

E-Coal Data Book

Quanta Environmental Energy Technologies, LLC

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Introduction

The Quanta Environmental Technologies, LLC (Quanta) process for solid waste conversion uses the principle of adiabatic thermolysis or pyrolysis to produce a high quality solid fuel product from many solid waste feedstocks. Municipal solid waste (MSW) will produce an excellent coal substitute via the Quanta thermolysis process. This "E-Coal" product has many characteristics of the best steam coals currently available but with drastically fewer harmful combustion byproducts as described in greater detail in the following sections.

Fuel Analysis

"E-Coal" is a high volatile, low moisture fuel product with a heating value falling between those of Midwestern bituminous and Western sub-bituminous coals. Table I presents average Proximate and Ultimate analyses for E-Coal. For comparison, Table I also presents ultimate and proximate analyses for MSW, RDF, Midwestern (Ohio) bituminous and Western (Wyoming) sub-bituminous coals.

Table 1. E-Coal Characteristics

	E-Coal	Range	MSW	RDF	Ohio Bituminous	Wyoming Sub- bituminous
<u>Proximate</u>						
<u>(%)</u>						
VM	50.24	± 3.06	-	-	37.07	33.30
FC	27.82	± 1.53	-	-	48.93	34.20
Ash	20.56	± 1.22	21.66	8.89	9.00	6.10
Moisture	1.38	± 0.32	24.10	22.75	5.00	26.40
<u>Ultimate (%)</u>						
C	53.12	± 0.60	29.04	34.29	69.41	49.90
H	4.88	± 0.12	3.61	4.39	4.74	3.53
O	18.57	± 1.87	20.68	29.02	7.31	21.56
N	0.75	± 0.02	0.78	0.37	1.36	0.95
S	0.22	± 0.01	0.13	0.29	3.18	0.59
<u>HHV, Btu/lb</u>						
	9418	± 110	5,200	6,183	12,550	8,633

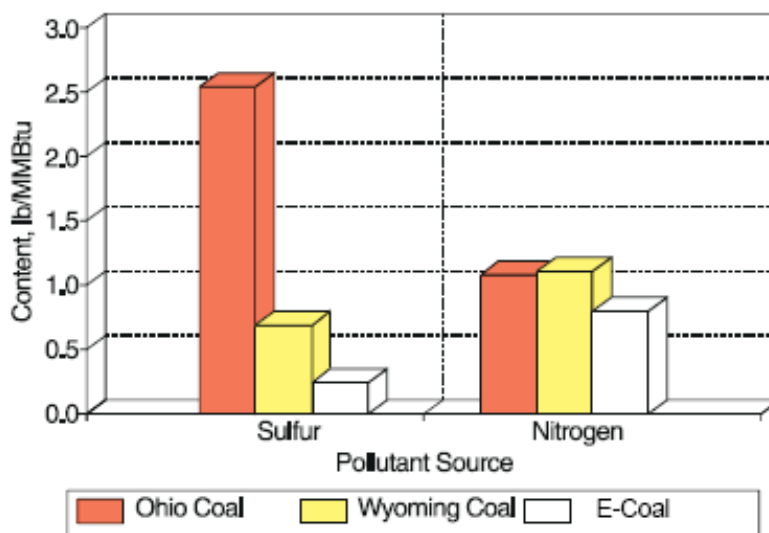
E-Coal has a volatile matter content in excess of 50 percent, which is slightly higher than that of

a premium high volatile bituminous coal. High volatile matter content insures that E-Coal will easily ignite and provide a stable flame in any furnace designed to burn fine coal. Conversely, E-Coal has a relatively low fixed carbon content; suggesting that carbon burnout in the furnace should be relatively complete. E-Coal also has a very low moisture content (1.4 percent), comparable to the inherent moisture levels in the best low and medium volatile Eastern bituminous coals. Low moisture content results in ease of handling in cold weather, little tendency to produce condensation in storage bunkers, less tendency toward spontaneous combustion in storage, and higher boiler efficiency (lower stack losses).

While E-Coal's VM, FC and moisture contents are exceptionally good, its ash content is comparable to that of an unwashed Eastern bituminous coal, run of mine Illinois basin coal, or a Montana sub-bituminous coal. Boiler operators will want to make certain their ash handling systems will support higher ash loadings.

E-Coal's ultimate analysis differs from that of the Western and Midwestern coals in several ways. E-Coal is higher in both hydrogen and oxygen content than are the other coals, suggesting high reactivity and lower air requirements. The acid rain forming elements sulfur and fuel-bound nitrogen are both lower than those seen in conventional coals. E-Coal contains less than 10 percent of the sulfur, per unit of energy content, that is present in the Ohio bituminous coal, and about one third of that present in the "low sulfur" Western coal. Figure 1 presents graphically the acid rain components of the three fuels, on a comparable energy input basis. Any coal burning installation seeking to substantially reduce sulfur emissions without adding flue gas scrubbing can do so by direct substitution of E-Coal for traditional coal.

Figure 1.
E-Coal Acid Rain Constituents



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E-Coal's heating value falls between those of the Midwestern bituminous and Western sub-bituminous coals. At nearly 10,000 Btu/lb, it also falls in the middle of the range of all commercial steam coals (6,000-14,000 Btu/lb). Figure 2 compares the heating value of E-Coal with typical commercial coals, by rank and type. E-Coal contains nearly twice the heat content of MSW, and as much as 50 percent greater heat content than traditional RDF. Because of its low moisture content and high heating value, E-Coal burns more efficiently than other waste fuels and even Western low sulfur coals. Figure 3 presents a comparison of boiler efficiency for several fuels, as calculated from stack losses. Only the Eastern bituminous coal burns more efficiently than E-Coal.

Figure 2.
Coal HHV and HGI

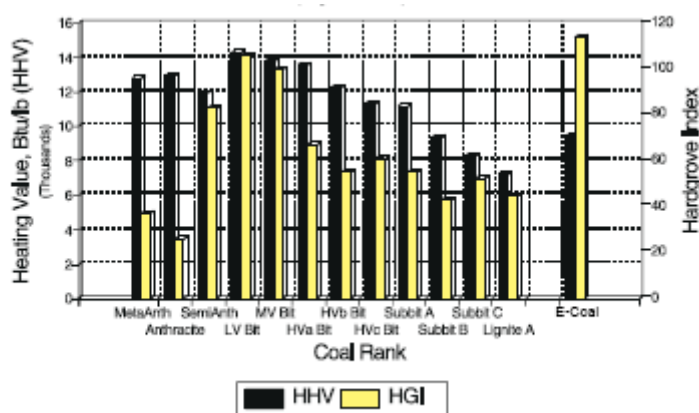
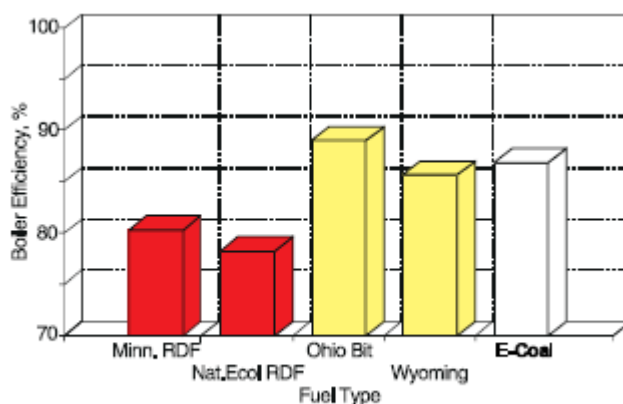


Figure 3.
Combustion Efficiency – Stack Losses

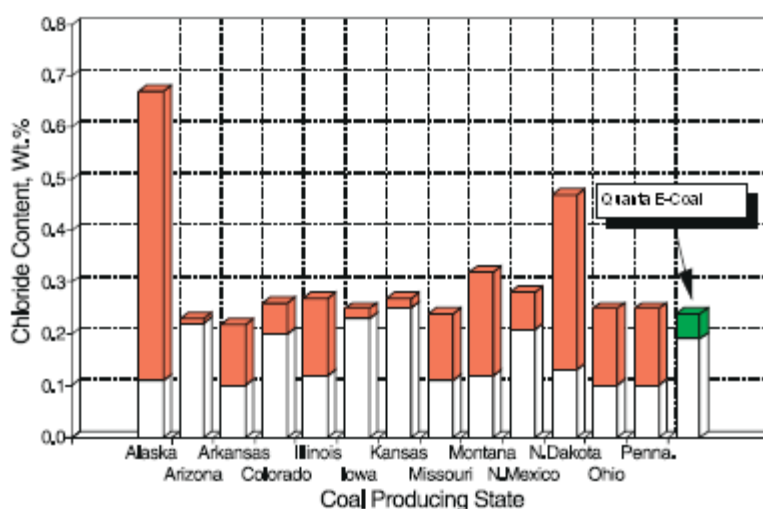


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Chloride Content

E-Coal production occurs at elevated temperature, driving off a major portion of the chlorides present in waste materials. As a result, E-Coal chloride content is comparable to that seen in naturally occurring coals from the major coal-producing Midwestern and Western basins. These include the following 13 major coal-producing states: Alaska, Arizona, Arkansas, Colorado, Illinois, Iowa, Kansas, Missouri, Montana, New Mexico, North Dakota, Ohio and Pennsylvania. Figure 4 presents a pictorial comparison of the chloride contents of these coals and E-Coal. Boilers and other combustion equipment designed to handle the chloride levels in these commercial coals can also handle the chloride level in E-Coal.

Figure 4.
Chloride Content – Representative Coals



Ash Characteristics

E-Coal ash is similar in composition to ash from conventional coals. Silica and Alumina, in roughly 3:1 weight proportion, comprise nearly 75 percent of the ash content. Other major constituents include Calcium, Iron and Alkali. Table II compares the composition of E-Coal ash to those of one Eastern and two Western coals. E-Coal ash composition is similar to that of a Montana (Ashland) sub-bituminous coal, but with lower Alkali content, giving lower fouling tendencies.

Table II
Ash Combustion Data

Component Wt%	E-Coal	Range	Ohio	Wyoming	Montana
SiO ₂	53.45	± 5.67	48.90	38.40	56.70
Al ₂ O ₃	21.31	± 3.73	22.10	20.60	22.20
TiO ₂	2.76	± 1.94	1.40	1.60	1.00
Fe ₂ O ₃	3.56	± 0.55	19.00	4.70	3.90
CaO	9.14	± 0.85	3.10	25.90	7.90
MgO	1.10	± 0.63	1.10	6.40	2.10
K ₂ O	2.08	± 0.43	1.60	0.50	1.80
Na ₂ O	2.81	± 0.94	0.30	1.30	4.30
Soluble Na*	0.03				
Soluble K*	0.03				
<u>Ash Indices</u>					
B/A Ratio	0.24		0.35	0.64	0.25
Fe/Ca Ratio	0.39		6.13	0.18	0.49
Fe/Dolomite	0.35		4.52	0.15	0.39
Silica %	79.50		67.80	50.90	80.30
Dolomite %	15.20		5.80	42.80	14.60
F _{CT&E}	0.68		0.10	0.83	1.08
S _{CT&E}	0.05		1.10	0.38	0.15
<u>Temperatures, °F</u>					
IT	2,229	± 108	2,080	2,099	2,015
ST	2,326	± 48	2,130	2,149	2,115
HT	2,383	± 52	-	-	-
FT	2,484	± 13	2,180	2,218	2,205
T ₂₅₀	2,660		-	-	-

Ash Indices

There are a number of useful indices, which relate ash properties to ash composition. The boiler industry has developed these indices over many years, with considerable experience on a wide range of coals. The indices can very effectively portray the fouling tendencies of E-Coal. The first useful index of ash characteristics is the Base/Acid ratio, defined as:

$$B/A = (\text{Fe}_2\text{O}_3 + \text{CaO} + \text{MgO} + \text{Na}_2\text{O} + \text{K}_2\text{O}) / (\text{SiO}_2 + \text{Al}_2\text{O}_3 + \text{TiO}_2).$$

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This ratio provides an indication of the tendency of a coal ash to form a low melting salt during combustion, more a slagging problem than one of fouling. A plot of ash fusion temperature versus B/A ratio for many coals will show a profound minimum melting point around a B/A of about 0.55. Much higher melting temperatures at the outer extremes of the B/A range indicate a lower slagging potential. E-Coal ash falls on the acid side, at 0.24, well outside the 0.4-0.7 range of concern.

B/A ratio is only a small element in ash behavior since many individual components can promote fluxing of the ash and other problems. Alkali metals, alumina and iron are of particular interest. The Silica/Alumina ratio is useful in comparing coals of similar B/A ratio, as basic silicates tend to melt at lower temperatures than basic aluminates. The Si/Al ratio for E-Coal is high, at 2.5, indicating that its ash would melt sooner than ash from another coal of lower Si/Al ratio.

More important is the Iron/Calcium ratio, which considers the effect of fluxing. A eutectic temperature curve, similar to the one described under B/A ratio, can be drawn against Fe/Ca ratio, and provides an excellent indication of the impact of calcium addition. The effect is minimal for ashes with an iron content below 14 percent, but shows a minimum temperature at a Fe/Ca ratio of about 0.5. Adding either iron or calcium raises the ash fusion temperature. E-Coal has an iron content of only 3.6 percent, but a Fe/Ca ratio of 0.4. On this basis, we would expect calcium (limestone) addition to raise the ash melting point, but only minimally.

The Iron/Dolomite ratio is defined as follows:

$$\text{Fe/D} = \text{Fe}_2\text{O}_3 / (\text{CaO} + \text{MgO}).$$

It performs the same function as the Fe/Ca ratio, especially with coal ashes high in magnesia, and also serves to define Eastern (bituminous) versus Western (lignite) coal ash types. E-Coal is clearly lignitic, with a value of 0.35.

Silica and dolomite percentages are primarily useful in correlating ash viscosity characteristics. In general, the higher the value of either index, the higher the melting point and slag viscosities.

The most direct influence on ash fouling tendencies is brought about by the presence of the alkali metals, sodium and potassium. Most sodium compounds melt at temperatures below 1650°F, and many vaporize at temperatures as low as 2350°F. The sodium compounds tend to condense on tube surfaces, providing a binding matrix for ash particles to fuse together on tube surfaces.

With Eastern coal ashes, the presence of large concentrations of iron and sulfur in the ash compounds the problem, producing complex alkaline iron sulfates, which bond to superheater and reheater tube surfaces.

Two general forms of alkali are present in the ash: a soluble form (typically chlorides) which is volatile and produces the fouling behavior; and an insoluble form of complex silicates, which must be chemically decomposed before it can create a fouling problem.

Boiler manufacturers relate the fouling tendencies to alkali content differently, depending on whether the ash is Eastern or Western (lignitic) in nature. The U.S. Bureau of Mines, at Grand Forks, N.D., has carried out extensive fouling studies on Western coals. Their experience showed that fouling tendencies of lignitic ashes could be directly correlated to total sodium content in the ash. Ash with less than three percent Na₂O was low fouling. Above this level, fouling rate increased proportionately with sodium content. On this basis, E-Coal would be low fouling, with a sodium content of 2.8 percent.

The fouling tendencies of Eastern coal ashes are best correlated against the soluble sodium component in the ash, which in turn correlates with coal chloride content. Insoluble alkali trapped in complex silicates do not contribute strongly to fouling tendencies. On a total as received coal basis, soluble sodium levels greater than 0.33 percent indicate a high fouling potential, while levels less than 0.07 percent would be quite low. E-Coal has a soluble sodium level of .03 percent, indicating a low fouling potential.

Other indices used by the industry include CT&E Laboratory's fouling and slagging indices described below:

$F = \% \text{ weight of } Na_2O$

$S = (B/A) * (\% \text{ Sulfur})$

Values of the indices and their significance are shown below:

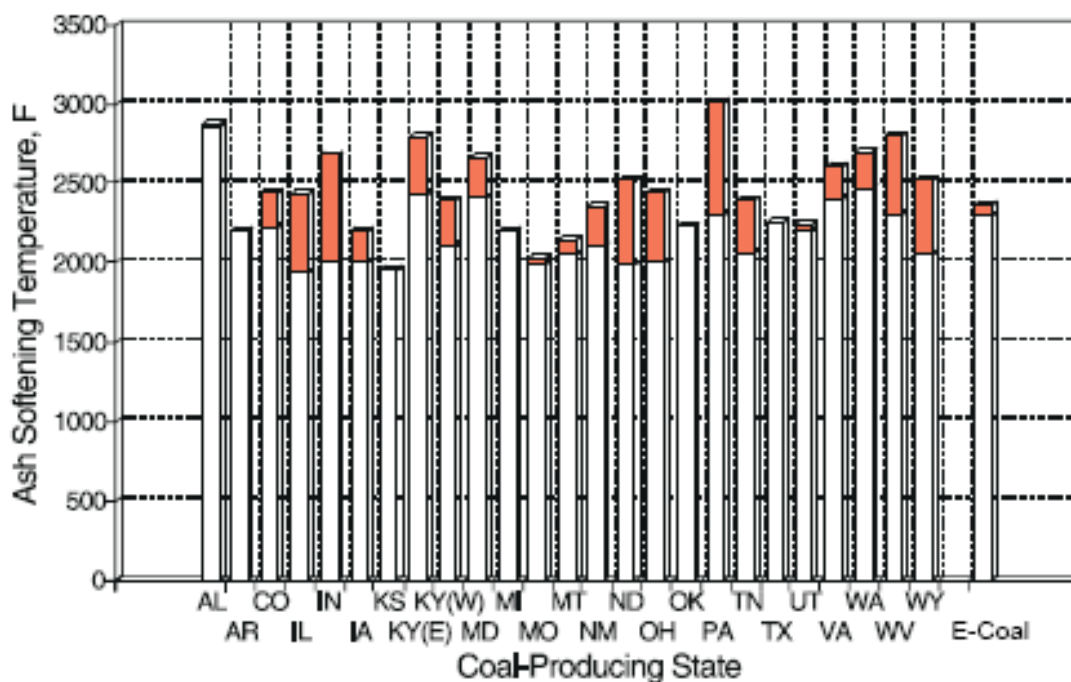
	Fouling	Slagging	Consequence
Low	0.2	0.6	
Medium	0.2 - 0.5	0.6 - 2.6	
High	0.5 - 1.0		Soot blow once/day
Severe	1		Soot blow hourly

On the basis of the CT&E indices, E-Coal would be considered a high fouling but low slagging coal.

Ash Fusion Temperature

Table II compares the ash fusion temperature points of E-Coal with three representative coal ashes. Unlike many Western and Midwestern coals, E-Coal does not require the use of a cyclone or wet-bottom furnace to control slagging. Its higher fusion temperature (~2484°F) lends itself far better to conventional pulverized coal and fluidized bed combustion applications, and its T250 temperature (2660°F) is too high for conventional slag tap operation. As a result, E-Coal is best suited for the dry bottom combustion applications that predominate the coal burning industry. Figure 5 presents a comparison of ash softening temperatures for E-Coal and commercial coals from most coal-producing states.

Figure 5.
Ash Softening Temperatures – Representative Coals



Trace Elements

Because E-Coal is produced from waste containing manufactured goods, it contains greater quantities of some trace metals than does coal produced from prehistoric sources. Table III provides a comparison of the trace element contents of E-Coal ash with ash from three other coals.

Table III
Trace Element Composition mg/kg (ash basis)

Element	E-Coal	Ohio	Wyoming	Montana
As	302	120	37	17
Ba	<1	-	-	-
Cd	32	1	2	3
Cr	336	14	123	30
Pb	114	26	43	69
Hg	0	1	3	1
Se	248	9	19	4
Ag	13	-	-	-
Be	2	17	5	7
Mn	94	154	642	202
Ni	232	55	90	15
V	1,291	137	383	69
Zn	437	120	284	110
F	216	564	802	549

In general, E-Coal ash tends to be higher in Lead, Zinc, Nickel and Cadmium (batteries), Copper (conductors), Selenium and Arsenic (semiconductors), Vanadium (oil products) and Chromium, while conventional ashes may be higher in Antimony, Beryllium, Manganese, Mercury, Fluorine and other trace elements. Overall, however, the levels of heavy metals are not significantly different from those occurring in natural coal ashes. The U.S. Geological Survey carried out an exhaustive analysis on American coal ashes, compiling heavy metal concentrations for up to 62 different samples from each of 359 mines representing 24 coal producing states. Figure 6 plots the range of heavy metal content for six priority metals in the ashes from coals in five of the largest coal producing states. In general, E-Coal ash metal contents fall within the normal range of the natural coals. Mercury is a significant exception, and tends to be much lower in E-Coal than in natural coals. As a result, although mercury emissions have created stack compliance problems for many waste incinerators, facilities burning E-Coal should not be at risk for mercury non-compliance.

Leachability

While trace element analysis is important in characterizing the potential environmental impact of using a solid fuel, a more meaningful measure is leachability. The environmental regulatory bodies refer to standard extraction procedures (E.P.Toxicity, Toxic Chemical Leachate Procedure [TCLP]) which characterize the ability of the trace elements to enter the environment through the ground water. Results of these tests are used to determine the suitability of solid fuels for outdoor storage and ash for landfill disposal.

Figure 6.
Heavy Metal Content – Comparison with Natural Coal Ashes

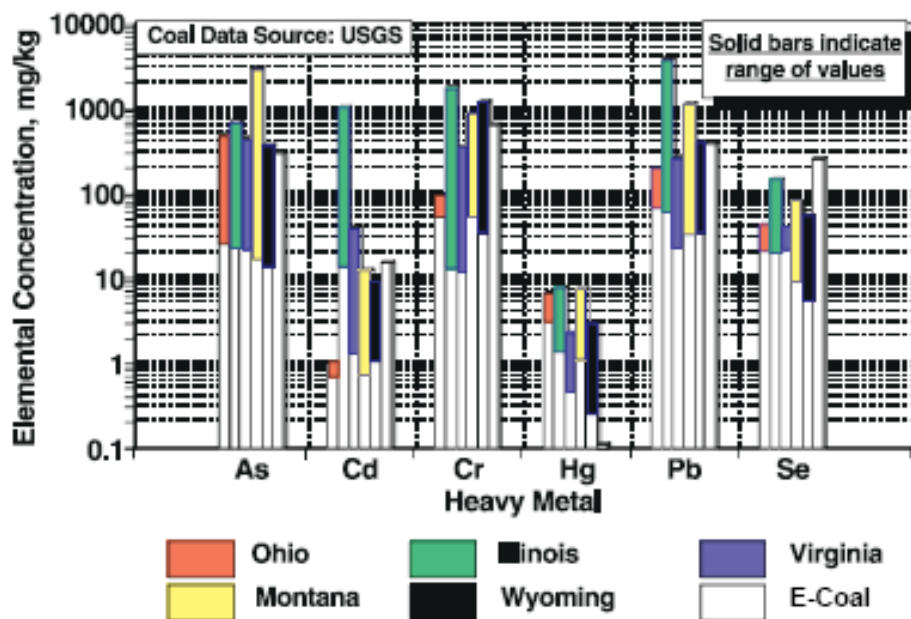


Table IV presents the results of E.P. Toxicity testing of both E-Coal and its ash, together with current Federal regulatory limits. The results of the TCLP analysis of E-Coal ash are also presented. For each element referenced by the procedures, leachate concentrations of both

Table IV.
E-Coal Leachability Characteristics

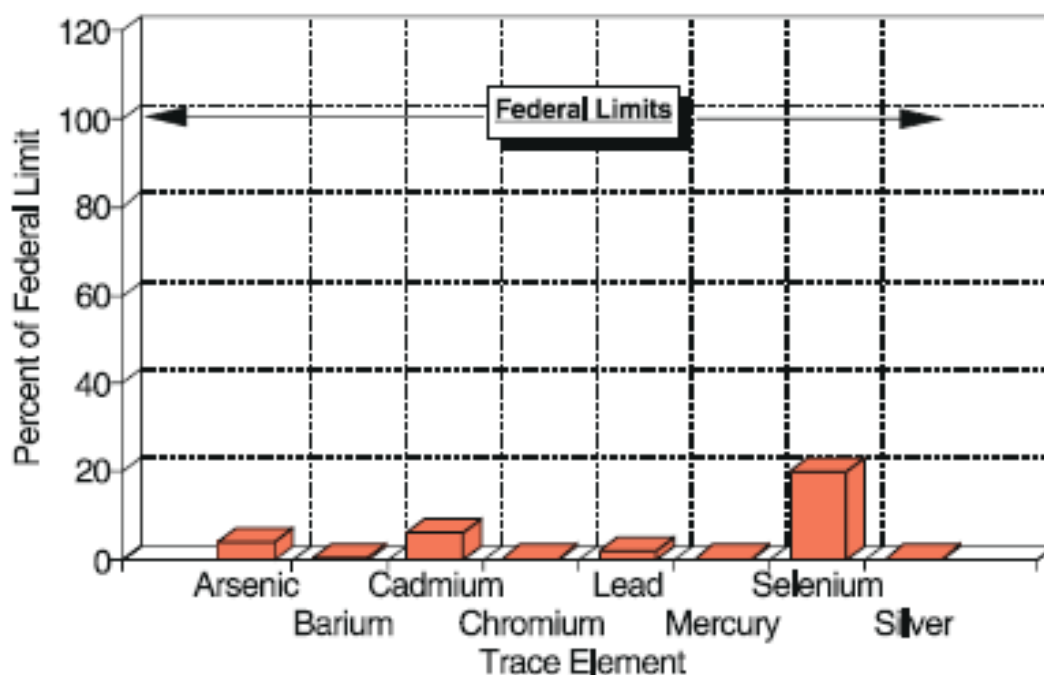
Species Concentration (mg/l)	E.P. Toxicity E-Coal	E.P. Toxicity Ash	TCLP Analysis E-Coal Ash	Regulatory Limits
Arsenic	< 1.0	< 0.2	< 0.2	5.0
Barium	< 0.1	0.34	0.50	100.0
Cadmium	< 0.1	< 0.01	0.01	1.0
Chromium	< 0.1	0.03	0.01	5.0
Copper	< 0.1	-	-	-
Lead	< 1.0	<0.05	0.09	5.0
Mercury	-	< 0.0002	0.0002	0.2
Selenium	< 1.0	0.14	0.20	1.0
Silver	< 1.0	0.05	< 0.01	5.0

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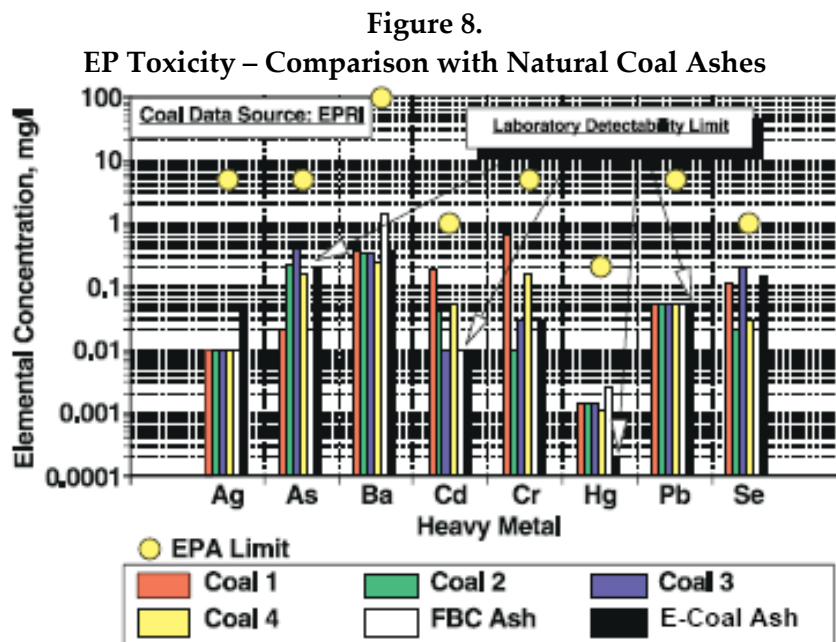
The E-Coal and its ash fall well within the regulatory limits, often by two to three orders of magnitude. As a result of this excellent performance, the Michigan Department of Natural Resources has determined that E-Coal ash can be disposed of in the same manner as, and in the same landfill with ash produced from the combustion of conventional coals. Figure 7 graphically compares the leaching characteristics (TCLP) of E-Coal ash against the Federal standards.

As with overall heavy metal content, the leaching characteristics of E-Coal are not significantly different from those of natural coal ashes. Figure 8 presents data developed by the Electric Power Research Institute in an extensive study evaluating the EP-toxicity and TCLP analysis procedures, and were taken from large utility boiler ash samples. The Quanta data were taken from E-Coal produced from first generation commercial RDF facilities. Four out of eight of the E-Coal measurements were below the commercial laboratory's detection limits. For all metals, the E-Coal measurements were comparable to those of natural coal ashes, and were at least one full order of magnitude below the allowable regulatory limits.

Figure 7.
TCLP Analysis – Quanta E-Coal Ash



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Physical Characteristics

E-Coal is a dry, granular, black solid material strongly resembling crushed coal. The particle size distribution chart given as Figure 9 shows that the average size of E-Coal is approximately 25 mesh, with 90 percent greater than 100 mesh, and 90 percent smaller than eight mesh. Because of its relatively fine size (compared to "run of mine" or double screened washed coals), E-Coal must be transported in covered trucks or rail cars, or sprayed to reduce dust losses during shipment.

Unlike conventional run of screened coals or mine, E-Coal does not require crushing prior to pile storage to minimize air infiltration and oxidation. E-Coal's very low sulfur and moisture contents also minimize the hazard of spontaneous ignition that occurs in conventional coal storage. E-Coal has a compacted bulk density of 45-50 lb/cu ft, comparable to conventional coal.

E-Coal is an excellent feedstock to pulverized coal boilers due to its high Hardgrove Grindability Index (HGI). Coal pulverizers are rated on capacity, fineness of product, and parasitic energy requirement, based on HGI, with a value of 50 or 55 taken as the reference standard. E-Coal, with a HGI of 114, will give a pulverizer 70 percent greater capacity at the same coal fineness, or the ability to produce 90 percent eight mesh particle size compared to a normal sizing of only 70 percent 8 mesh. This improvement in coal fineness translates to a 70 percent reduction in unburned carbon losses, a 1-2 percent improvement in boiler efficiency, and a reduction in ash deposition tendencies inside the boiler. Figures 2 and 10 compare the Hardgrove index for E-Coal with those of commercial coals.

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Figure 9.
Particle Size Distribution – Quanta E-Coal

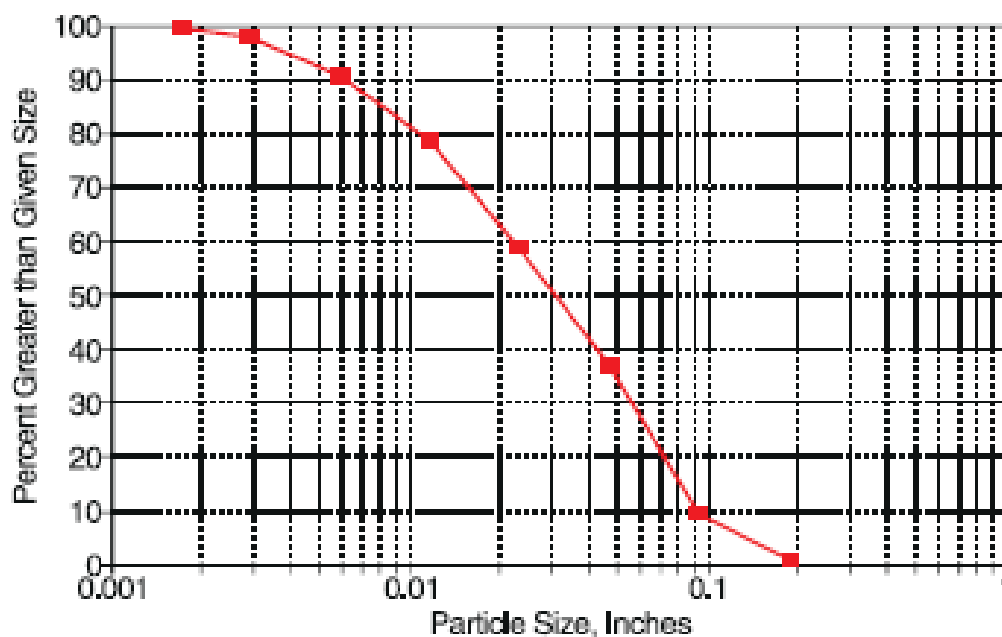
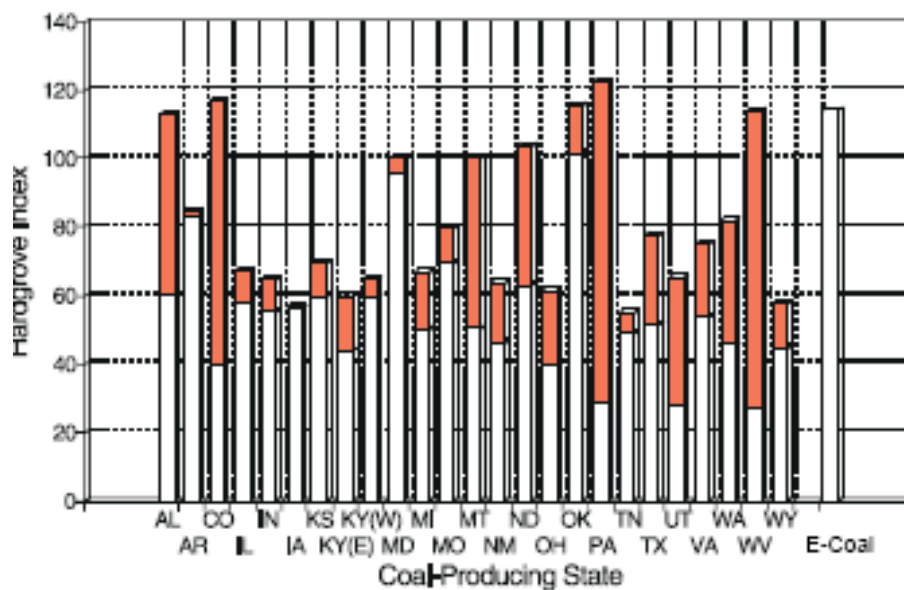


Figure 10.
Hardgrove Grindability Index

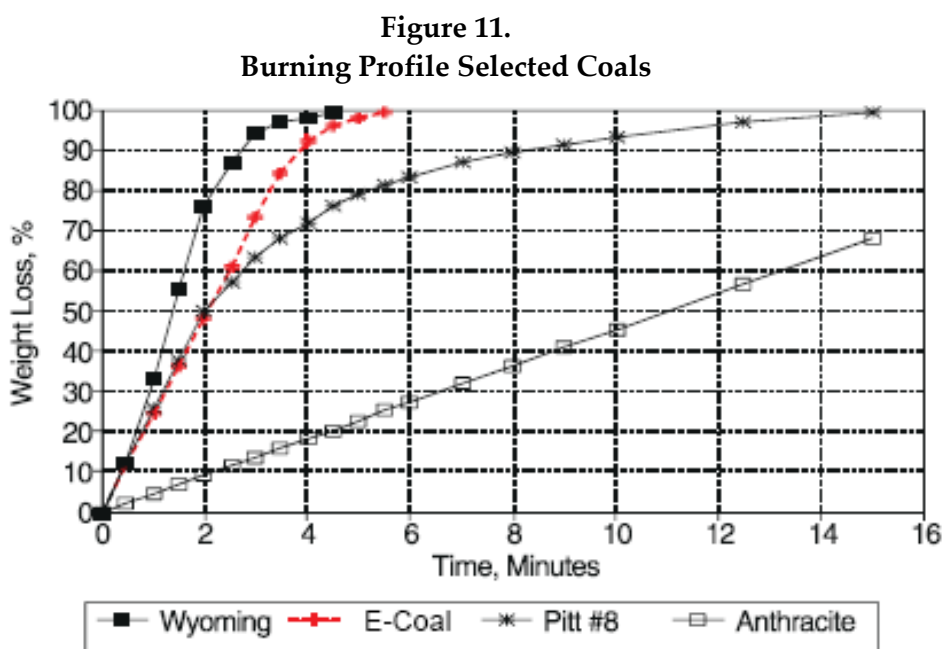


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Combustion Characteristics

As a dry, high volatile solid fuel, E-Coal can be easily burned in conventional pulverized coal burning equipment. E-Coal has a flammability index of 750°F, and produces stable flames. The laboratory test that measures ignitability, reactivity and carbon burnout characteristics is the "Burning Profile", or DTGA analysis. Figure 11 compares burning profiles for three coals and E-Coal, as performed by Combustion Engineering's Kreisinger Combustion Laboratory. The initial slope of the burning profile indicates ignitability. E-Coal's profile parallels that of the high volatile bituminous coal, demonstrating good ignition characteristics. Similarly, the E-Coal profile tails out to complete combustion at a point between those of the sub-bituminous and bituminous coals, showing good carbon burnout characteristics.

When compared with Eastern bituminous and Western sub-bituminous coals in actual combustion tests, E-Coal has been found to be fully compatible with boilers now burning those coals.



Carcinogenic Materials and Dioxin Formation

Many fuels derived from waste have been found to contain polycyclic chlorinated hydrocarbons and other materials the EPA suspects of being carcinogenic in nature. Incomplete combustion of these materials may lead to the formation of dioxins. The EPA has developed several test procedures (EPA 8240, 8270) to detect the presence of roughly nine (9) dozen environmentally sensitive chemical species. These procedures were applied to E-Coal, with the results summarized in Table V. For each compound of concern, an independent laboratory was unable to detect any presence of that material.

Dioxins form when polycyclic organic compounds react with chlorine and free oxygen at temperatures between about 600°F and 1800°F. Above 1800°F, the organic compounds (and

dioxins) are destroyed. E-Coal is produced in a strong reducing environment at a temperature below 600°F, and therefore has shown no evidence of containing dioxins. In a conventional boiler, E-Coal burns at temperatures in excess of 2500°F, resulting in the destruction of the hydrocarbons that could lead to dioxin formation.

Table V.
E-Coal Volatile Organic Analysis

Organic Species	Detection Limit ug/Kg	Concentration
Acetone	<100	BDL
Acroline	<5	BDL
Acrylonitrile	<5	BDL
Benzene	<5	BDL
Bromodichloromethane	<5	BDL
Bromoform	<5	BDL
Bromomethane	<10	BDL
2-Butanone (MEK)	<100	BDL
Carbon Disulfide	<5	BDL
Carbon Tetrachloride	<5	BDL
Chlorobenzene	<5	BDL
Chloroethane	<10	BDL
2-Chloroethylvinyl ether	<10	BDL
Chloroform	<5	BDL
Chloromethane	<10	BDL
Dibromochloromethane	<5	BDL
1,1-Dichloroethane	<5	BDL
1,2-Dichloroethane	<5	BDL
1,1-Dichloroethene	<5	BDL
trans-1,2-Dichloroethene	<5	BDL
1,2-Dichloropropane	<5	BDL
cis-1,3-Dichloropropene	<5	BDL
trans-1,3-Dichloropropene	<5	BDL
Ethyl Benzene	<5	BDL
2-Hexanone (MnBK)	<50	BDL
Methylene Chloride	<5	BDL
4-Methyl-2-Pentanone (MIBK)	<50	BDL
Styrene	<5	BDL
1,1,2,2-Tetrachloroethane	<5	BDL
Tetrachloroethylene	<5	BDL
Toluene	<5	BDL
1,1,1-Trichloroethane	<5	BDL
1,1,2-Trichloroethane	<5	BDL
Trichloroethylene	<5	BDL
Xylenes	<5	BDL
Vinyl Acetate	<50	BDL
Vinyl Chloride	<10	BDL

BDL = Below Detection Limits

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Acid Fraction	Detection Limit ug/Kg	Concentration
4-Chloro-3-methylphenol	<1300	BDL
2-Chlorophenol	<660	BDL
2,4-Dichlorophenol	<660	BDL
2,4-Dimethylphenol	<660	BDL
2,4-Dinitrophenol	<3300	BDL
2-Methyl-4,6-dinitrophenol	<3300	BDL
2-Methylphenol	<660	BDL
4-Methylphenol	<660	BDL
2-Nitrophenol	<660	BDL
4-Nitrophenol	<3300	BDL
Pentachlorophenol	<3300	BDL
Phenol	<660	BDL
2,4,5-Trichlorophenol	<660	BDL
2,4,6-Trichlorophenol	<660	BDL

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Base Neutral Fraction	Detection Limit ug/Kg	Concentration
Acenaphthene	<660	BDL
Acenaphthylene	<660	BDL
Anthracene	<660	BDL
Benzidine	<660	BDL
Benzo(a)anthracene	<660	BDL
Benzo(b)anthracene	<660	BDL
Benzo(k)anthracene	<660	BDL
Benzoic Acid	<3300	BDL
Benzo(a)pyrene	<660	BDL
3,4-Benzofluoranthene	<660	BDL
Benzo(ghi)perylene	<660	BDL
Benzo(k)fluoranthene	<660	BDL
Benzyl Alcohol	<1300	BDL
Bis(2-chloroethyl)ether	<660	BDL
Bis(2-chloroethoxy)methane	<660	BDL
Bis(2-ethylhexyl)phthalate	<660	BDL
Bis(2-chloroisopropyl)ether	<660	BDL
4-Bromophenyl phenyl ether	<660	BDL
Butyl benzyl phthalate	<660	BDL
4-Chloroaniline	<1300	BDL
2-Chloronaphthalene	<660	BDL
4-Chlorophenyl phenyl ether	<660	BDL
Chrysene	<660	BDL
Dibenzo(a,h)anthracene	<660	BDL
Dibenzofuran	<660	BDL
Di-n-butylphthalate	<660	BDL
1,2-Dichlorobenzene	<660	BDL
1,3-Dichlorobenzene	<660	BDL
1,4-Dichlorobenzene	<660	BDL
3,3'-Dichlorobenzidine	<3300	BDL
Diethyl phthalate	<660	BDL
Dimethyl phthalate	<660	BDL
2,4-Dinitrotoluene	<660	BDL
2,6-Dinitrotoluene	<660	BDL
Di-n-octylphthalate	<660	BDL
1,2-Diphenylhydrazine	<660	BDL
Fluoranthene	<660	BDL
Fluorene	<660	BDL
Hexachlorobenzene	<660	BDL
Hexachlorobutadiene	<660	BDL
Hexachlorocyclopentadiene	<660	BDL
Hexachloroethane	<660	BDL
Indeno(1,2,3-cd)pyrene	<660	BDL
Isophorone	<660	BDL
2-Methylnaphthalene	<660	BDL
Naphthalene	<660	BDL
2-Nitroaniline	<3300	BDL
3-Nitroaniline	<3300	BDL
4-Nitroaniline	<3300	BDL
Nitrobenzene	<660	BDL
N-nitrosodimethylamine	<660	BDL
N-nitrosodiphenylamine	<660	BDL
N-nitrosodi-n-propylamine	<660	BDL

Not For Public Distribution

Phenanthrene	<660	BDL
Pyrene	<660	BDL
1,2,4-Trichlorobenzene	<660	BDL