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The Case for Fuel Delivery System Upgrades on Utility Boilers

Robert E. Sommerlad, Consultant Donald B. Pearson, The Babcock & Wilcox Co.(Retired), Secretary, PRB Coal Users Group Grant E. Grothen, Burns & McDonnell, and Steven McCaffrey, Greenbank Energy Solution



ASME Research Committee on Energy, Environment and Waste

- 1960s Industrial Waste
- 1970s Municipal Solid Waste
- 1980s Hazardous Waste & Medical Waste
- 2000s Energy, and other environmental issues
- 2011 Renaissance

Fuel Delivery System Upgrades for Utility Boilers Subcommittee

 Subcommittee deals with coal-fired boilers and the fuel delivery system evaluating upgrades & benefits; costs & savings

Roster of the Fuel Delivery Systems Upgrade Subcommittee

- Robert Chase, Terrasource (Supplier)
- Blaz Jurko, Gebr. Pfeiffer, Inc. (Supplier)
- David J. Stopek, Consultant, Sargent & Lundy LLC (Consultant)
- Grant E. Grothen, Principal, Burns & McDonnell (Consultant)
- Steve McCaffrey, President, Greenbank Energy (Supplier)
- Melanie Green, Director, CPS Energy (User)

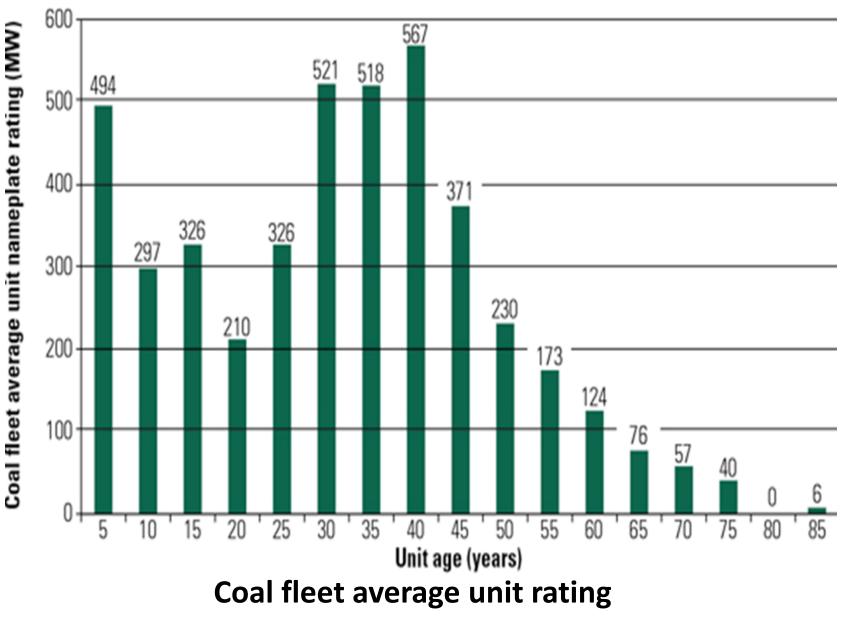
- Don B. Pearson, Babcock & Wilcox (Retired) (Supplier)
- Richard Himes, EPRI (User)
- Tony Licata, Licata EEC & Chair RC EEW (Supplier)
- Robert E. Sommerlad, Consultant & Chair, FDS Subcommittee (Consultant)
- Todd Melick, Vice President, Promecon USA (Supplier)
- Joe Von der Haar, Plant Manager, East Kentucky Power (User)

Overview

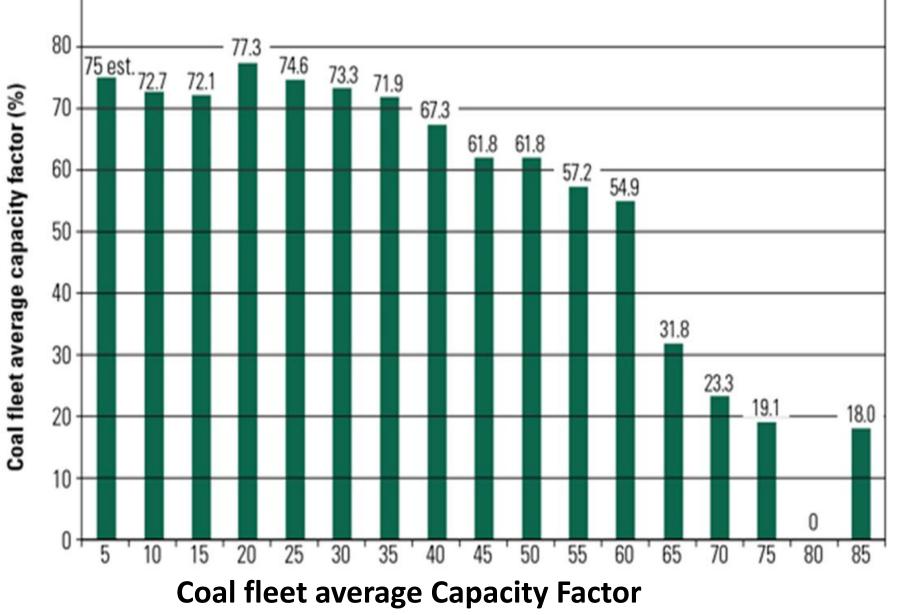
- Plant Retirements
- Focus on 35- to 45- year old coal-fired units
- Fuel Delivery System
- Potential Upgrades
- Methodology Present status; Determine Upgrades & Benefits: Costs & Savings; Breakevens
- Case Studies 500-MW units converted to PRB Coal
 - 1. Opposed Wall
 - 2. Tangential
 - 3. Cyclone
- Results

Analogy to Plane Geometry Theorems

- Given: A group of boilers will be retired putting increased performance requirements on the next younger boilers.
- To Prove: Younger group of boilers can be upgraded and achieve significant benefits
- Analogies:
 - > Analyze critical parts of typical coal-fired power plant
 - Select Fuel Delivery System as the carburetor of the system
 - Consider, select potential upgrades, and cost same
 - Determine potential benefits, and savings
 - Evaluate, review, rereview, and report
 - "To Prove" proven

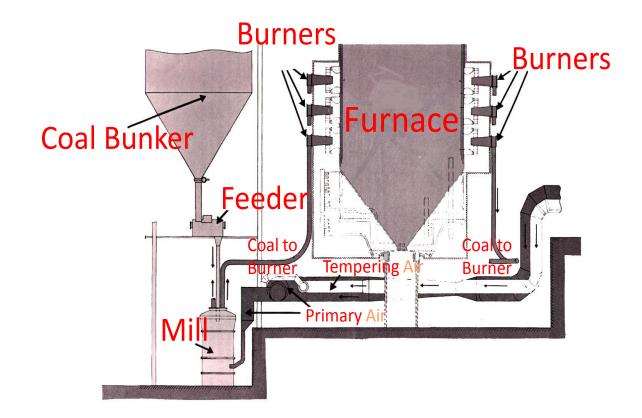


- Greater than 50 years 53 GW or 20% of fleet
- 30 to 45 year old units 216 GW or 63% ~ 500 MW



- 30 to 45 year old with >50 year old gone,
- 75% of fleet and Capacity Factor near 80%

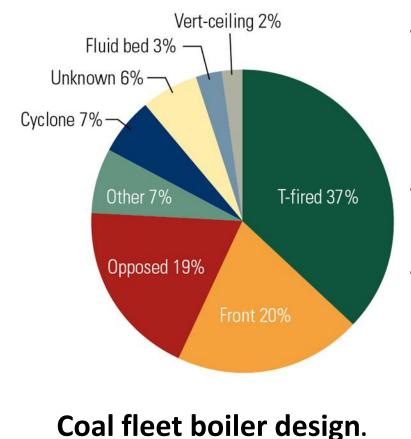
Fuel Delivery System



Potential Upgrades for FDS

<u>Component</u>	<u>Upgrade</u>	<u>Benefit</u>
Feeders	Metering	Flow control
Pulverizers	Dynamic Classifier	Fineness/Capacity
Coal Pipes	Coal-air flow	Flow & Air/Fuel
	Metering	Ratio
Burners	Metering	Improved
		combustion
Boiler Control	Neural Networks	Improved
System		performance

Case Studies



- Based on real 35- to 45year old 500-MW boilers now firing PRB coal & derated
- No Air Quality Control System Upgrades
- No increase in emissions to avoid NSR & PSD
 - 1. Opposed-Wall
 - 2. Tangential
 - 3. Cyclone

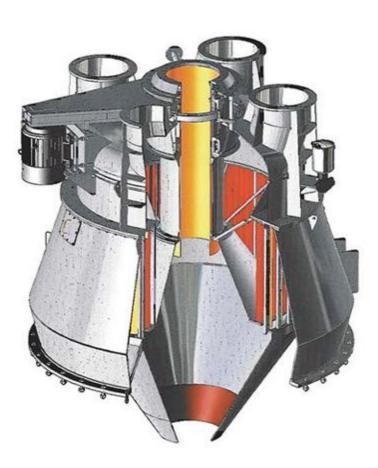
Case Study 1 – Opposed Wall

Component	Upgrade
Feeder	New Feeder
Pulverizer	Dynamic Classifier
Coal Pipes	Coal-air flow
Burner Modernization	LNBs & OFA
Boiler Control System	Neural Network

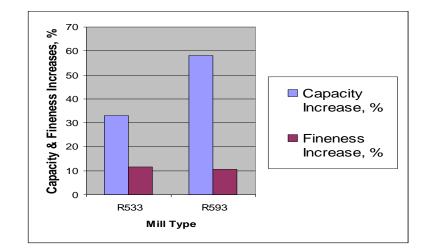
Case Study 1 – Opposed Wall

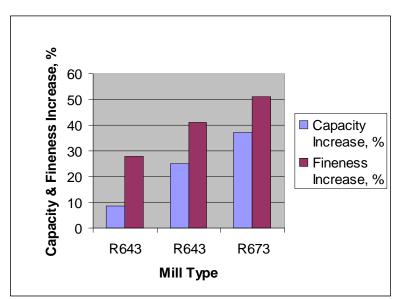
Component	Upgrade	Benefits
Feeder	New Feeders	Improved Flow Control
Pulverizer	Dynamic Classifiers	Increase Fineness (X50 Mesh) & Capacity (~5%)
Coal Pipes	Coal-air flow	Improved Flow Control
Burner Modernization	LNBs & OFA	NOx and UBC; <nh3< td=""></nh3<>
Boiler Control System	Neural Network	Improve Boiler Efficiency & Fan Power; <nh3< td=""></nh3<>

Dynamic Classifiers



Courtesy of Loesche Energy Systems.





Case Study 1 – Opposed Wall

Component	Upgrade	Cost, \$k	Savings, \$k/y	
Feeder	New Feeders	900	Combine with DCs	
Pulverizer	Dynamic Classifiers	3,600	2 Days Op	3,760 <u>960</u> 9,720
Coal Pipes	Coal-air flow	700	Combine with BC	S
Burner Mods	LNBs & OFA	5,400	NH ₃	210
Boiler Control System	Neural Network	<u>300</u> Subtotal 10,900	Efficiency Fan NH ₃ Subtotal	596 314 <u>85</u> 995
PM&ES	25%	2,725		
Total		13,625	10),925

Breakeven 15 months

Case Study 2 - Tangential

Component	Upgrade	Cost, \$k	Savings, \$k/y
Feeder	New Feeders	750	Combine with DCs
Pulverizer	Dynamic		5% "Recovery" 8,760
	Classifiers		2 Days Op <u>960</u>
		3,000	Subtotal 9,720
Coal Pipes	Coal-air flow	584	Combine with BCS
Burner Mods	New Burners &		Some NO _x , UBC but no
(Burners & SOFA)	SOFA & Other	4,800	significant savings 0
Boiler Control	Neural		Efficiency 596
System	Network	<u>300</u>	Fan <u>314</u>
Subtotal		9,434	Subtotal 910
PM & ES	25%	2,359	
Total		11,763	10,630

Breakeven 13 months

Case Study 3 - Cyclone

Component	Upgrade	Cost, \$k		Savings	, \$k/y
Feeder/Crusher	New Feeders			Combine	e with
"Island"	&			Cyclone	
	Instrumentation		1,200	Moderniz	zation
Cyclone	Cyclone			Regain 7 c	lays
Modernization	upgrades and			full load op	per-
	new "Split" air			ation due t	0
	damper		2,880	slagging	3,360
Boiler Control	Update Boiler			Efficiency	268
System	Control System		<u>400</u>	Fan	<u>57</u>
		Subtotal	4,480	Subtotal	455
PM & ES	25%		1,120		
Total			5,600		3,815

Breakeven 18 months

Summary of Case Study Costs, Savings, and Breakevens

Case	Туре	Cost,	Savings,	Breakeven,
Study		\$k	\$k/y	Months
1	Opposed Wall	13,625	10,925	15
2	Tangential	11,697	10,630	13
3	Cyclone	5,600	3,815	18

500 MW, 80% Capacity Factor

Impact of Capacity Factor on Savings and Breakevens

Capacity Factor, %			60	70	80
Case Study	Boiler Type				
1	Opposed Wall	Savings, \$k	8,295	9,096	10,925
		Breakeven, Months	20	18	15
2	Tangential	Savings, \$k	7,973	9,301	10,630
		Breakeven, Months	18	15	13
3	Cyclone	Savings, \$k	2,861	3.331	3,815
		Breakeven, Months	23	20	18

Other Considerations

- Redoing Case Studies for Eastern Coal
 Price of eastern coal has increased
- Market Size approximate
 - Opposed Wall 226
 - Tangential 143
 - > Cyclone 15
- Next steps
 - Presentations, feedback

Other Considerations Cont.

• CO₂ Emissions

- ➢ Pulverized coal units (Case Studies 1 and 2)
 ✓ 0.34% Improvement in Boiler Efficiency
 ✓ 6.5 lb CO₂/MW or 11,380 t CO₂/y
- Cyclone units (Case Study 3)
 - ✓About half of pulverized coal units
- Investigate other potential way of reducing CO₂ Emissions not only for 30 – 45 year old units but also 0-25 year old units

Conclusions

This Research Subcommittee came together with concerns by some that this effort could not be done, but with some considerable give and take the Subcommittee succeeded. Most were surprised by the short breakevens or short payback periods. The costs and savings were revisited and largely remain unchanged. Clearly the Dynamic Classifier and Neutral Network upgrades provided some amazing savings.



Footnote

The Subcommittee is to be applauded for its enthusiastic efforts over a 20-month effort in monthly one-hour conference calls. As its Chair, it was an honor and pleasure to work with them.

