

PT. ADARO INDONESIA

adaro

ENVIROCOAL



THE BENEFITS OF ENVIROCOAL

INTRODUCTION

PT Adaro Indonesia has developed a major steam coal deposit in the Tanjung district of South Kalimantan. The defined coal resource to date is 1,970 million tonnes of surface minable coal. The coal is exceptionally clean at 1.0% ash and 0.1% sulphur and has been trademarked 'Envirocoal'.

Mining conditions are excellent with a number of thick seams up to 50 meters in thickness, uniform coal quality throughout the seams, and relatively thin overburden.

Envirocoal is widely used in power plants and industrial plants throughout Europe, Asia and the Americas. Results have consistently shown considerable benefits from use of the coal. The benefits are both environmental, meeting required standards, and economic.

Overview

Envirocoal has a number of quality features:

- sulphur of 0.1%
- low to very low pyritic sulphur
- ash of 1%
- low nitrogen
- total moisture of about 25%
- heat value of 5,250 kcal/kg on an as received basis

Although Envirocoal is unique in some of its properties it can be handled and transported like other coals, and also pulverized and fired in equipment used for other coals. Envirocoal has been used successfully in all types of boilers, including pulverized coal boilers, fluidized bed boilers, stokers, in the cement industry and in general industry such as pulp and paper plants.

The benefits are:

1. *technical performance*
 - excellent ignition and good combustion characteristics
 - 99% combustion efficiency
 - minimal impact on equipment
 - low ash deposition rate
2. *environmental*
 - low SO₂ emissions
 - decrease in particulate emissions
 - less wastes
 - low NO_x emissions
3. *economic*
 - environmental compliance at lowest cost
 - reduced equipment maintenance
 - FGD's not required
 - higher unit availability
 - less waste for disposal
 - low cost of electricity or steam

Envirocoal is also an excellent coal for blends. The chemical interaction of ash from different coals, often a problem with blends, is minimized or eliminated when using Envirocoal. Other benefits are improved ignition, stable flames, and higher combustion efficiency of the blends. There will be a decrease in emissions and wastes.

In general no special equipment is needed to handle the coal. Stockpile compaction and maintenance may be required if the coal is stored for extended periods of time.

Technical Benefits

Envirocoal is a low ash, low sulphur sub-bituminous coal that is easily stored with no detrimental effect to the environment. Tables 1, 2 and 3 show the trace metals in the coal, the amount of certain chemical species that will be leached by rainwater during storage, and the amount of radionuclides in the coal. These characteristics are some of the lowest of any coal in the world.

The coal is a reactive coal, and in most cases it is not necessary to grind the coal as fine as other coals to burn well. This can result in less energy to grind the coal. (Figure 1) The high surface area, combined with higher volatile matter, results in excellent ignition, stable combustion, and near complete char burnout. Combustion efficiency is often greater than 99.7%.

Ash from export bituminous coals is predominantly silica, alumina, and pyrite (often greater than 90% of the ash). These minerals, especially when they are large discrete particles, contribute to wear, erosion and slagging in the furnace. In Envirocoal the amount of silica and alumina can be less than 60%, pyrites are low or nonexistent, and actual ash particles are relatively small in size. This will result in much less wear and erosion when using Envirocoal.

Ash has an impact on the operation and availability of a power station. Compared to other coals, the greatly reduced amount of ash being “processed” by the power plant when using Envirocoal can significantly reduce the impact of ash on the equipment. Although these benefits have not been quantified, experience has shown:

- reduced wear and erosion of pulverizer parts
- reduced maintenance on pulverizers
- reduced wear and erosion of coal pipes, burner parts and boiler tubes
- reduced wear and erosion of air preheated elements
- increased availability due to the low rate of ash deposition

It is expected that the combined effect of all these, compared to standard higher-ash coals will amount to savings of millions of dollars over the life of a power plant.

Ash deposition is always a potential problem in coal-fired furnaces. The deposition rate from Envirocoal is much lower, and sometimes non-existent. The experience from using the coal is that slagging is generally very low. The use of wall blowers and soot blowers, which reduce thermal efficiency, can be reduced significantly. Fouling is virtually non-existent.

TABLE 1. TRACE METALS IN ADARO ENVIROCOAL

Element	Concentration (mg/kg, arb)	Element	Concentration (mg/kg, arb)
Antimony	0.06	Manganese	8.83
Arsenic	0.37	Mercury	0.07
Barium	12.5	Molybdenum	<0.01
Beryllium	0.31	Nickel	2.7
Boron	<10	Selenium	0.2
Bromine	12	Silver	<0.01
Cadmium	0.01	Strontium	2.7
Chlorine	<0.02%	Thallium	0.16
Chromium	1.99	Tin	<1
Cobalt	1.3	Uranium	0.07
Copper	1.32	Vanadium	4.53
Fluorine	40	Zinc	6.18
Lead	1	Zirconium	3.9
Lithium	0.58		

TABLE 2. LEACH CHARACTERISTICS OF ADARO ENVIROCOAL

Element	Concentration* (mg/L in leachate)
Arsenic	<0.001
Barium	0.57
Cadmium	<0.001
Chromium	<0.005
Lead	0.03
Mercury	<0.0005
Selenium	<0.0005
Silver	<0.01

- Laboratory Toxicity Characteristic Leaching Procedure (TCLP)

TABLE 3 RADIONUCLIDES IN ADARO ENVIROCOAL

Isotope	Bq/kg ⁺
²³⁸ Uranium	<50
²³⁴ Thorium	<50
²²⁶ Radium	<50
²¹⁴ Lead	<50
²¹⁴ Bismuth	<50
²¹⁰ Lead	<50
⁴⁰ Potassium	<30
²³² Thorium	<30
²²⁸ Actinium	<30
²²⁸ Thorium	<30
²³⁴ Radium	<30
²¹² Lead	<30
²¹² Bismuth	<30
²⁰⁸ Thallium	<30

* Becquerels per kg

Environmental Benefits

Overview

Envirocoal is the best environmental solid fuel available. Gaseous emissions and particulate airborne emissions are lower than with any other solid fuel. The amount of captured ash wastes are small on an absolute basis, and very low compared to other coals. The chemical composition of airborne and captured ash wastes renders the ash wastes benign, and they are suitable for recycling, as in the cement industry.

Sulphur Oxides

The sulphur in Envirocoal is 0.1%, or less. This equates to 0.38 kg SO₂ /10⁶ kcal (0.21 lb SO₂/10⁶ Btu). Actual SO₂ emissions are lower because the basic nature of the ash will 'capture' some SO₂. Figure 2 shows SO₂ emissions. In some cases SO₂ emissions without FGD have been as low as 40 to 45 ppm.

Nitrogen Oxides

Most nitrogen oxides emissions, NO_x (NO and NO₂) come from the nitrogen in the fuel. In addition, the chemical bonding of nitrogen in the coal and combustion conditions contribute to NO_x emissions. Nitrogen in Envirocoal is a low 0.8% on an as received basis and in this type of coal it appears that much of the nitrogen exists in chemical groups exterior to the basic coal molecule. These critical factors, combined with the fact that Envirocoal can be burned with low excess oxygen, leads to unusually low NO_x emissions (Figure3).

Not all coals perform well in modern low NO_x burners with / without over fire air. Envirocoal is an exception. The lowest NO_x in Figure 3 of 74 ppm (~ 92 mg/Ncum) was achieved in a 550 MW wall-fired unit, with 3.5% excess O₂ plus 30% over-fire air. The unburned carbon in this case was less than 1%. This is an excellent performance for any coal.

Ash Wastes

The amount of ash wastes produced from Envirocoal is 80% to 90% less than most export bituminous coals. This represents a significant savings in the cost of disposal. Figure 4 shows the amount of ash for disposal from the 1% ash coal from a 655 MW unit compared to a 10% ash coal. This means that the life of existing ash ponds can be extended considerably. In some cases using a low ash coal has extended the life of a plant. In an atmosphere of ever tighter regulations, this single benefit of low ash can be significant in the permitting of new or extended, ash disposal areas.

Tests have been completed on the potential behavior of the ash wastes in the disposal area. Table 4 shows trace and other metals in fly ash, and how much is leached from the ash in a laboratory procedure. Based on this standard environmental test, there will not be significant leaching by the action of rainwater or groundwater. The amounts leached are relatively small and are well below the acceptable standard in most countries.

Particulate Emissions

Experience has shown that standard electrostatic precipitators can easily collect ash from Envirocoal. This is contrary to the notion that ash is difficult to collect when the sulphur is very low. The electrical resistivity of Envirocoal's fly ash is in the range of $1 \times 10^{10-12}$ ohm-cm at typical gas temperatures. Sulphur trioxide (SO₃) is not needed to reduce fly ash resistivity. However, if SO₃ is available the fly ash from Envirocoal reacts very well. In the laboratory 2.7 ppm SO₃ reduced fly ash resistivity to 4×10^8 ohm-cm.

Actual data from power stations has shown that collection efficiency might be slightly lower when using the coal. However, in spite of possible lower efficiency of ash collection the amount of ash particles is emitted significantly lower than when using high ash coals. An example is shown in Figure 5.

In most electrostatic precipitators where Envirocoal is being used, the opacity is only 3 to 5 percentage points lower than typical higher ash bituminous coals. This is surprising since there is only 1% ash in the coal. Some possible reasons for this might be that the fly ash is normally a reddish-brown color, which might affect the light measurement of opacity in the stack. Also, the ash particles in Envirocoal are relatively small, compared to other coals.

TABLE 4 TRACE METALS LEACHED FROM FLY ASH

Metal	PPM, FLY ASH (dry basis)	PPM, LEACHED* (extract basis)
Aluminium	42,900	4.88
Antimony	<1	<0.005
Arsenic	22	0.011
Barium	1,020	0.078
Beryllium	11	<0.005
Cadmium	<1	<0.005
Calcium	35,900	259
Chromium	62	0.015
Copper	94	<0.005
Iron	37,200	<0.01
Lead	22	<0.01
Manganese	680	<0.005
Mercury	0.5	<0.0002
Molybdenum	<5	0.04
Nickel	100	<0.01
Selenium	<1	0.103
Silver	<1	<0.005
Sodium	3,050	26.5
Thallium	3	<0.005
Zinc	440	<0.005

* Extracted with a weak mineral acid in laboratory.

Unburned Carbon

Low unburned carbon is a requirement for the use of fly ash in the cement industry.

The loss of energy in the fly ash is much lower with Envirocoal because of the excellent combustion characteristics and the small amount of ash. As seen in Figure 6 for each tonne of coal fired, the equivalent of 0.5 kg of coal lost in the fly ash, while for the higher ash coal the equivalent of approximately 5 kg of coal is lost.

Modern environmental regulations require low NO_x. With most coals it is difficult to get low unburned carbon while achieving low NO_x. Using low NO_x burners and over fire air it is possible to achieve unburned carbon from 2% to 5%. In a 550 MW unit using low NO_x wall burners with 20% to 25% over fire air, NO_x less than 100 ppm (6% O₂) was achieved while unburned carbon varied from 0.7% to 2.2%.

Economic Benefits

The economic benefits are dependent upon a specific company and a specific power plant. Once the power plant has been built, the cost of electricity or steam is aggregated into three cost areas:

- fuel, approximately 85% of costs
- maintenance, approximately 10% of costs
- operating, approximately 5% of costs

Market conditions determine the fuel costs. Envirocoal is competitive with higher rank coals on per unit of energy basis. Maintenance costs of pulverizers, coal pipes, boiler tubes, and other equipment along the 'coal path' can usually be reduced because of the lessened impact of the ash.

In situations where Envirocoal can be used to meet environmental regulations without the need for a FGD system significant capital and operating costs can be saved. For example, for a 550 MW plant the cost of a limestone scrubber is approximately \$ 110 million (\$200 per kw). The fixed and variable operating costs are over \$ 10 million per year for the FGD system. In addition the electrical consumption of the FGD system is approximately 1% of generation. Depending on the value of electricity, over \$ 1.0 million per year can be saved. Thus, the use of Envirocoal can significantly affect the bottom line of the power plant.

For selective catalytic reduction (SCR) systems it is estimated that the capital cost is \$1,400 to \$3,000 per MW to remove NOx. In many cases it is possible to eliminate this cost when using Envirocoal. In one instance in Europe a power plant with SCR also needed to use 30% to 40% of Envirocoal to meet the NOx regulations. It is possible that the ultimate value of the coal will be the ability to achieve low NOx levels.

Many unit outages are directly related to ash. The amount of ash and the properties of the ash are important in this regard. Envirocoal can improve unit availability because the ash is low and its properties are not detrimental to the mills, the boilers, the air heater, and the ash handling system.

FIGURE 1. SPECIFIC MILLING POWER

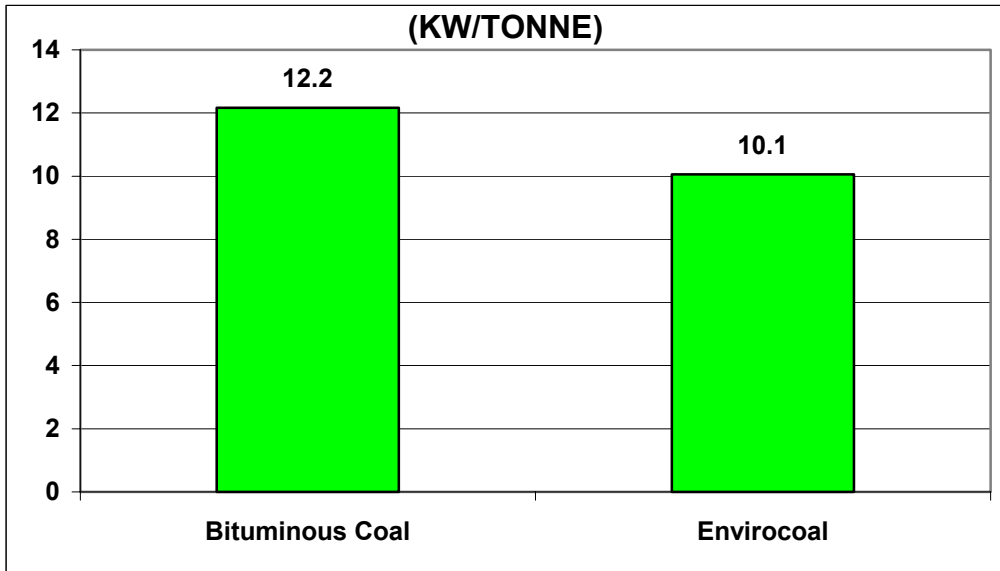


FIGURE 2. SO2 EMISSIONS

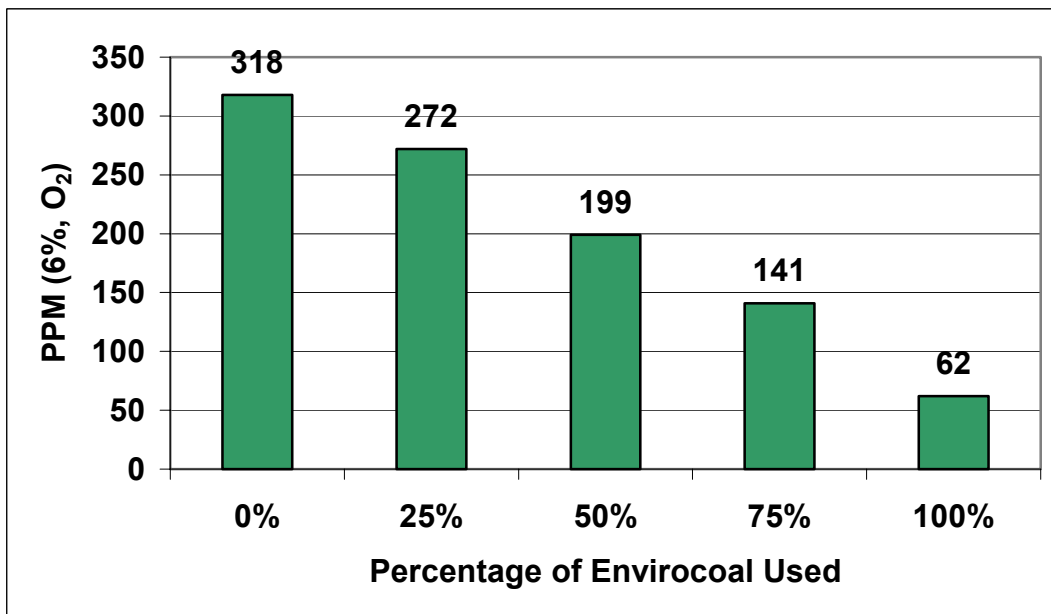


FIGURE 3. Nox EMISSIONS

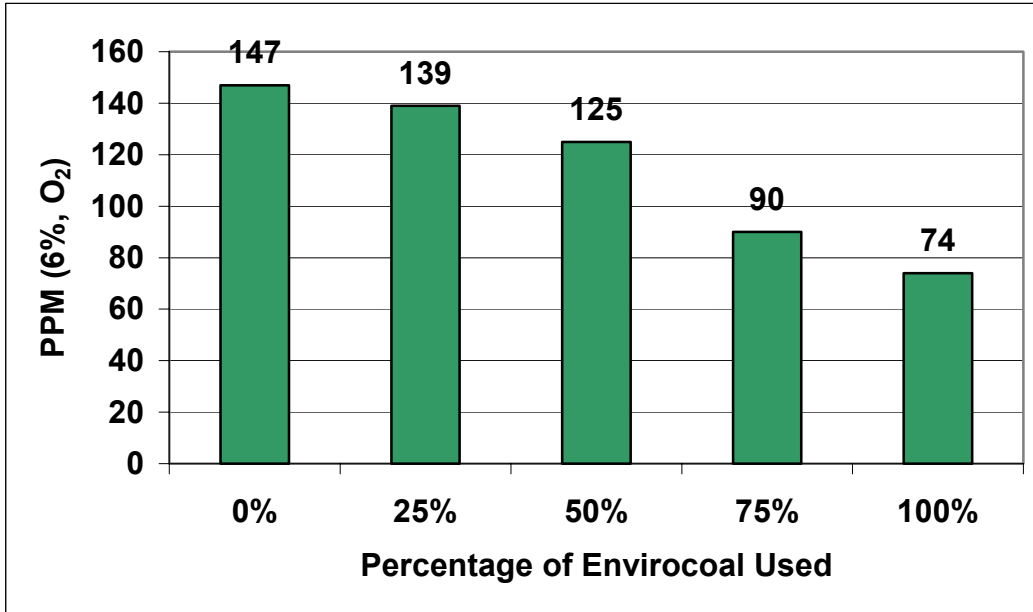


FIGURE 4. ASH FOR DISPOSAL

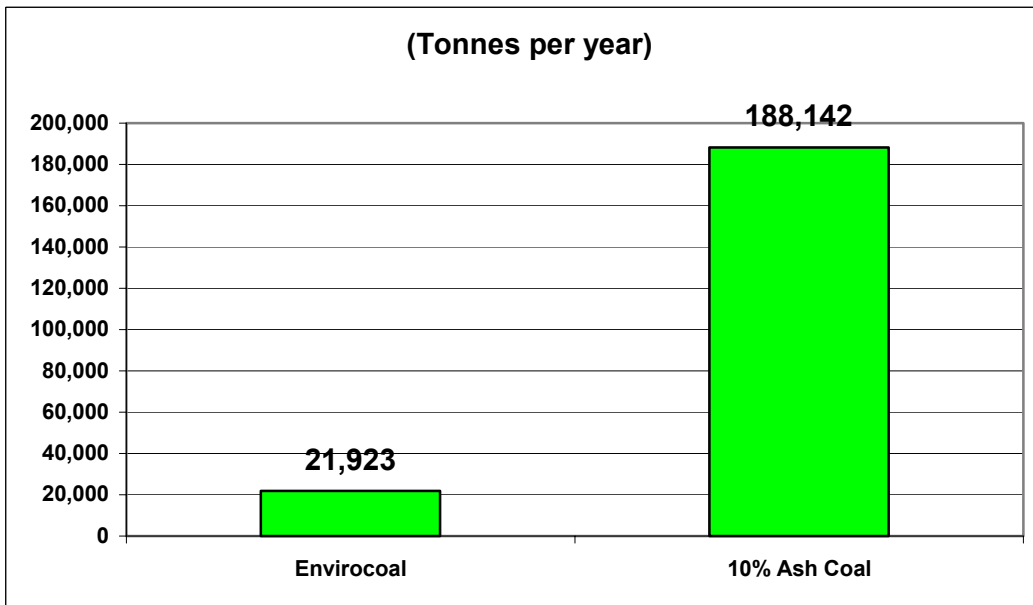


FIGURE 5. ASH EMISSIONS

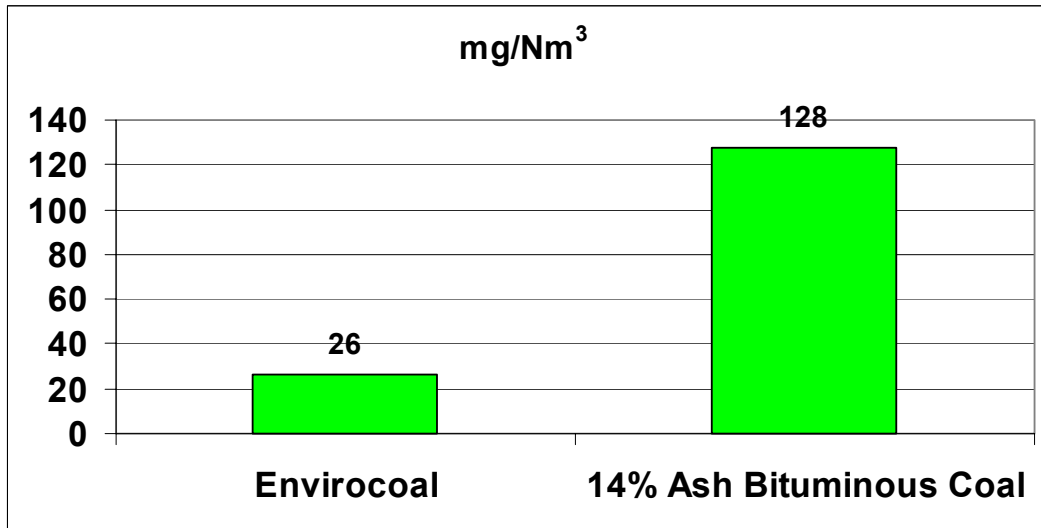


FIGURE 6. ENERGY LOSS IN FLYASH

