
DRYCol®
Microwaves for Coal Quality Improvement
The Drycol Process.

This Presentation

The Drycol Project is an ongoing development concerned with applying advanced microwave (MW) technology for improving coal quality as a large-scale, continuous process. The Project is an initiative of DBAGlobal Australia, an established organisation for delivering feasibility studies, engineering, project management and management support services for (mainly) mining companies, operations and projects.

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The “Problem”

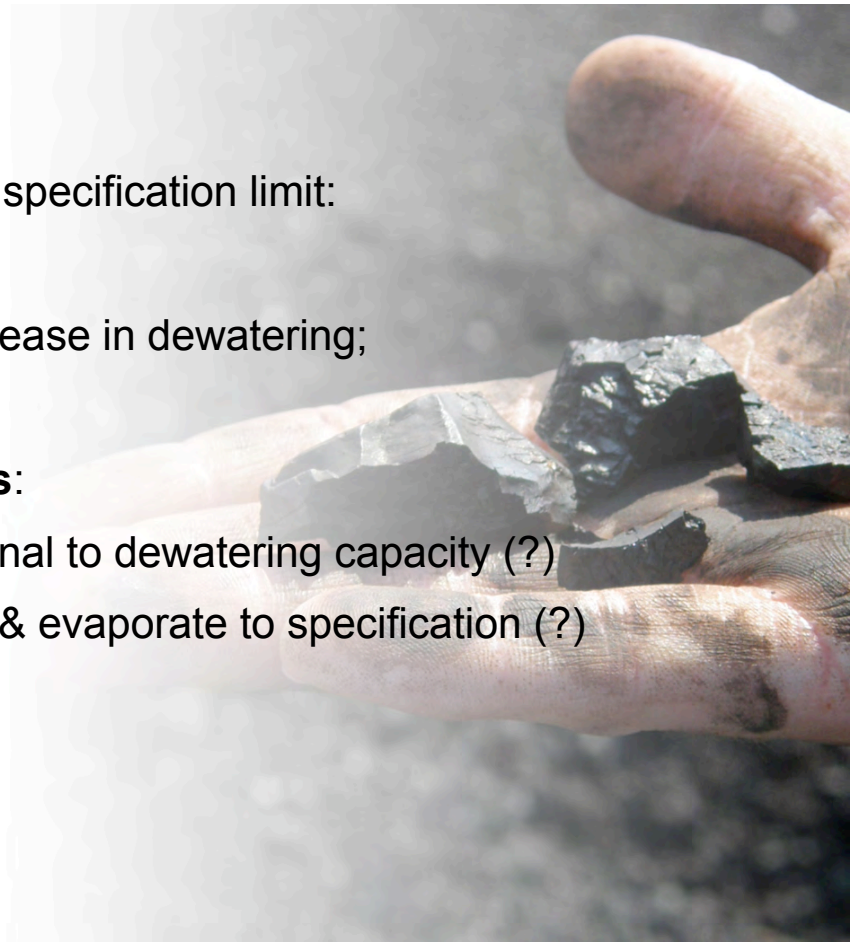
(1) **Increased total moisture** (%TM) above specification limit:

- Increase in % fines;
- Increase in plant throughput / decrease in dewatering;
- Inclement weather.

(2) **Lack of suitable control action options**:

- Reduce plant throughput proportional to dewatering capacity (?)
- Stockpile for long enough to drain & evaporate to specification (?)
- Reject coal fines (?)
- Hope and pray*(?)

* **Note: this is not a management tool...**



The “Prize”

(1) **Moisture controlled by MW drying:**
- Robust, proven technology;
- Simple process control

(2) **Sulfur and Mercury reduction:**
- Reduced emissions;
- Potential savings in emissions trading;
- Mitigation of license requirements for coal customers

(3) **Sustainable Development:**
- Water recovery;
- Fuller utilization of coal reserves

(4) **Potential to reduce Alkalis and Phosphorus in coal:**

(5) **Add value to product coal**

The Concept

Coal Mine

The Drycol Process adapts existing, proven industrial microwave technology, for improving coal quality as a large-scale, continuous operation.

Microwave drying plant

End User.

Reject Coking Coal Ultrafines?

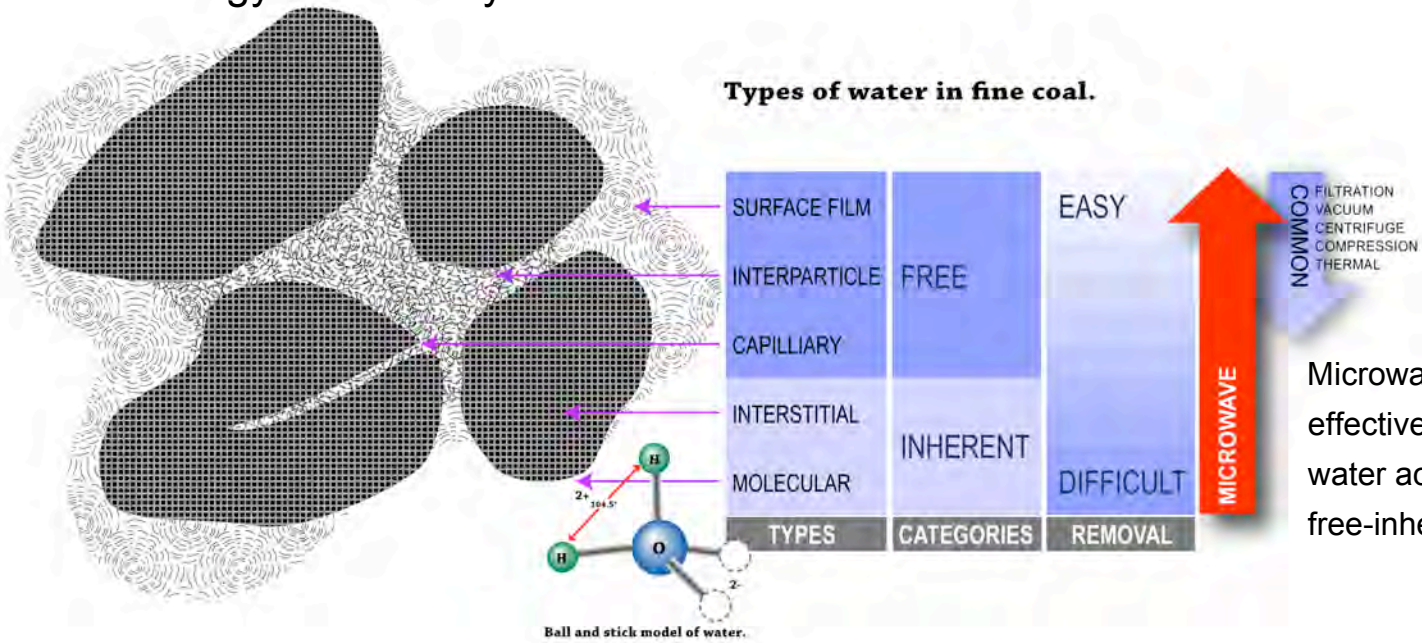
DRYING OPTION COMPARISONS (2 MTPY OPERATION)				
		Discarding Fines (Base Case)	Fluidized Bed Thermal Drier (Product as fuel)	Microwave Drier
CPP Product	tph	212.5	261.0	264.0
Dryer Feed		N/A	All Product	All Filter Cake
CAPEX	$	2,400,000	(19,953,005)	(35,280,000)
OPEX (p.a.)	$	500,000	2,610,000	3,240,000
Additional Revenue (p.a.)	$	-	66,514,286	70,628,571
NPV (i = 10%)	$	5,472,284	261,442,826	266,119,180

Assumptions:	Total Product Moisture:	8%
	Product Sale Price	$240/tonne

Why the Technology is Effective

Why the technology is effective:

- The geological makeup of coal is largely transparent to MW energy;
- Water is super-absorbent to MW energy;
- MW energy is efficiently delivered to both free and inherent water.

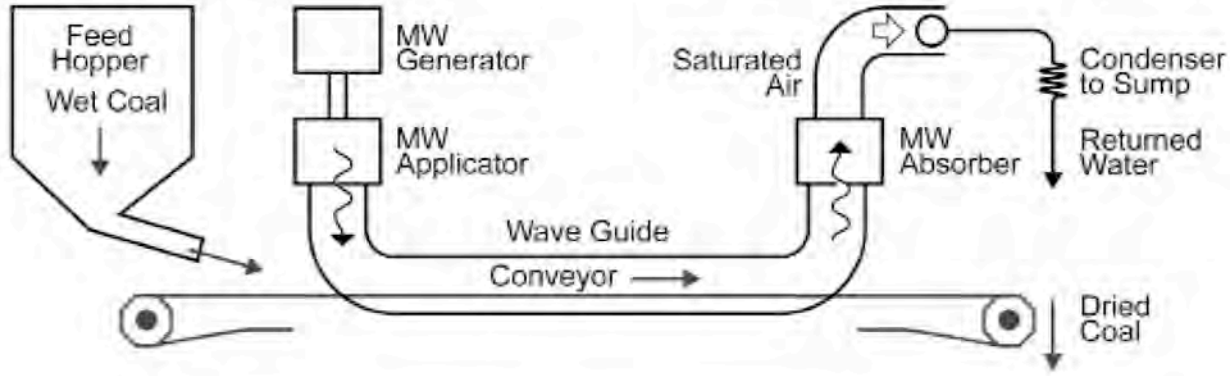


Microwaves are effective for removing water across the entire free-inherent spectrum

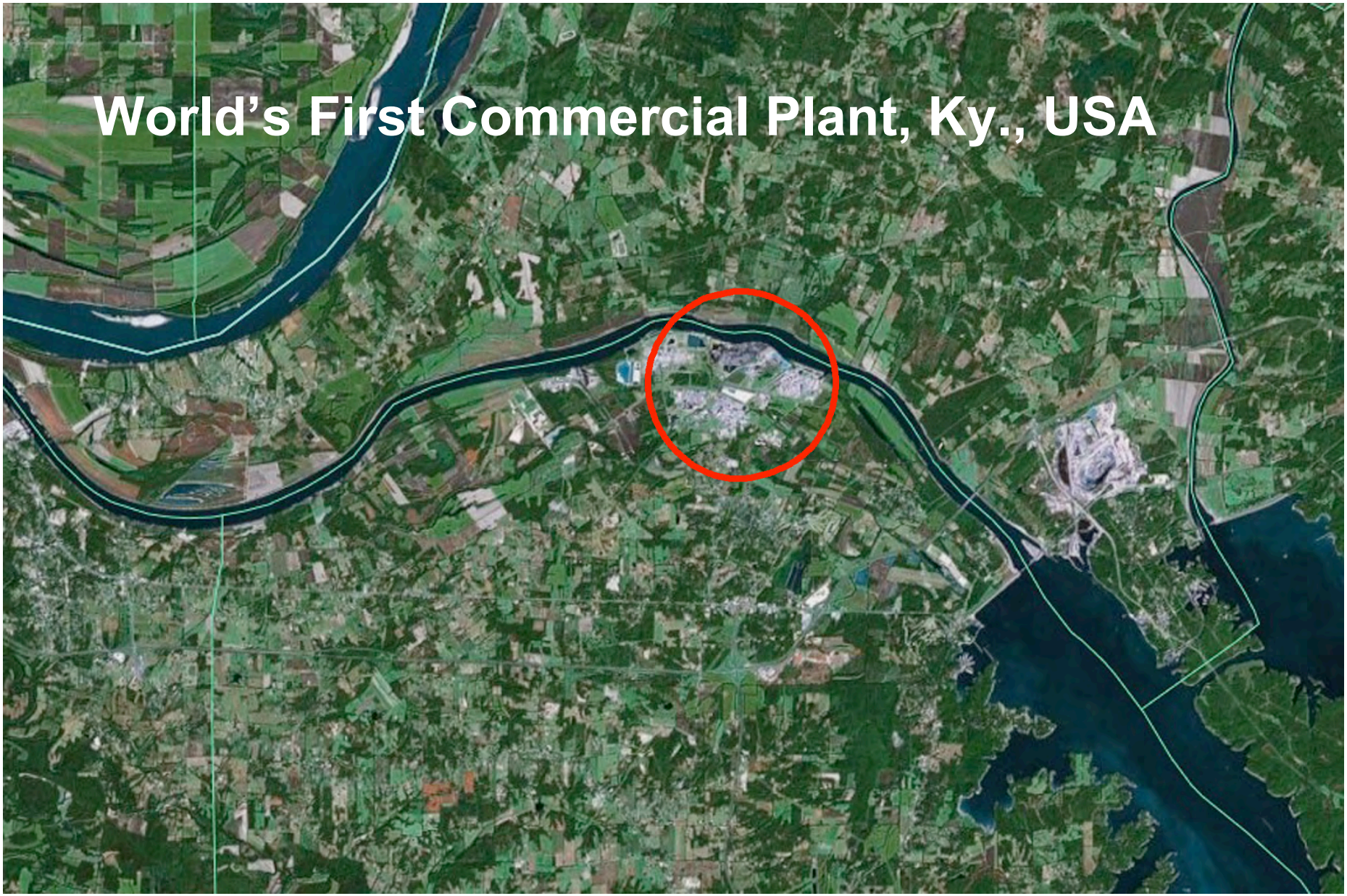
The Process

The process is effective because:

- It adapts existing, proven industrial equipment;
- Real-time electronic (eg, SCADA) controls achieve precise process targets;
- It is robust, reliable, instantly responsive to control inputs



MICROWAVE DRYING OF COAL: US Patent Application 2007015114; International Patents Pending

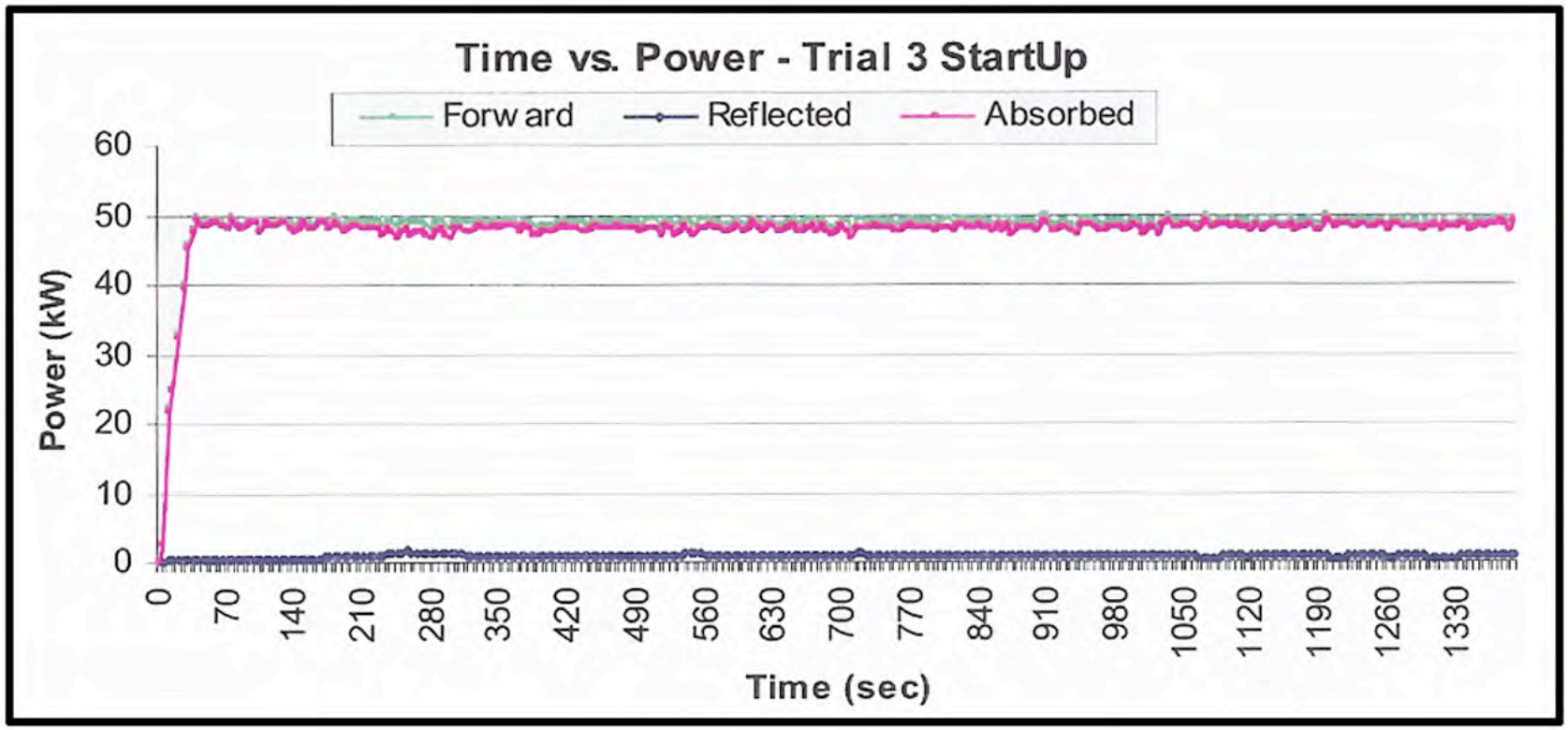

World’s First Commercial Plant, Ky., USA

View from footbridge of the world-first Commercial-Scale (3 MW) Microwave Coal Drying Plant in Kentucky.


Feed zone for -50mm sized coal.

Microwave dried coal emerging from the Drying Zone.

Microwave Energy Absorbed




Free and Inherent Moisture is removed
The product acquires a “dried through” consistency, with no measured degradation of Thermal or Coking qualities.

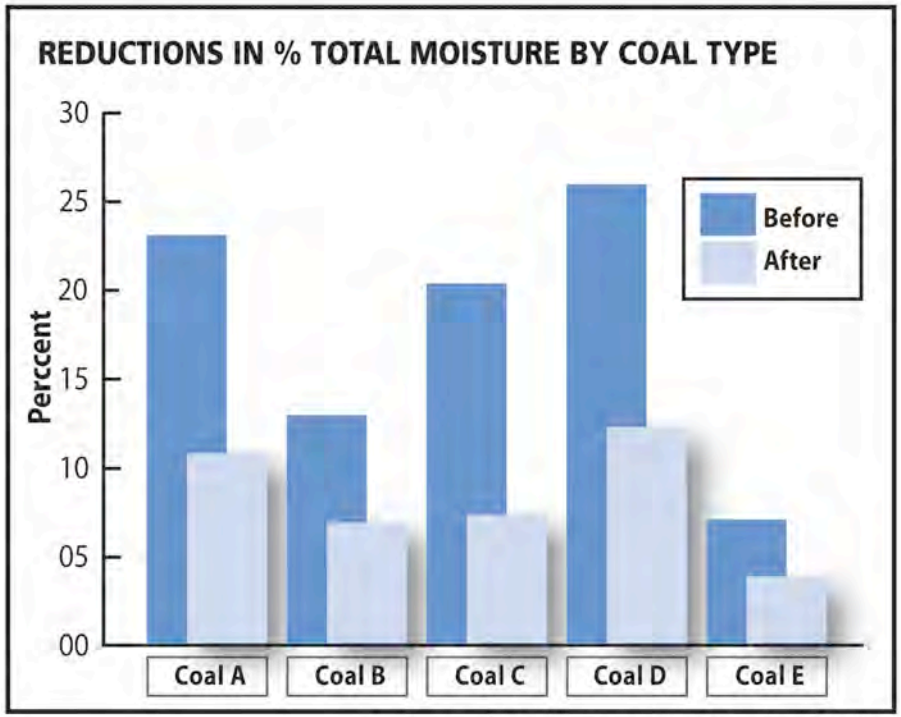
Moisture Reduction Program

Testwork

The Process was used to dry five types of Fine metallurgical coal to suitable levels for moisture control. The dried coal was compared with control samples.

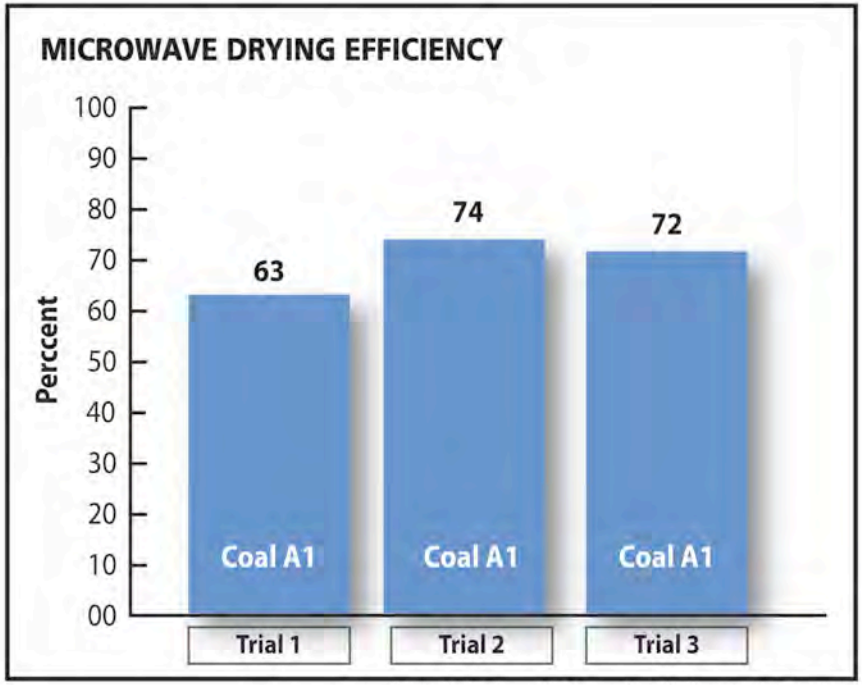
The Process significantly lowered the %TM in each of the processed samples.

Analysis showed that the moisture reduction had been achieved without raising the product temperature sufficiently to diminish coking and thermal properties.

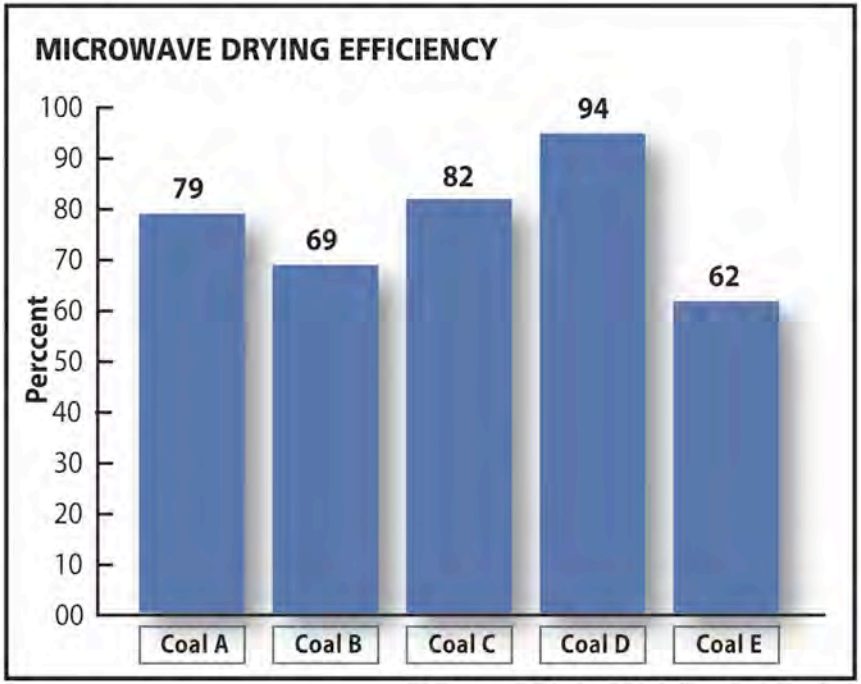


(5 Types of Washed Fine Metallurgical Coal)

Microwave Drying Efficiency



(Single Type of Unwashed Thermal Coal)



(5 Types of Washed Metallurgical Coal)

Reduction in Sulphur was observed

Microwaves were used to dry various coal types. Dewatering remained the primary focus, with power settings and belt speeds aimed at moisture control. The dried coal was analysed and compared with control samples.

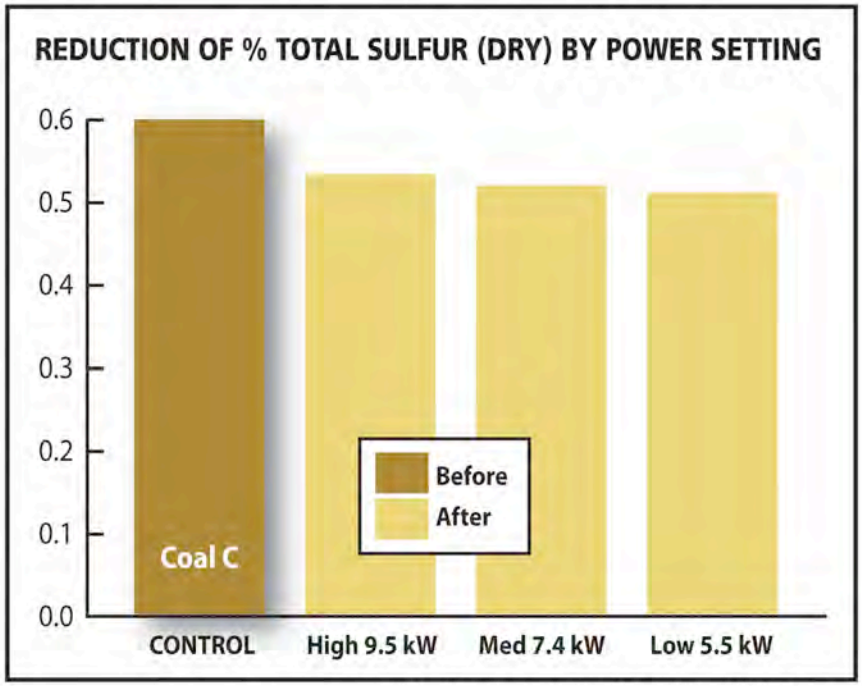
A reduction in Sulphur was observed.

Conclusions:

(1) Sulfur reduction results were specific to coal type (Coal C);

(2) The highest reduction occurred on the “Low” power setting;

(3) Further investigation is warranted.



(Single Type Washed Metallurgical Coal)

Reduction in Alakali-Phosherous

The dried samples were analysed and compared with control samples to confirm there had been no detrimental effect on coking and thermal properties.

The testwork had been targeting moisture reduction. Nevertheless, a reduction in Alkali-Phosphorus was observed.

The anticipated Sulphur reduction (as described in the literature) was not observed in this initial program.

Additional testwork was then undertaken:

(1) to confirm the moisture reduction; and

(2) to examine the Sulfur-Alkali-Phosphorus reduction phenomenon.

Figure 12: Rank vs K_2O

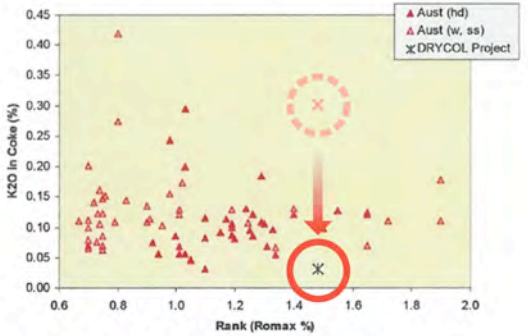
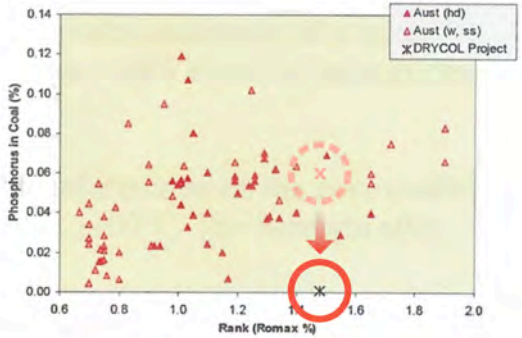
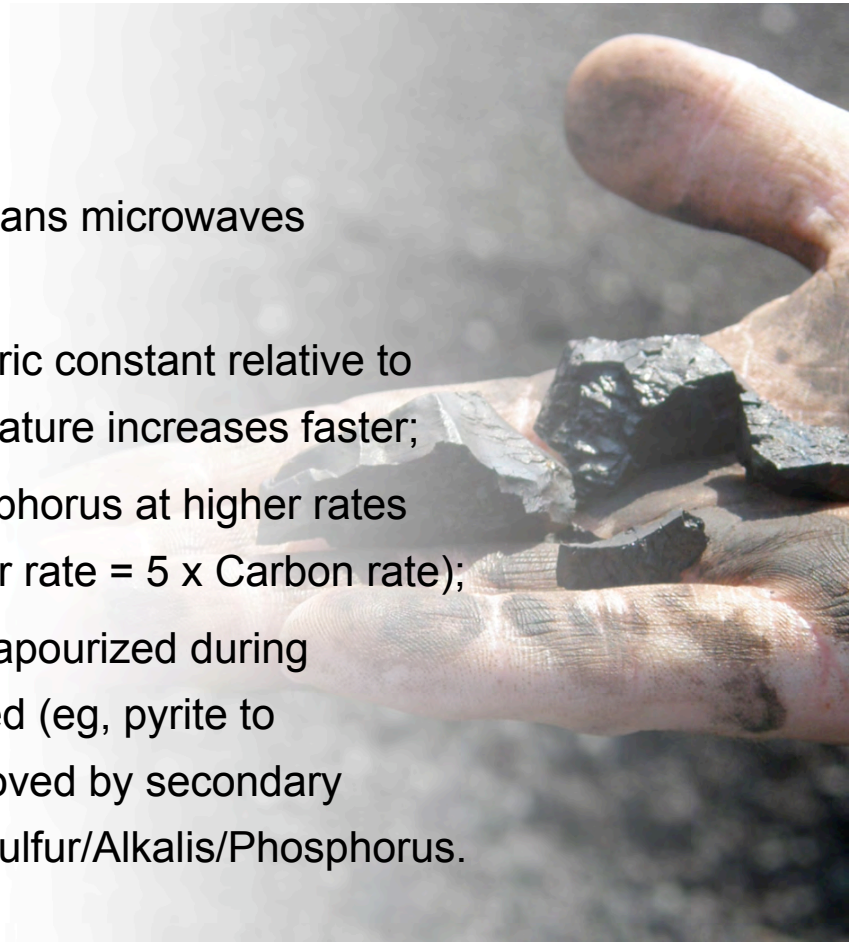


Figure 17: Rank vs Phosphorus



Source ACIRL. Drycol Coal Analysis Report

Hypothesis



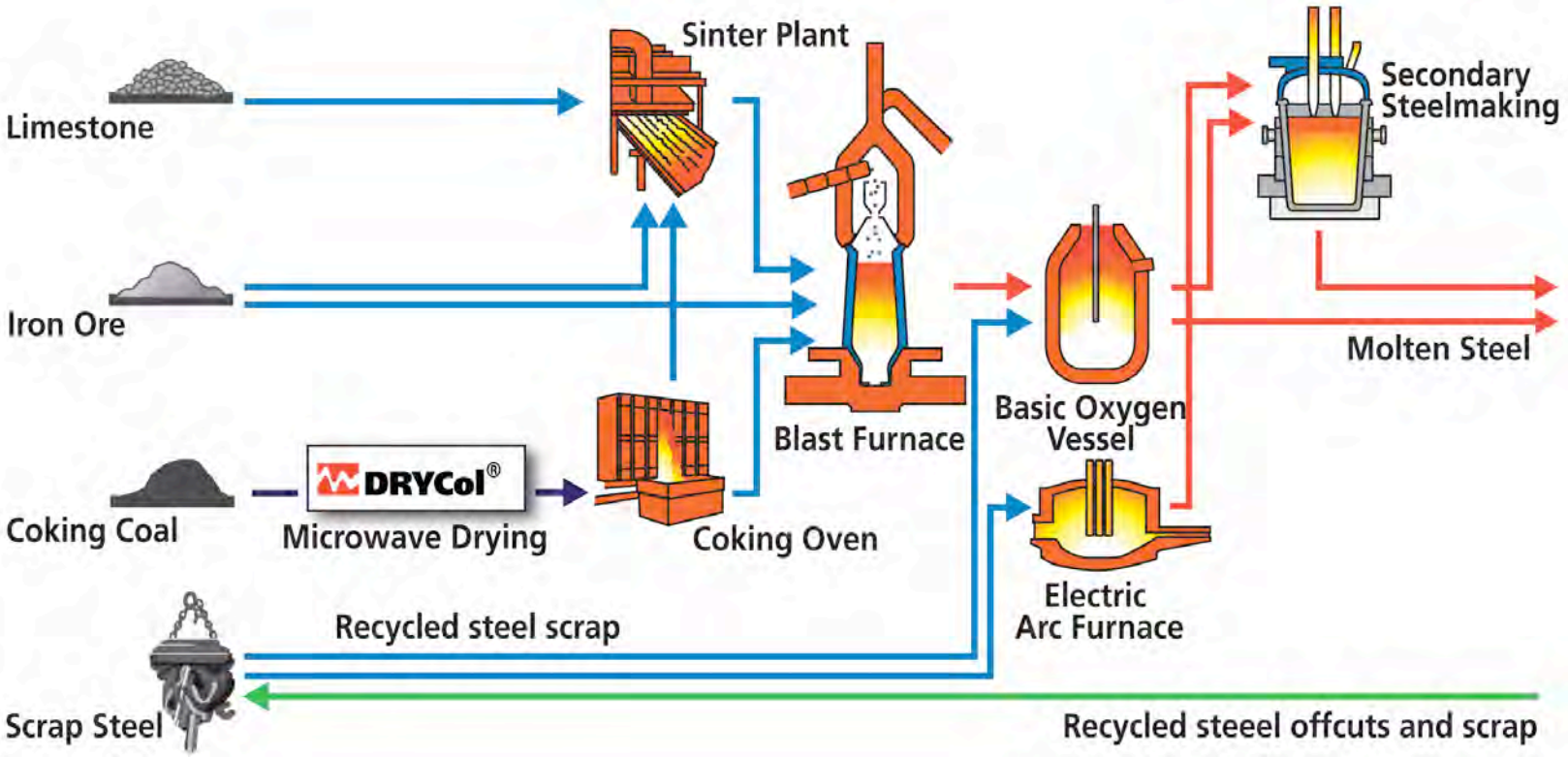
(1) A high dielectric constant for water means microwaves preferentially heat water molecules;

(2) Coal components with a higher dielectric constant relative to other components means their temperature increases faster;

(3) Microwaves excite Sulfur/Alkalis/Phosphorus at higher rates than other coal components (eg. Sulfur rate = 5 x Carbon rate);

(4) These unwanted analytes are either vapourized during exposure to microwaves or are reduced (eg, pyrite to pyrrohtite), such that they can be removed by secondary processing to maximise reduction of Sulfur/Alkalis/Phosphorus.

Microwave Drying in Steel Production



The “Prize” for Steel Producers

$$CY = (96.1 = 0.75 * VM) \times \frac{(100 - TM)}{100}$$

VM = Volatile Matter
TM = Total Moisture
CY = Coke Yield

Summary of Microwave Drying Benefits

(1) Moisture controlled by Microwave Drying:
- Robust, proven technology;
- Simple process control

(2) Sulphur and Mercury reduction:
- Reduced emissions;
- Potential savings in emissions trading;
- Mitigation of license requirements for coal customers

(3) Sustainable Development:
- Water recovery;
- Fuller utilization of coal reserves

(4) Potential to reduce Alkalis and Phosphorus in coal:

(5) Value add to product coals.

Thank You for Your Interest.

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