Reinhold Environmental Ltd.

2008 APC Round Table & Expo Presentation

July 13-15, 2008, in Savannah, GA

Good Afternoon

Thank You for the Invitation to Speak Today

Please take a moment to give your pagers and cell phones a rest; either shut them off or switch to vibrate mode

Now grab a coffee, a pen/pencil and a buddy to keep you awake

"Fuels Quality's Effects on Air Pollution Control Devices"

2008 APC Conference

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Tony Widenman
Technological Specialist-Fuel & Fuel SME
DTE Energy, Detroit Edison

313-897-1296
widenmana@dteenergy.com

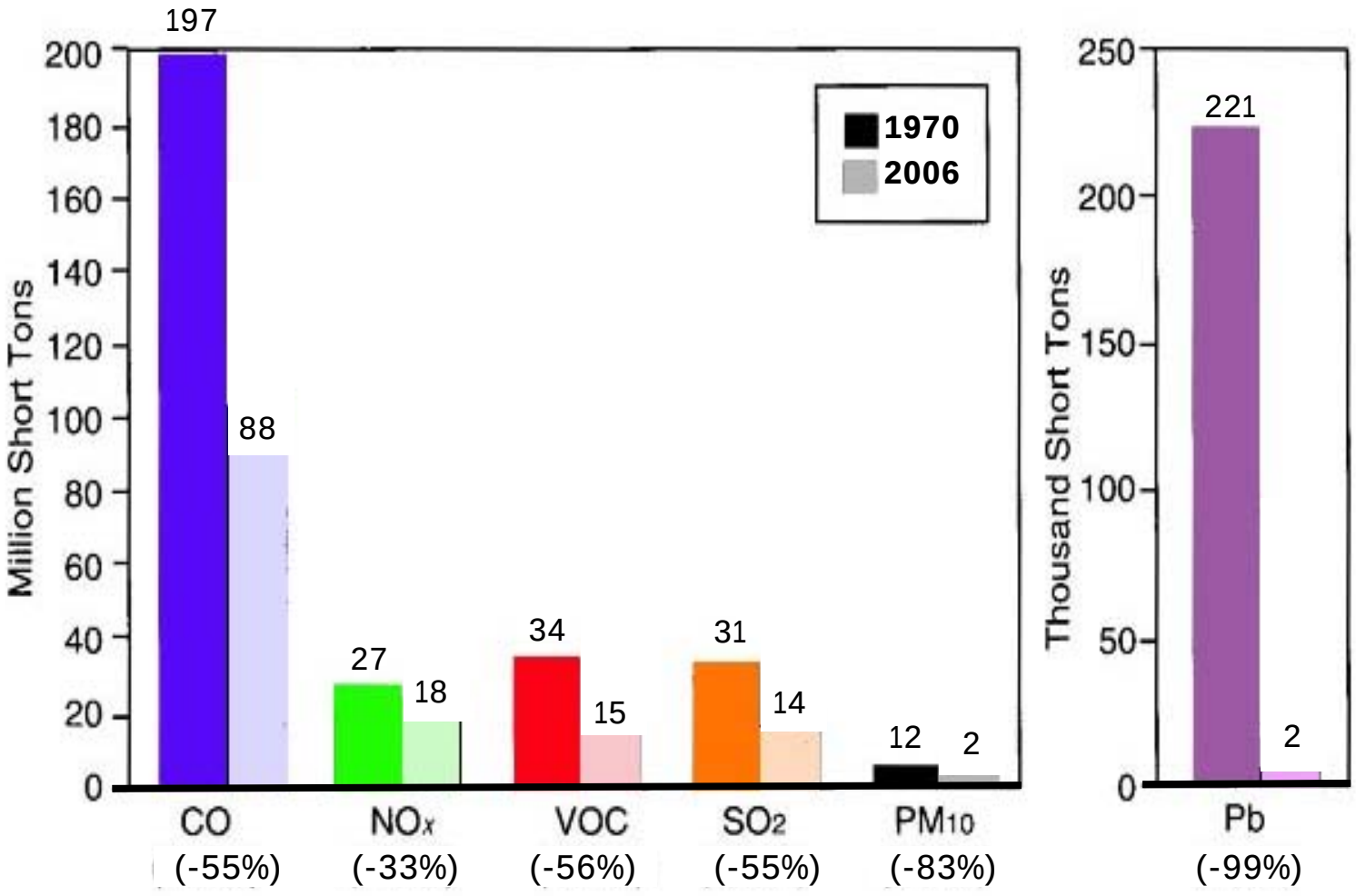
Objective

To present a brief tutorial on fuel quality's affects on air pollution control devices

OK, we all think coal is this nasty fuel that should be replaced by wind, solar, biomass, natural gas, etc… & not to mention nuclear

(Shh… don't say this too loud, but nuclear plants do not emit greenhouse gases)

Fossil-Fired Emissions 1970-2006 — Criteria Air Pollutants



Comparison of 1970 & 2006 emission of criteria air pollutants, Office of Air Quality Planning & Standards, US EPA

SE Michigan's baseload at 4 AM, Sunday during Spring & Fall is >4,000 MWs

So…

What are our energy options today, Monday, 14 July 2008?

United State's electric power baseload energy mix is nominally:

- Coal 51%
- Nuclear 20%
- Natural Gas 18%
- Hydro 7%
- Oil 3%
- Other 1%

With the exception of nuclear, hydro & some of the Other category, they all emit GHGs and some type of undesirable emissions…NO_x, SO_2, particulate, CO, CO_2, H_2O, HCl, HF, Hg, other miscellaneous HAPs

Since coal is the single largest producer of electricity, and given the time allotted, I'll concentrate on conventional coal combustion

To understand emissions from coal combustion, we must have a basic understanding of:

- coal
- coal combustion
- combustion product deposition
- combustion product collection
- emissions

What is coal?

It's definitely not just black and burns

Coal Analysis

Mine/Supplier:	Pittsburgh Seam	Sampling Method:	Mechanical
Sample #:	99F-00852	Sample Date:	2/25/1999
Sample Description:	S> 1.7%	Sample Receipt:	2/26/1999

Proximate	As=Received	Dry	MAF
Moisture (-)	4.52		
Ash (-)	6.78	7.10	
Volatile (+)	34.31	35.95	38.68
Fixed Carbon (+)	54.39	56.99	61.32
Sulfur	2.05	2.14	
Heating Value	13,376	14,010	15,080

ADL	2.30
Residual Moisure	2.27

Moisture Load	3.38
Ash Load	5.07
SO2	3.07
V/FC	0.63

Ultimate	As=Received	Dry	MAF
Carbon	75.23	78.82	84.84
Hydrogen	5.00	5.24	5.64
Nitrogen	1.45	1.52	1.64
Oxygen	4.97	5.21	5.61

Hardgrove Grindability Index

HGI	**50.8 @2.89% Moisture**

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Ash Fusion - 8 point	Reducing	Oxidizing
Initial	2,209	2,535
Spherical	2,280	2,575
Hemispherical	2,372	2,595
Fluid	2,460	2,665
Plastic Range	251	130

Ash Mineral

SiO2	50.52
Al2O3	23.10
TiO2	0.93
Fe2O3	15.63
CaO	2.64
MgO	0.78
K2O	1.94
Na2O	0.56
SO3	1.25
P2O5	0.35
BaO	0.26
SrO	0.81
MnO2	0.01
Undetermined	1.22

B/A	0.29
Ash Ratio	0.22
Ash Type	Bituminous
Slagging Index	1
Slagging Type	Medium
Fouling Index	0.16
Fouling Type	Low
Silica Ratio	0.73
Si/Al	2.19
Fe/Ca	5.92
Dolomite %	15.87

Trace Elements	*Units*	*Value*		*Units*	*Value*		*Units*	*Value*
Sb, Antimony	ppm	0.11	Pb, Lead	ppm	8.24	Ag, Silver	ppm	0.067
As, Arsenic	ppm	11.97	Mn, Manganese	ppm	18.9	Tl, Thalium	ppm	0.62
Ba, Barium	ppm	104	Hg, Mercury	ppm	0.082	V, Vanadium	ppm	30.1
Be, Beryllium	ppm	2.2	Mo, Molybdenum	ppm	1.12	Zn, Zinc	ppm	14.5
Cd, Cadmium	ppm	0.061	Ni, Nickel	ppm	13.61			
Cl, Chlorine	ppm	957.28	Se, Selenium	ppm	3.22			
Cr, Chromium	ppm	12.4						
Co, Cobalt	ppm	6.21						
Cu, Copper	ppm	15.8						
F, Fluorine	ppm	<10						

Definitions of Coal

- **A brown or black combustible sedimentary rock (in the geological sense) composed principally of consolidated and chemically altered plant remains.** (ASTM D121)

- Coal is a rock, a sediment, a conglomerate, a biological fossil, a complex colloidal system, an enigma in solid-state physics and an intriguing object for chemical and physical analyses *(van Krevelen)*

- Coal is a chemically and physically heterogeneous, "combustible," sedimentary rock consisting of both organic and inorganic material (Bruce Miller, Penn State)

Coalification Process

Materials	Partial Processes	Main Chemical Reactions		C	H	O
Decaying Vegetation	Peatification	Bacterial and fungal life cycles	Wood	49	7	44
Peat	Lignitification	Air oxidation, followed by decarboxylation and dehydration	Peat	60	6	34
Lignite	Bituminization	Decarboxylation and hydrogen disproportioning	Lignite	70	5	25
			Subbituminous	75	5	20
Bituminous coal	Preanthracitization	Condensation to small aromatic ring systems	Bituminous	85	5	10
Semianthracite	Anthracitization	Condensation of small aromatic ring systems to larger ones; dehydrogenation	Anthracite	94	3	3
Anthracite	Graphitization	Complete carbonification				

Increasing Aromatization & Loss of Oxygen with Time

Wt%, dry mmf basis

FIGURE 1-2. The coalification process. [From Van Krevelen, D. W., *Coal: Typology–Physics–Chemistry–Constitution*, Third ed., Elsevier Science, Amsterdam, 1993. With permission].