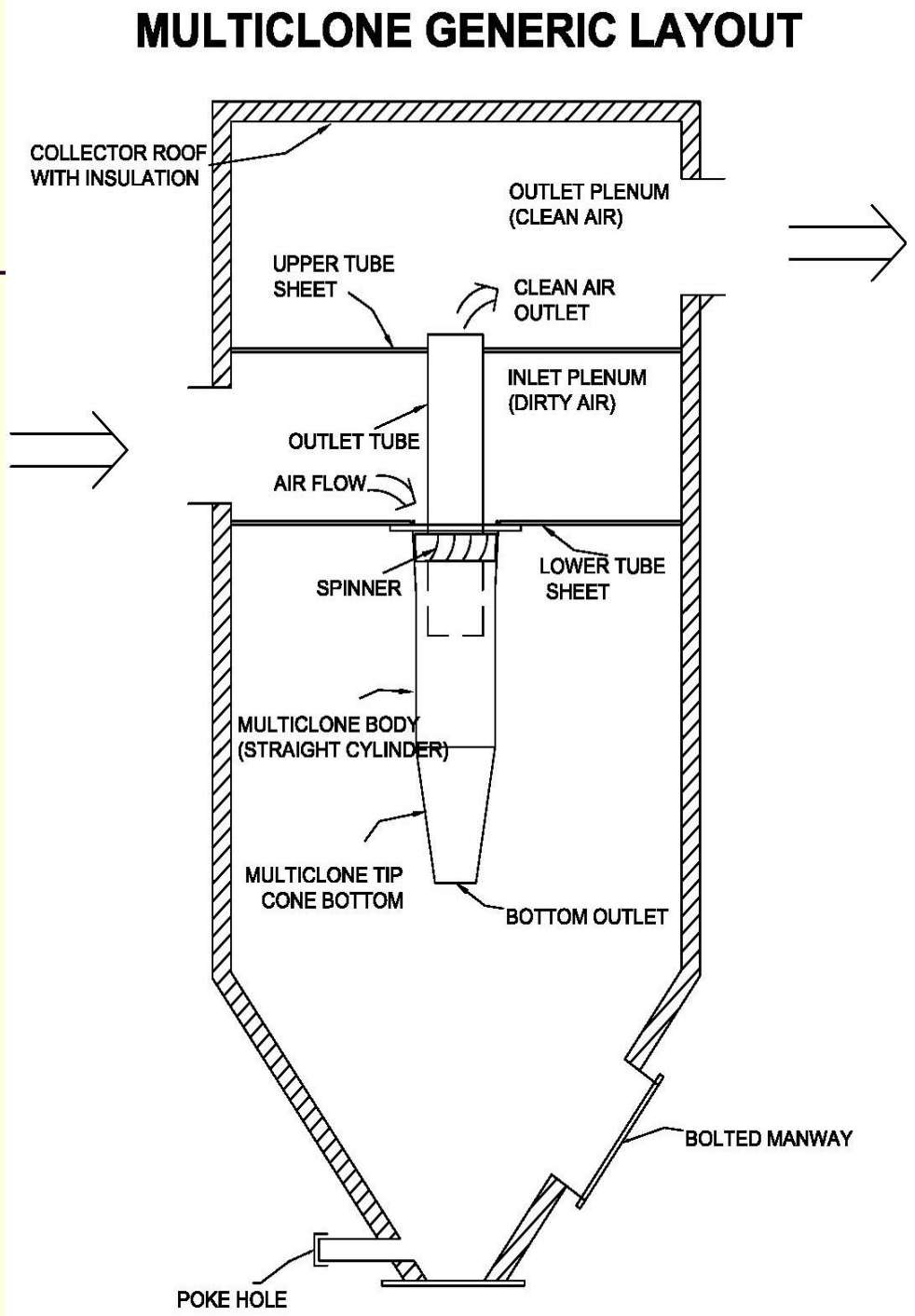
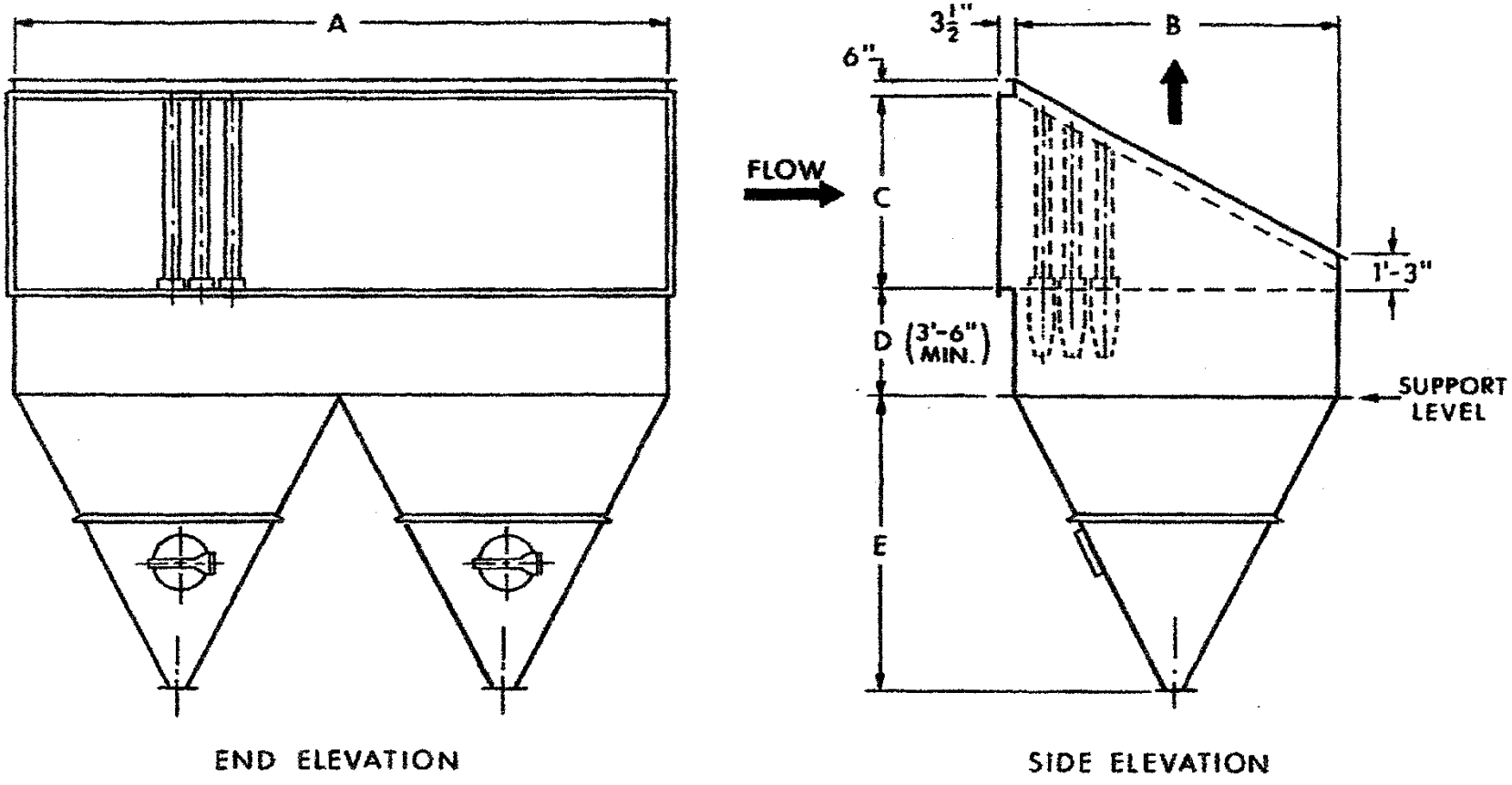



Mechanical collector.

# Components

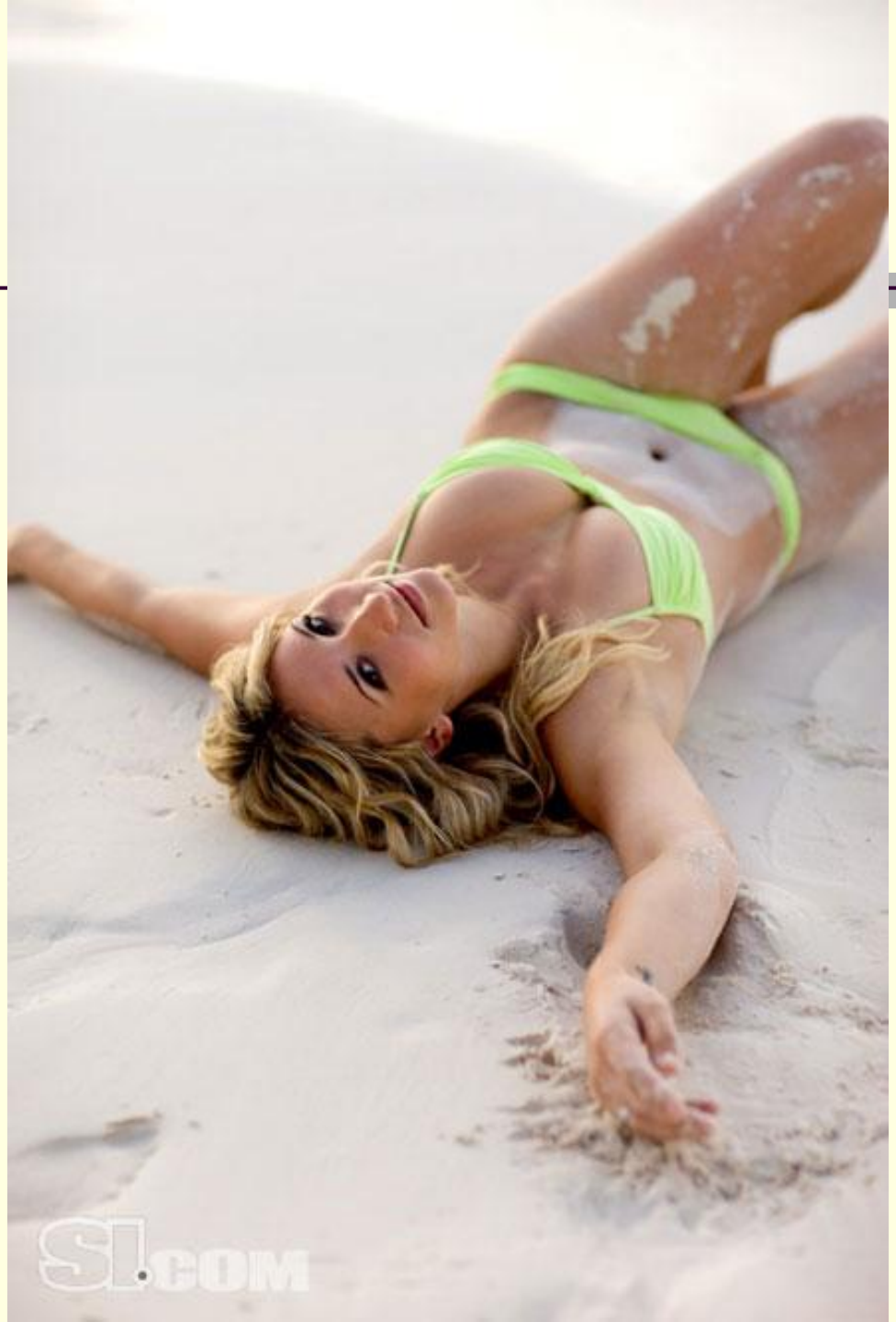
- Inlet plenum (dirty plenum)
- Outlet plenum (clean plenum)
- Hopper section
- Spinner
  - Integral
  - Separate
- Cone Casting
  - Tapered cone tip
  - Flat bottom
- Outlet tube
- Dirty air tube sheet (bottom - horizontal)
- Clean air tube sheet (top – sloped, stepped, or horizontal)
- Hopper outlet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






END ELEVATION

SIDE ELEVATION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# 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 $SiO_2$, $TiO_2$, $Al_2O_3$, (all first class abrasives)
- Particle specific gravity and particle shape
- Under 7-10 microns abrasion goes down
- Abrasion is affected by angle of impact

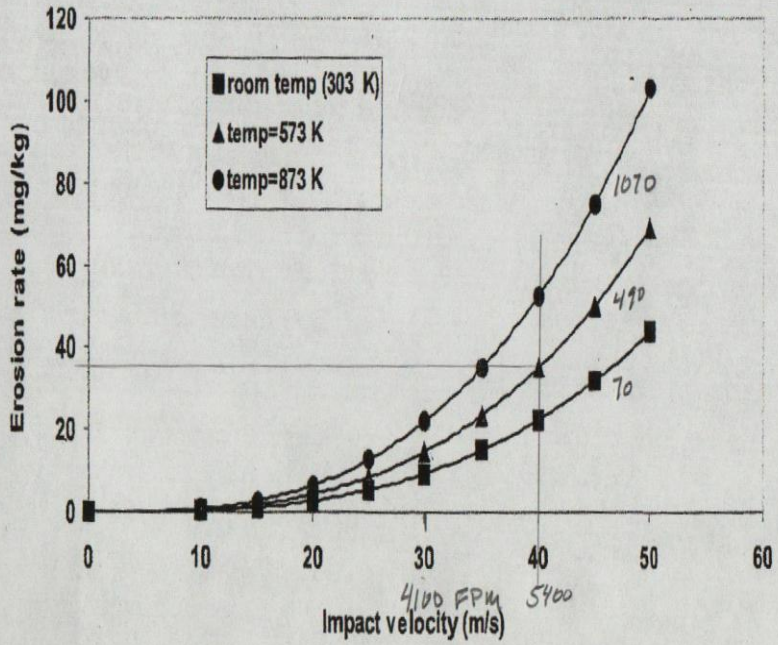



**Figure 9.** Variation of erosion rate with impact velocity at room temperature and elevated temperatures at 573 K and 873 K (carbon steel).

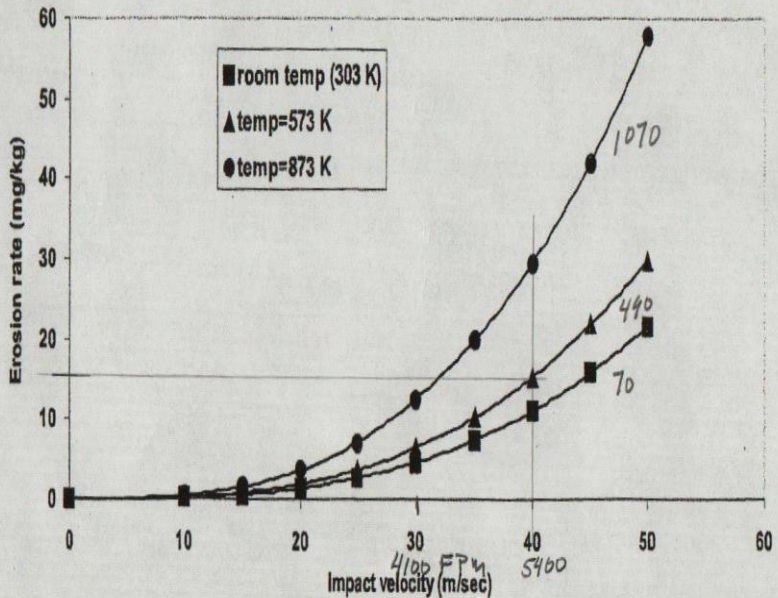



**Figure 10.** Variation of erosion rate with impact velocity at room temperature, and elevated temperatures at 573 K and 873 K (1·25Cr-1Mo-V steel).

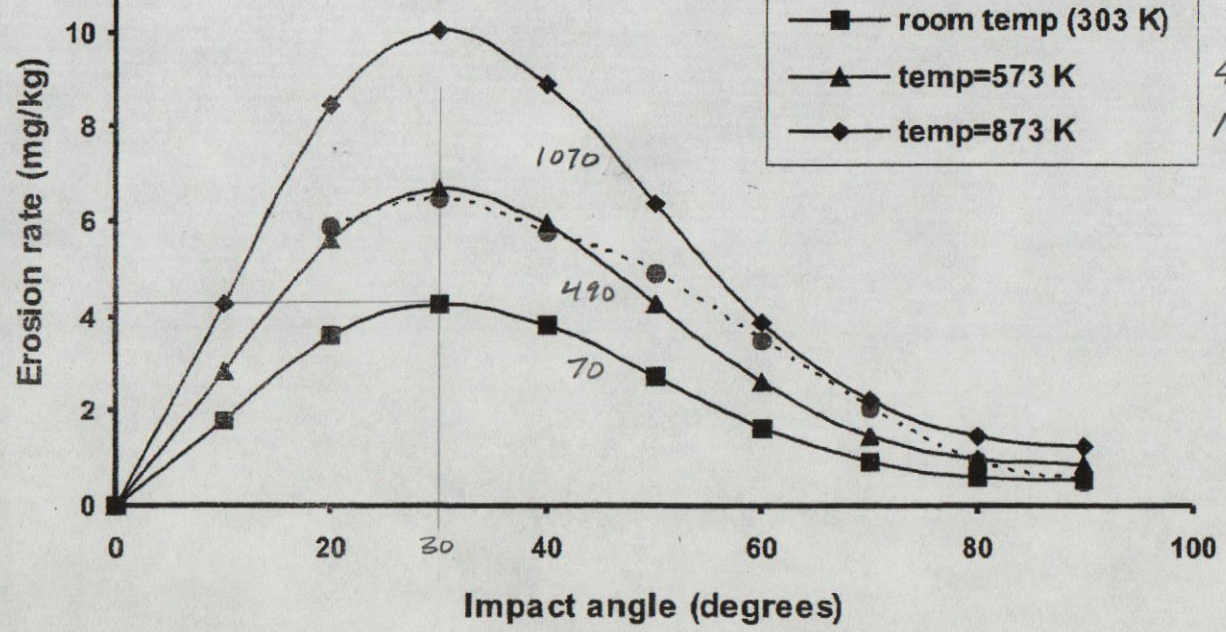



**Figure 7.** Variation of erosio rate with impingement angle a room temperature and elevate temperatures at 573 K and 873 K (carbon steel).

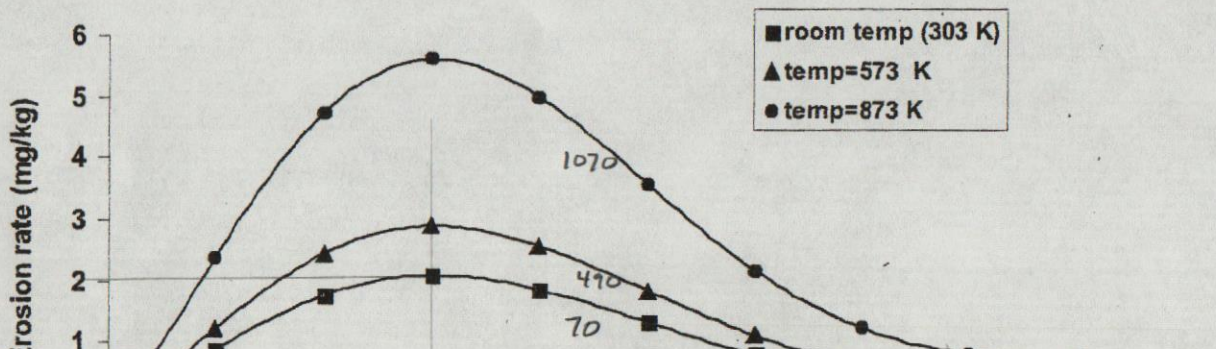



**Figure 8.** Variation of erosio rate with impingement angle a room temperature and elevate temperatures at 573 K and 873 K (1·25Cr-1Mo-V steel).

# 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

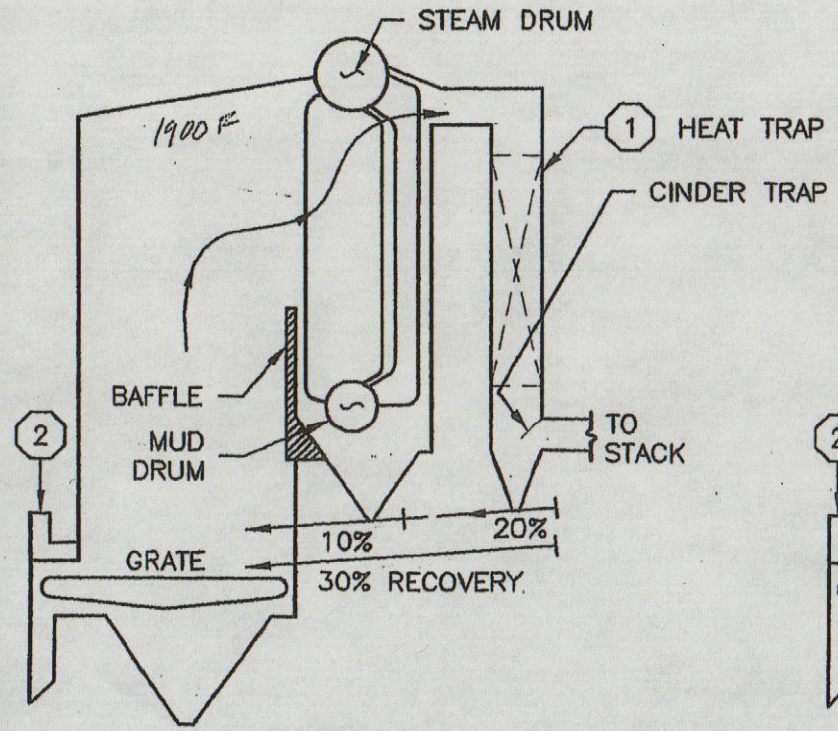
# Reducing Abrasives

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:

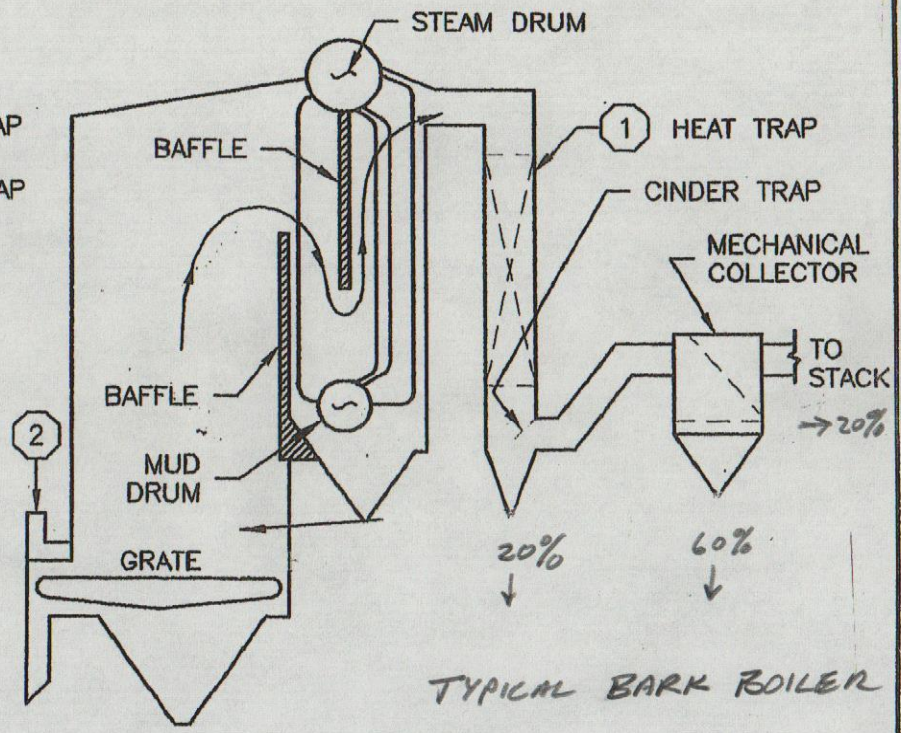
1. ECONOMIZER AND OR AIR HEATER
2. COAL FEEDER




## SINGLE OR OPEN PASS BOILER SECTION

NO SCALE

1. 10% RECOVERY – BOILER HOPPER ONLY
2. 30% RECOVERY – BOILER HOPPER + CINDER TRAP




## MULTIPLE PASS BOILER SECTION

NO SCALE

1. 30% RECOVERY – BOILER HOPPER ONLY
2. 50% RECOVERY – BOILER HOPPER + CINDER TRAP
3. 70% RECOVERY – BOILER HOPPER + CINDER TRAP + MECHANICAL DUST COLLECTOR

COAL FIRED

Schmidt Associates, Inc.
CONSULTING ENGINEERS
7333 FAIR OAKS ROAD
CLEVELAND, OHIO 44146-6098
PHONE: (440) 439-7300
FAX: (440) 232-9939
EMAIL: SAIENGINER@AOL.COM

CARBON LOSS FOR SPREADER STOKER BOILER

SINGLE AND MULTIPLE PASS BOILERS

# Hog Fuel Ash

SGS

January 27, 2006

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

Page 1 of 1

ATTN: DAVE SHARPE

| | | | |
|---|---|---|---|
| Client Sample ID: | Hog Fuel #2 | Sample ID By | Boiler & Steam Systems |
| Date Sampled: | January 11, 2006 | Sample Taken At | [redacted] |
| Date Received: | Jan 23, 2006 | Sample Taken By | D. Sharpe |
| Product Description: | WOOD Ponderosa | P. O. # | J-152-06 |

**SGS Minerals Sample ID: 491-0606251-002**

| | As Received | Dry | MAF |
|---|---|---|---|
| % Total Moisture | 49.30 | | |
| % Ash | 2.30 | 4.53 | |
| Gross Calorific Value (Btu/lb) | 4570 | 9014 | 9442 |
| % Volatile Matter | 31.00 | 61.14 | |
| % Fixed Carbon | 17.40 | 34.33 | |
| % Sulfur | 0.041 | 0.082 | |
| % Chlorine | 0.010 | 0.019 | |

| Analyte | Result |
|---|---|
| **FUSION TEMPERATURE OF ASH, REDUCING** | |
| Initial Deformation | 2020 °F |
| Softening | 2040 °F |
| Hemispherical | 2065 °F |

SGS

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 | Sample ID By | Boiler & Steam Systems |
| Date Sampled: | October 6, 2005 | Sample Taken At | [redacted] |
| Date Received: | Oct 10, 2005 | Sample Taken By | D. Sharpe |
| Product Description: | WOOD | P. O. # | J-119-05 |

**SGS Minerals Sample ID: 491-0503969-005**

| | As Received | Dry | MAF |
|---|---|---|---|
| % Total Moisture | 27.50 | | |
| % Ash | 9.53 | 13.14 | |
| Gross Calorific Value (Btu/lb) | 5627 | 7762 | 8937 |
| % Volatile Matter | 46.94 | 64.74 | |
| % Fixed Carbon | 16.03 | 22.12 | |
| % Sulfur | 0.017 | 0.024 | |

[redacted]

Sample Identification
[redacted] Log Yard Cleanup

| Reporting Basis > | As Rec'd | Dry | Air Dry |
|---|---|---|---|
| **Proximate (%)** | | | |
| Moisture | 46.79 | 0.00 | 3.08 |
| Ash | 8.51 | 16.00 | 15.51 |
| Volatile | 33.85 | 63.62 | 61.66 |
| Fixed C | 10.85 | 20.38 | 19.75 |
| Total | 100.00 | 100.00 | 100.00 |
| Sulfur | 0.010 | 0.020 | 0.019 |
| Btu/lb (HHV) | 4212 | 7915 | 7672 |
| MMF Btu/lb | 4638 | 9569 | |
| MAF Btu/lb | | 9423 | |
| Air Dry Loss (%) | 45.10 | | |
| **Ultimate (%)** | | | |
| Moisture | 46.79 | 0.00 | 3.08 |
| Carbon | 25.97 | 48.81 | 47.31 |
| Hydrogen | 2.76 | 5.20 | 5.04 |
| Nitrogen | 0.14 | 0.26 | 0.25 |
| Sulfur | 0.01 | 0.02 | 0.02 |
| Ash | 8.51 | 16.00 | 15.51 |
| Oxygen* | 15.82 | 29.71 | 28.79 |
| Total | 100.00 | 100.00 | 100.00 |
| Chlorine** | | | |
| **Forms of Sulfur (as S,%)** | | | |
| Sulfate | | | |
| Pyritic | | | |
| Organic | | | |
| Total | 0.01 | 0.02 | |
| **Water Soluble Alkalies (%)** | | | |
| Na2O | | | |
| K2O | | | |

Lb. Alkali/MM Btu=
Lb. Ash/MM Btu= 20.22
Lb. SO2/MM Btu= 0.05
HGI= @ % Moisture
As Rec'd. Sp.Gr.=
Free Swelling Index=
F-Factor(dry),DSCF/MM BTU= 10,104

Report Prepared By:

Gerard H. Cunningham
Fuels Laboratory Supervisor

March 12, 2004

SOUTH HOLLAND, IL 60473
TEL: (708) 331-2900
FAX: (708) 333-3060

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 ID: D.C. Ash
03/04/04

Sample taken at [redacted]

Sample taken by -----

Date sampled March 4, 2004

Date received March 9, 2004

P.O. No. J-054

Analysis Report No. 71-228919



| | Dry Basis, % Wt. |
|---|---|
| Chloride | 0.06 |

| MINERAL ANALYSIS | Ignited Basis, % Weight |
|---|---|
| Silica, $SiO_2$ | 1.21 |
| Alumina, $Al_2O_3$ | 0.73 |
| Titania, $TiO_2$ | 0.10 |
| Iron oxide, $Fe_2O_3$ | 1.96 |
| Calcium oxide, CaO | 6.08 |
| Magnesium oxide, MgO | 1.40 |
| Potassium oxide, $K_2O$ | 27.06 |
| Sodium oxide, $Na_2O$ | 13.86 |
| Sulfur trioxide, $SO_3$ | 9.90 |
| Phosphorus pentoxide, $P_2O_5$ | 1.25 |
| Strontium oxide, SrO | 0.04 |
| Barium oxide, BaO | 0.08 |
| Manganese oxide, $Mn_3O_4$ | 0.43 |
| Zinc oxide, ZnO | 17.70 |
| Undetermined | 18.20 |
| | 100.00 |

| | |
|---|---|
| LOSS ON IGNITION @ 950°C | 17.52 |

# Benefits

- Reduced abrasion Boiler Tubes, Airheater, Economizer, Multiclone, I D 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!)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# 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 deliverers 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


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