

Coal Quality & Combustion

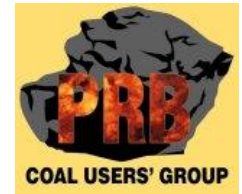


Coal Combustion Inc.
Understanding the business of coal

Member:

American Society of Mechanical Engineers
American Chemical Society
Society for Mining, Metallurgy, and Exploration
North Carolina Coal Institute

sponsor



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Topics

Coal Properties

Rank and Combustion

Pulverizer Performance

Slags and Ash Deposits

Engineering

1.5 meter desk



1.55 meter door

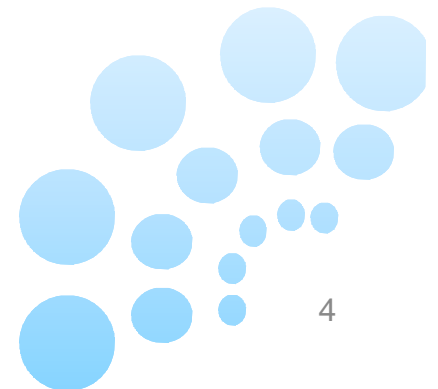
Fits through every time

Coal Quality



1.55 Meter
Door

Only about 1/2 people fit



Coal Rank

**Used to determine
Reactivity and
Combustion properties**

Coalification

Wood

PRESSURE

Peat

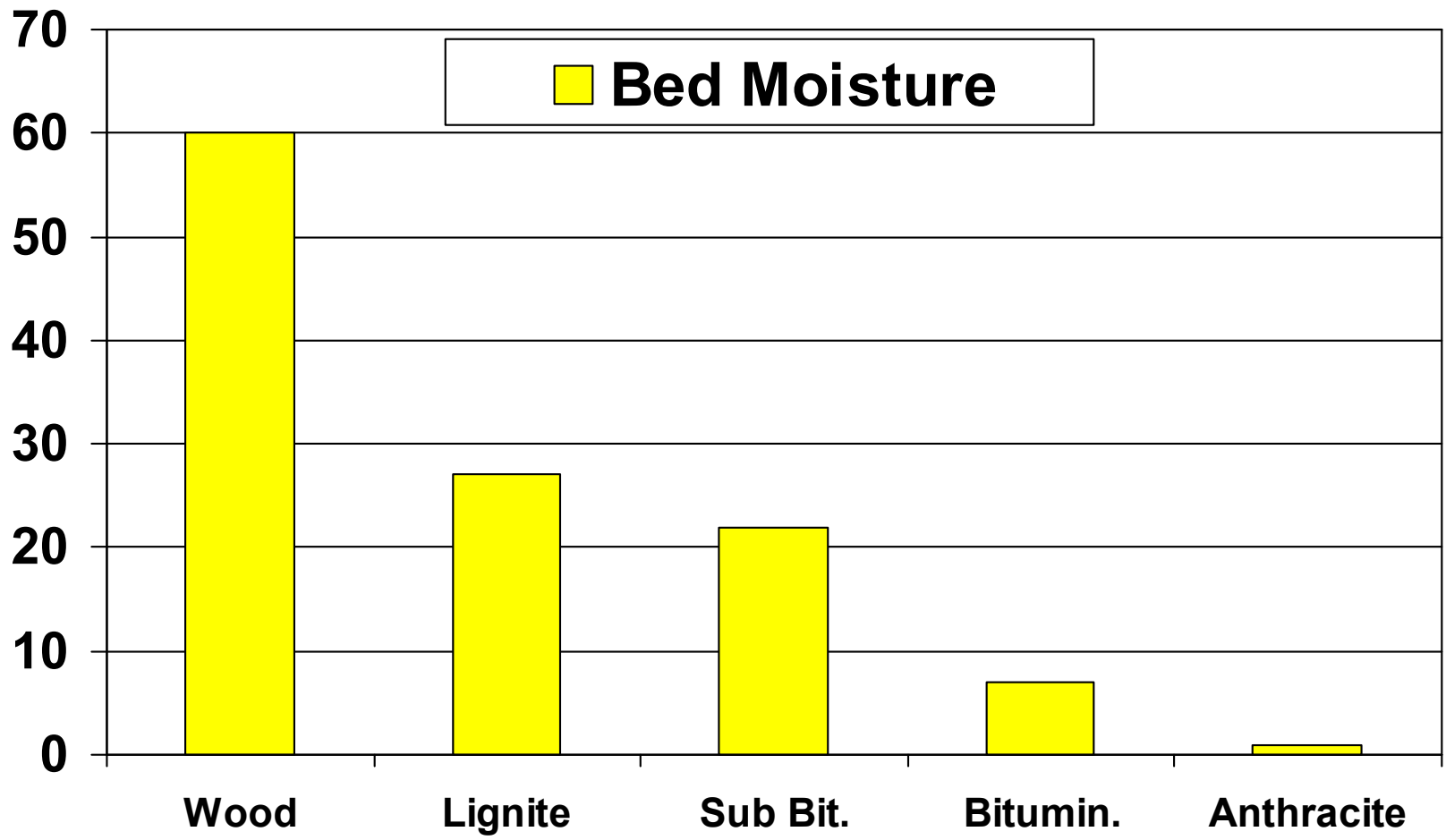
Lignite

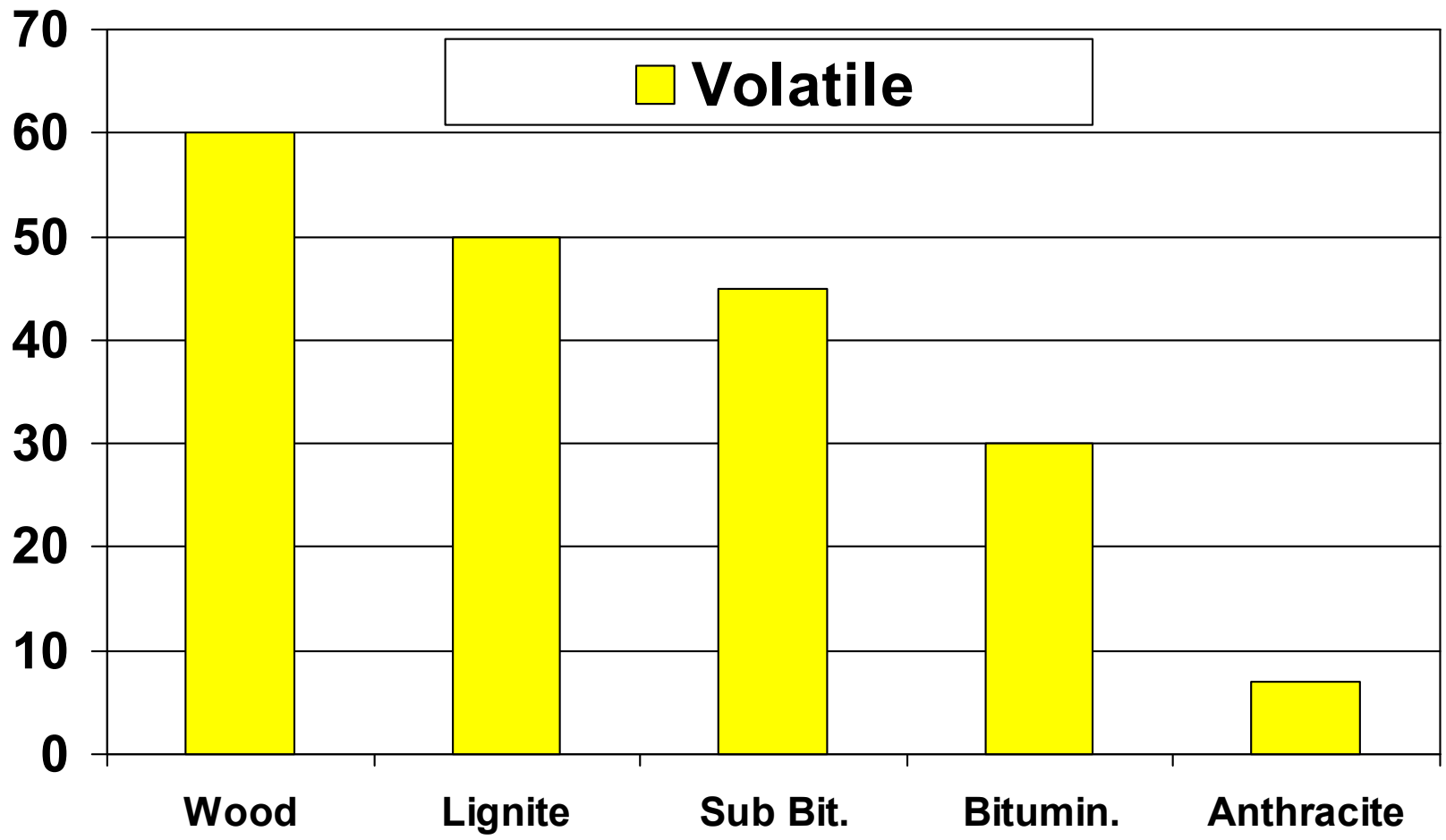
Sub-bituminous

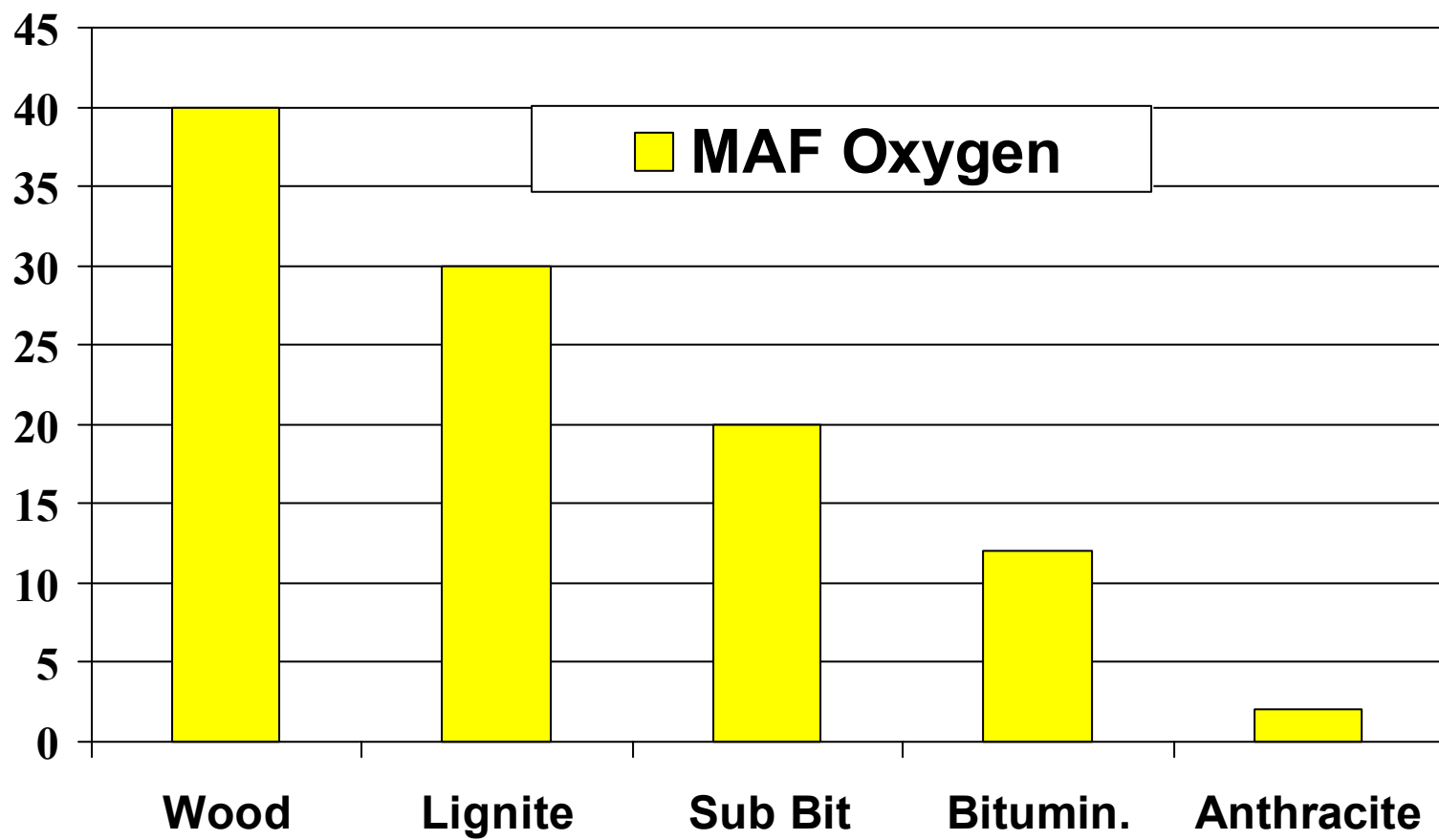
TIME

Bituminous

Anthracite







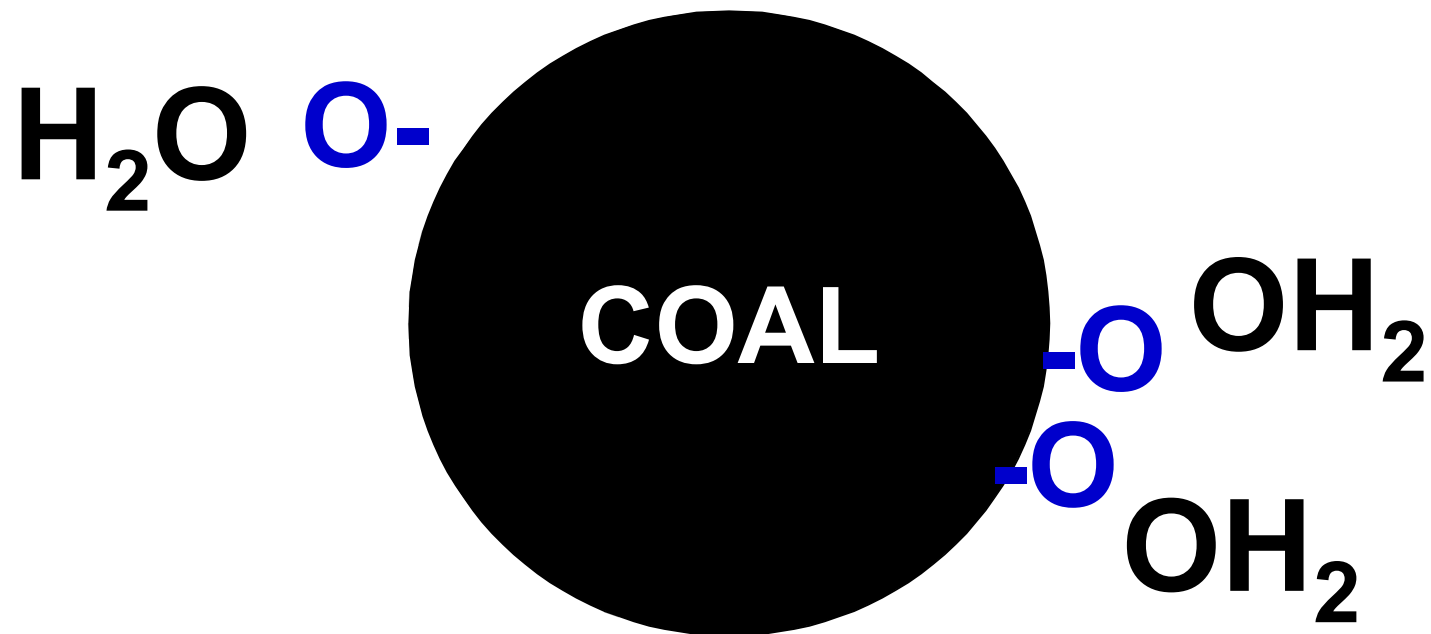
Chemistry

Like Likes Like

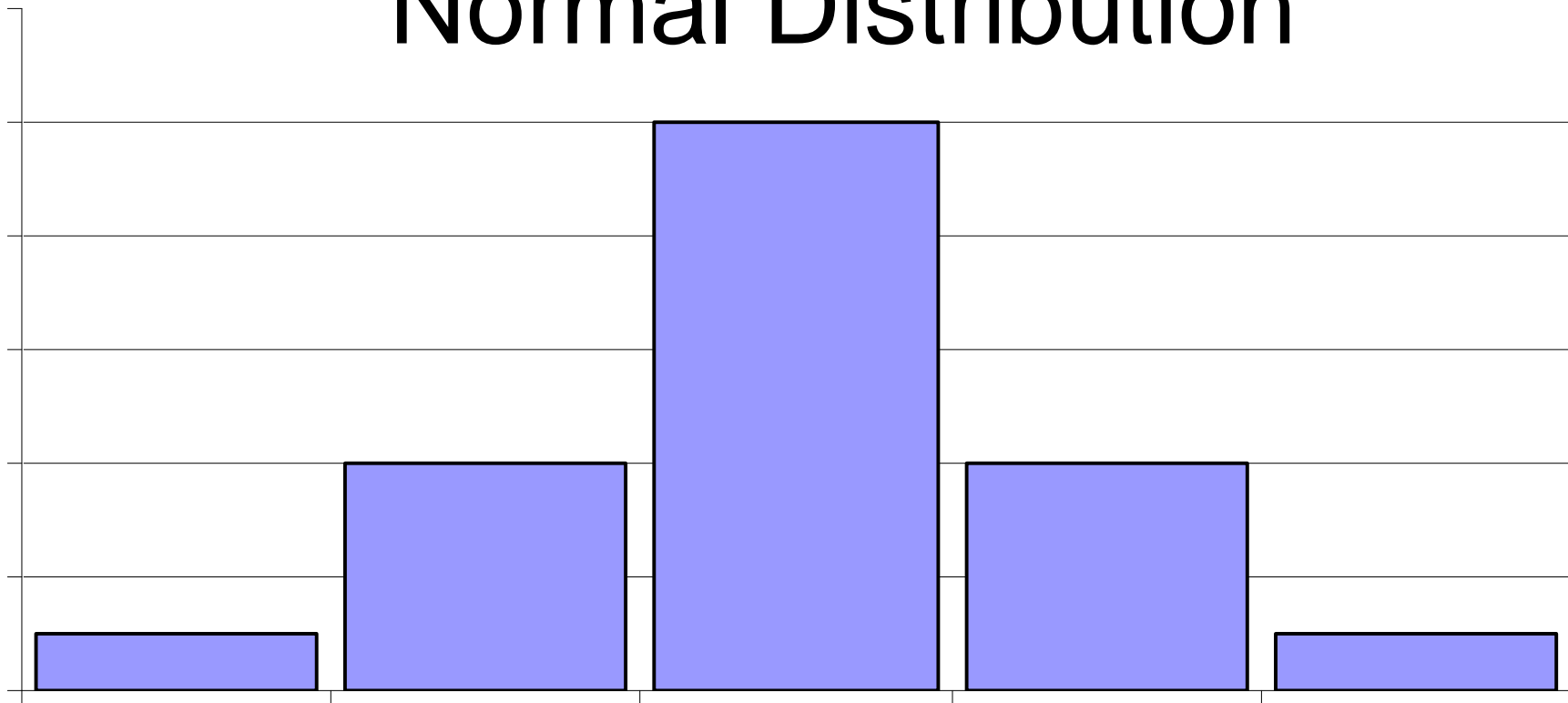


Chemistry

Like Likes Like

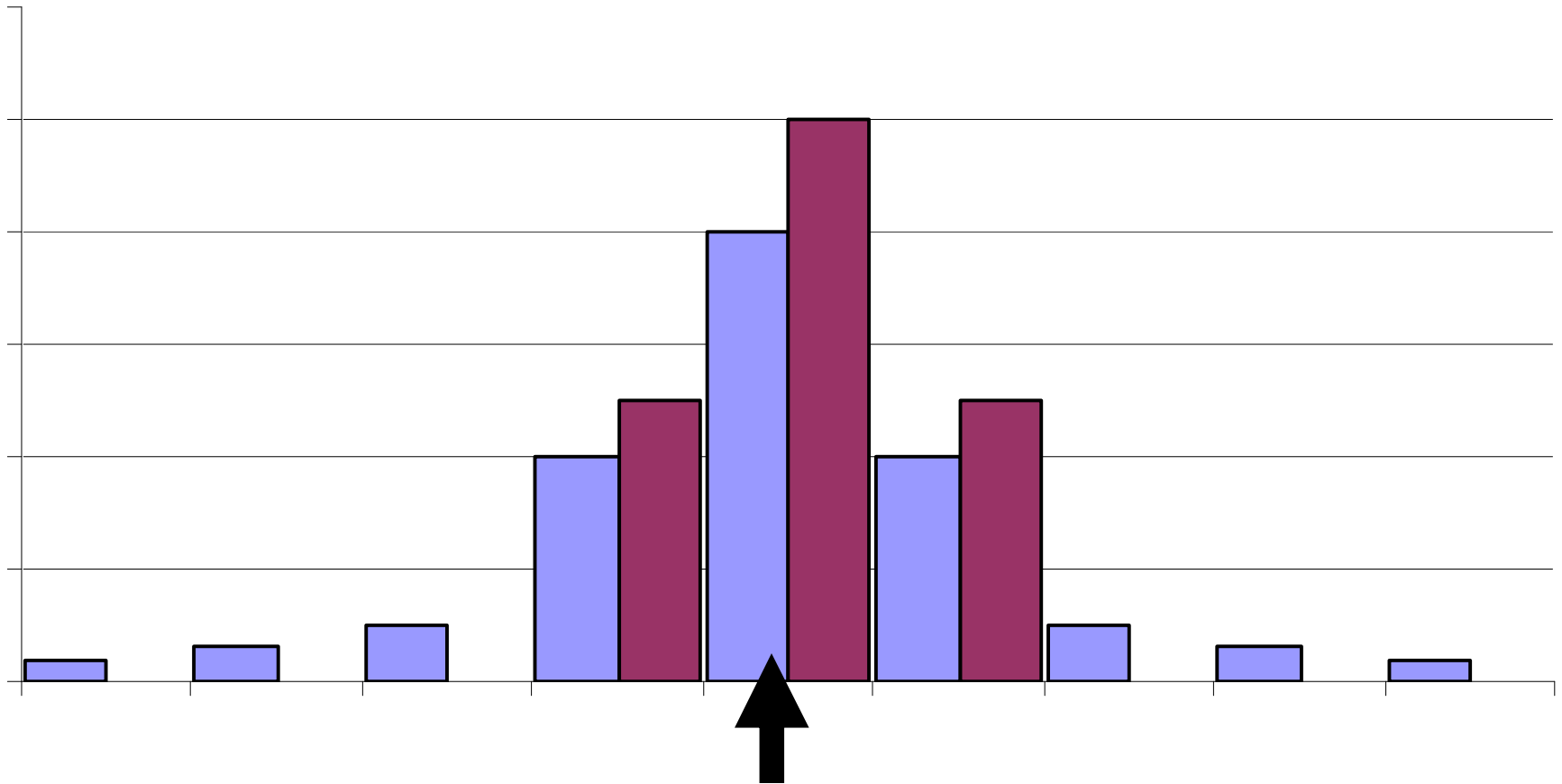


Normal Distribution

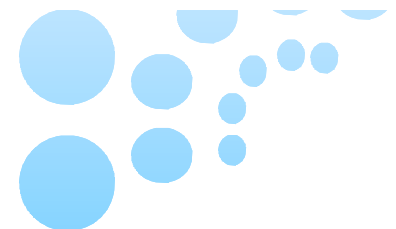


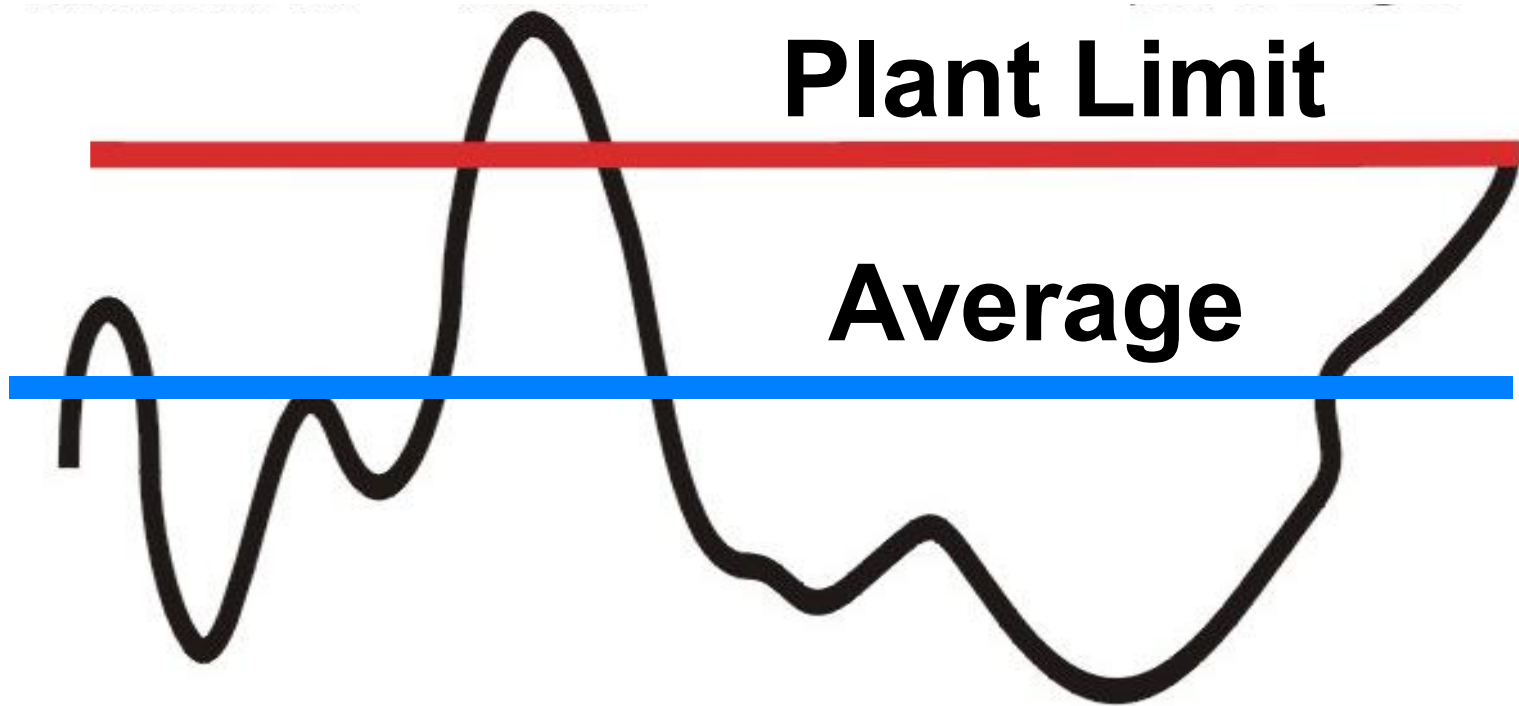
Quality Parameter

Small and Large Variability



Same Average





Does this coal met spec?

Measuring Coal Quality

**Lab data only produces
average data**

**Power plants respond to
swings in quality**

**Lets look at all boiler related
coal qualities on a heat
basis; lets put all
percentages on a per million
Btu basis**

LOADING LEVELS

Coal Reactivity

Volatile

Fuel Ratio, FC/Vol

MAF Oxygen

C/H

HGI and others

Coal Reactivity

Volatile

Oxygen

per million Btus

Volatiles

	<u>Hi Qual. Bit.</u>	<u>Sub-Bit</u>
Volatile%	34	34
KCal/KG	12500	8500
FC/Vol	1.5	1.0
Kg Vol/MKcal	27	40
$40/27 = 1.47$ or PRB = 47% more vol		

Pulverizers

Coal Flow

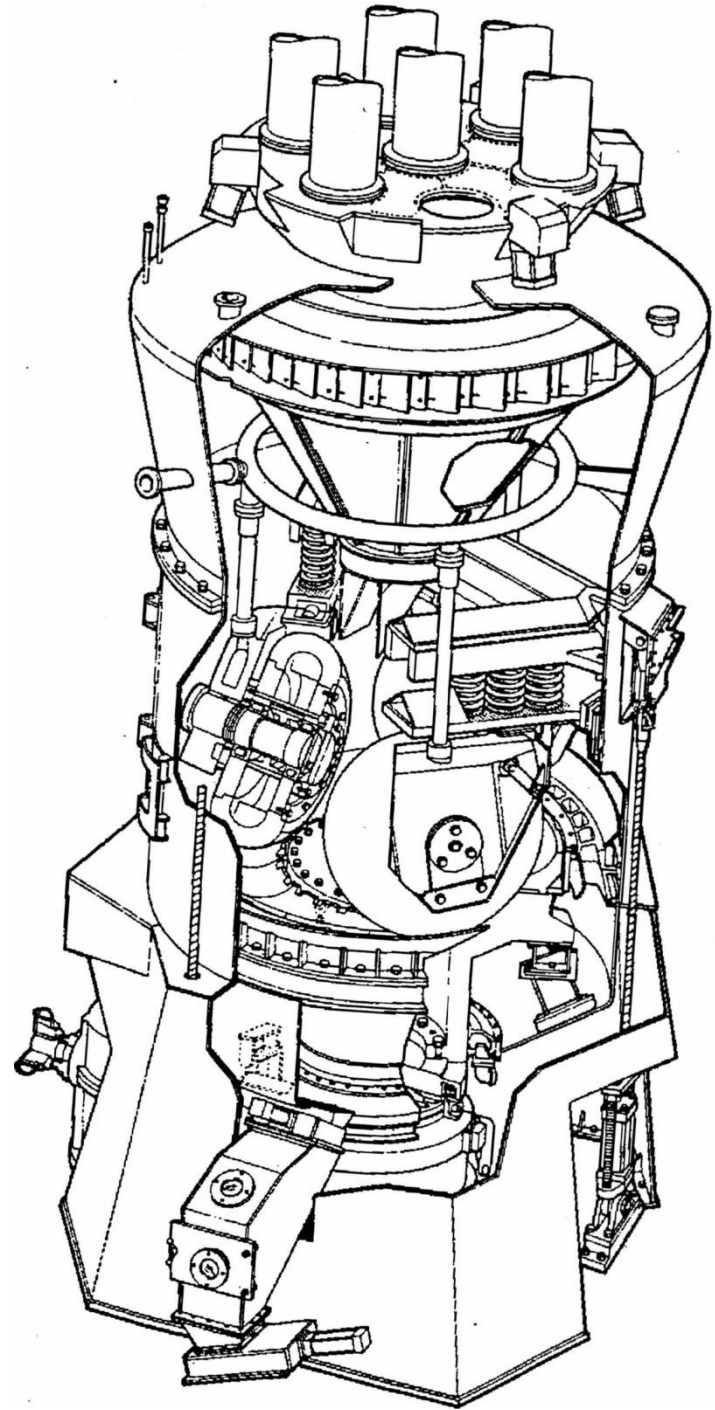
Air Flow

Coal Pipe Velocity

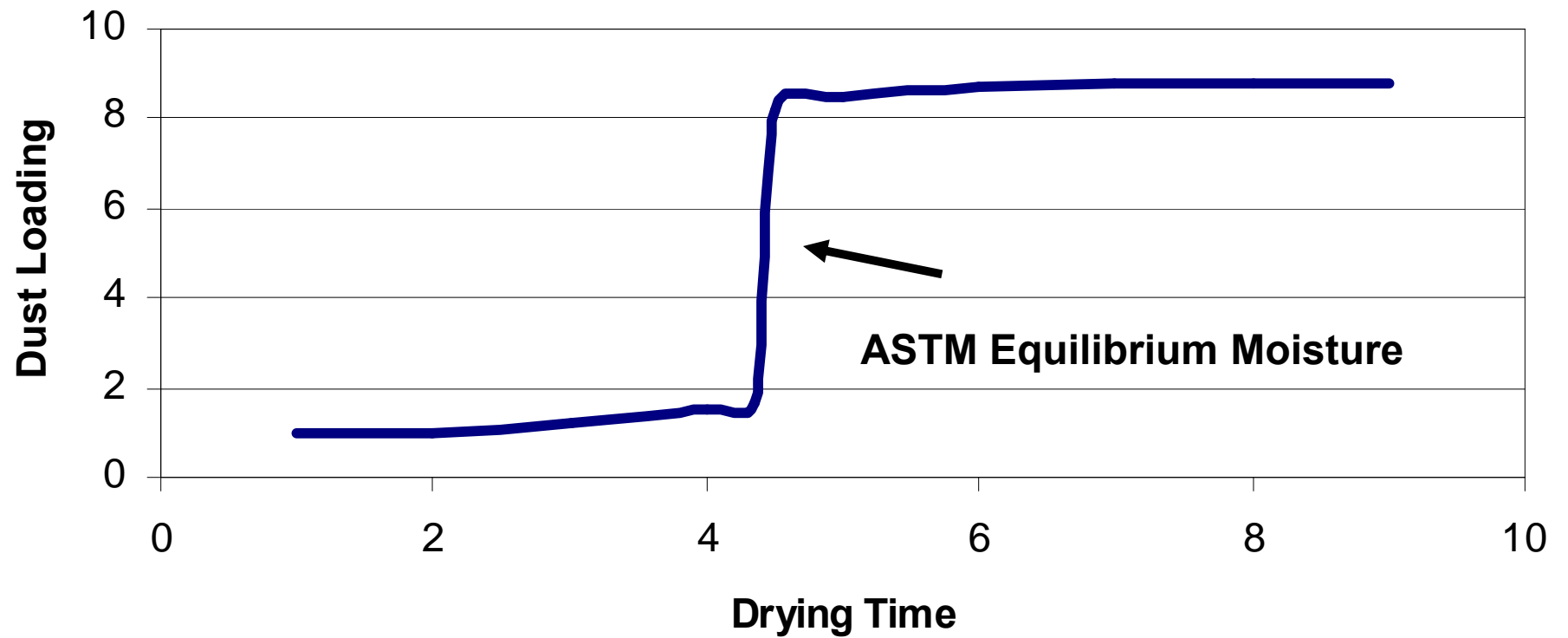
Outlet Temperature

Coal Fineness

Reject Material



Dust vs Drying Time



KEMA Research

Pulverizers Dry and Grind

More Moisture

- Lower Outlet Temp

Lower Kg/Kcal

- Higher Tonnage Rate

- Higher PA Flow



Designation: D 409 – 08

**Standard Test Method for
Grindability of Coal by the
Hardgrove-Machine Method**

1.1.1 Some coals, such as some high-volatile bituminous, **subbituminous**, and lignite coals, can undergo physical change as the natural or seam moisture is released during handling and preparation. This change is often sufficient to alter the grindability characteristics that will be reported when tested in the laboratory

and could produce different indices

dependent on

the conditions of drying and the moisture level of the 1.18-mm by 600- μ m (No. 16 3 No. 30) (see Test Method D 4749)

materials used for the test. Therefore, the repeatability and reproducibility cited in this test method may not apply for

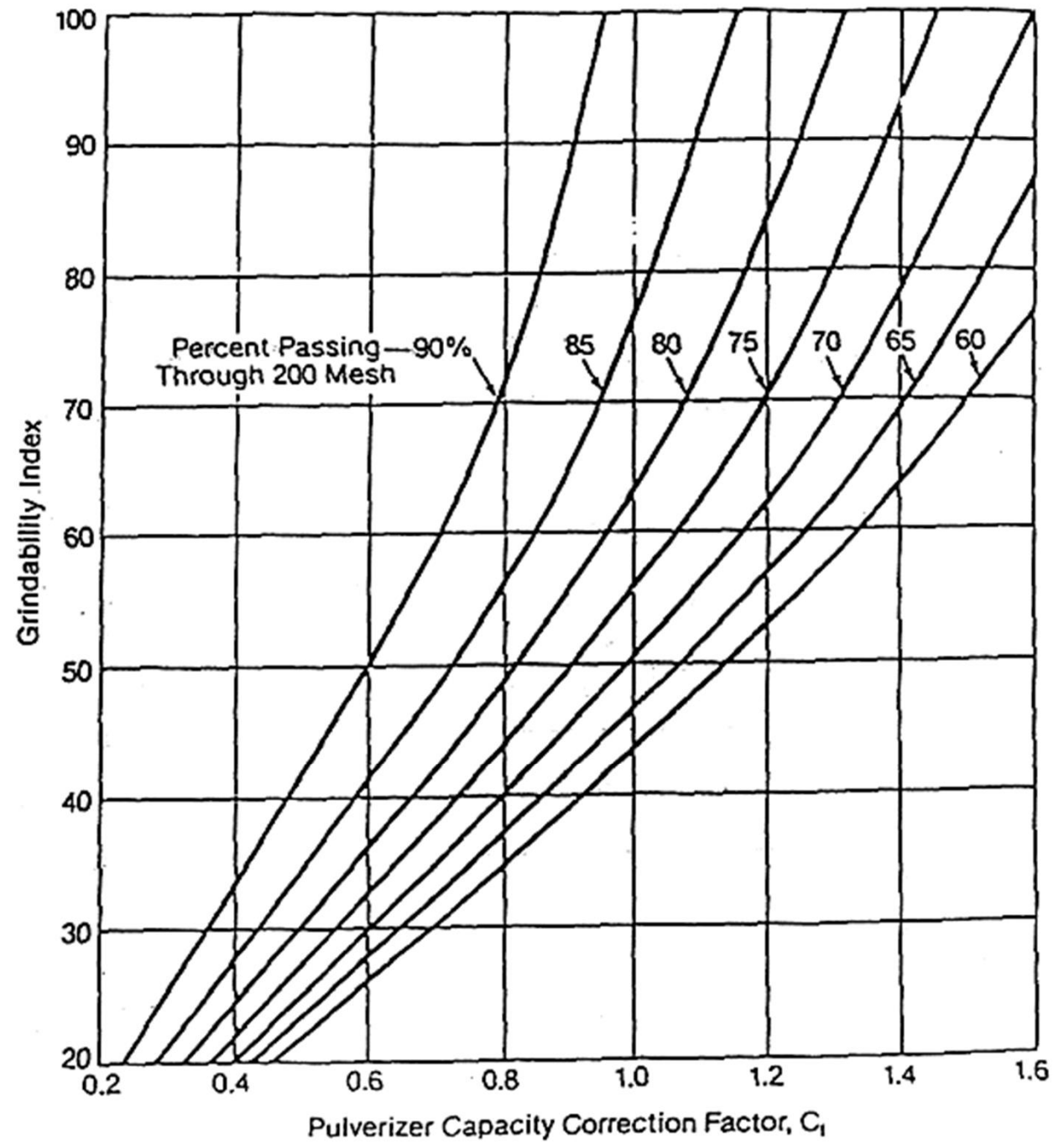
these high-volatile bituminous, subbituminous, and lignite coals.

HGI

Moisture sensitive
only three values

High, Medium, Low

Mill Capacity And HGI



Sizing

Set for Coal type

Set for Slag control

May be opposite directions

Sizing

200 mesh 75 microns

55-75 % passing

50 mesh 300 microns

0.1 to 4 % retained

40 x more oversize

Ash Wears Them Out

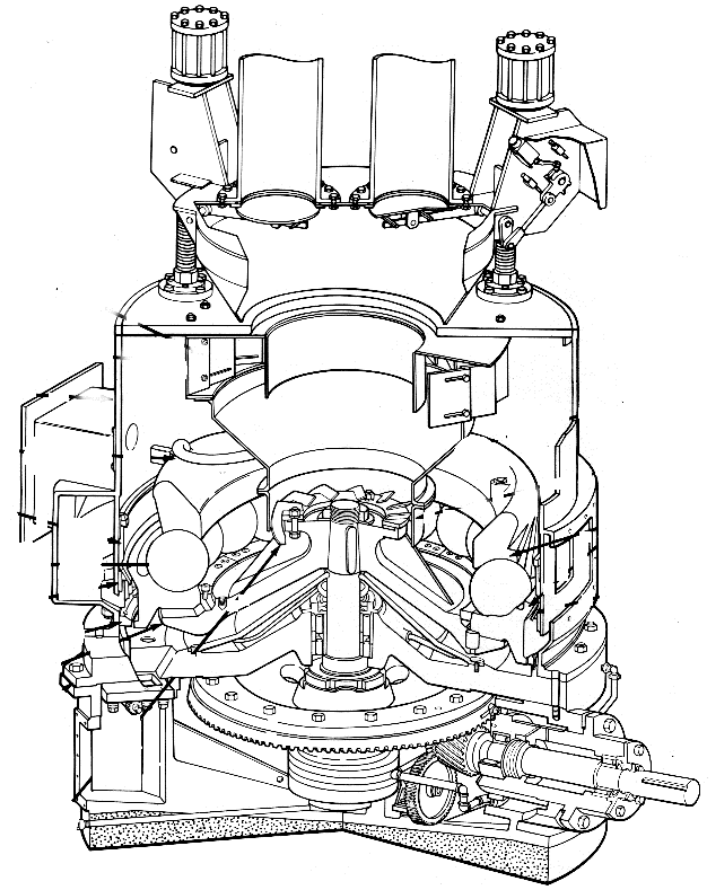
Impacts load

High Maintenance

Performance Testing

**“Most miners I know
will sell you rocks
at the price of coal.”**

rmh

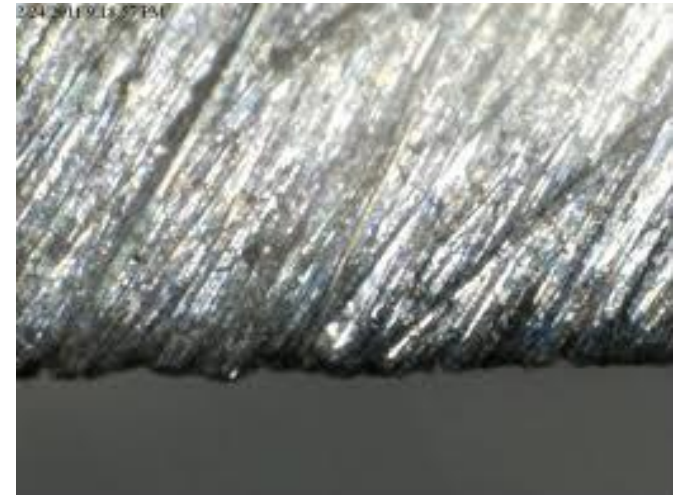




Sizing



200 mesh polish



50 mesh grinds

Ash Deposits

Slagging - Molten

Fouling - Sulfate Salts

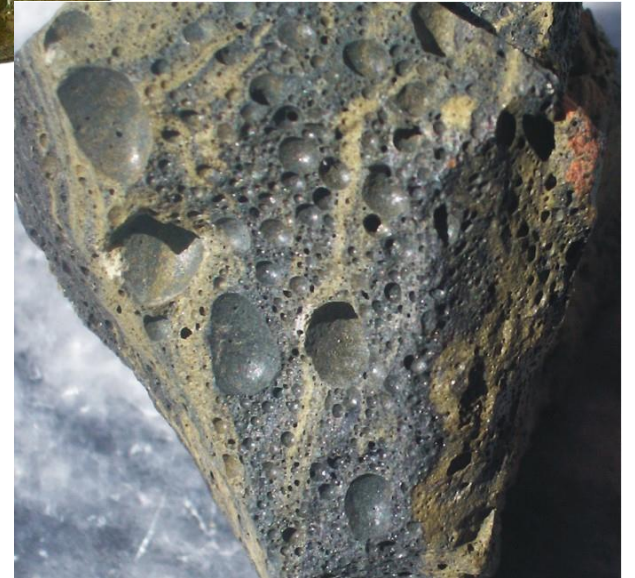
The Many Faces of Slag



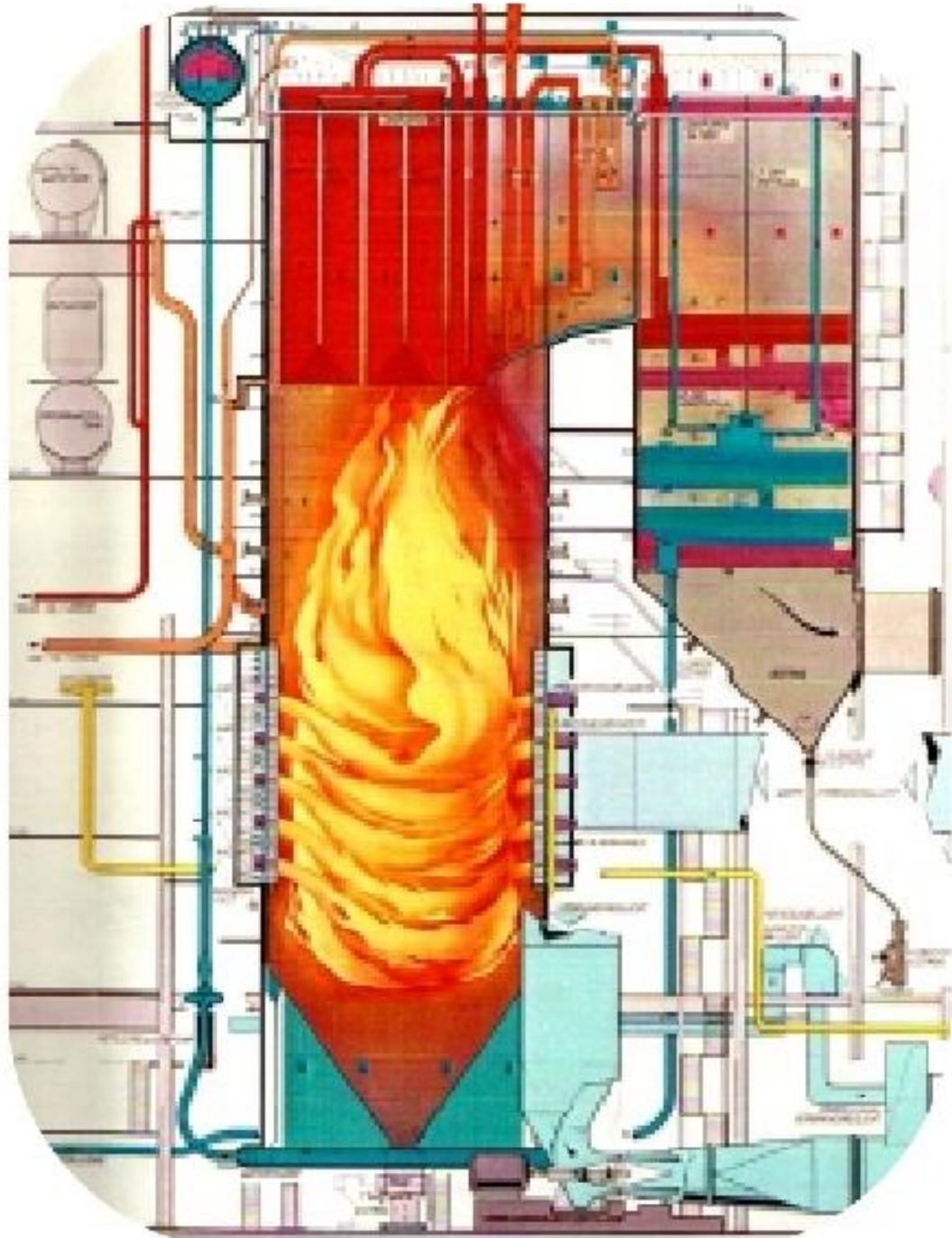
Kansas Style

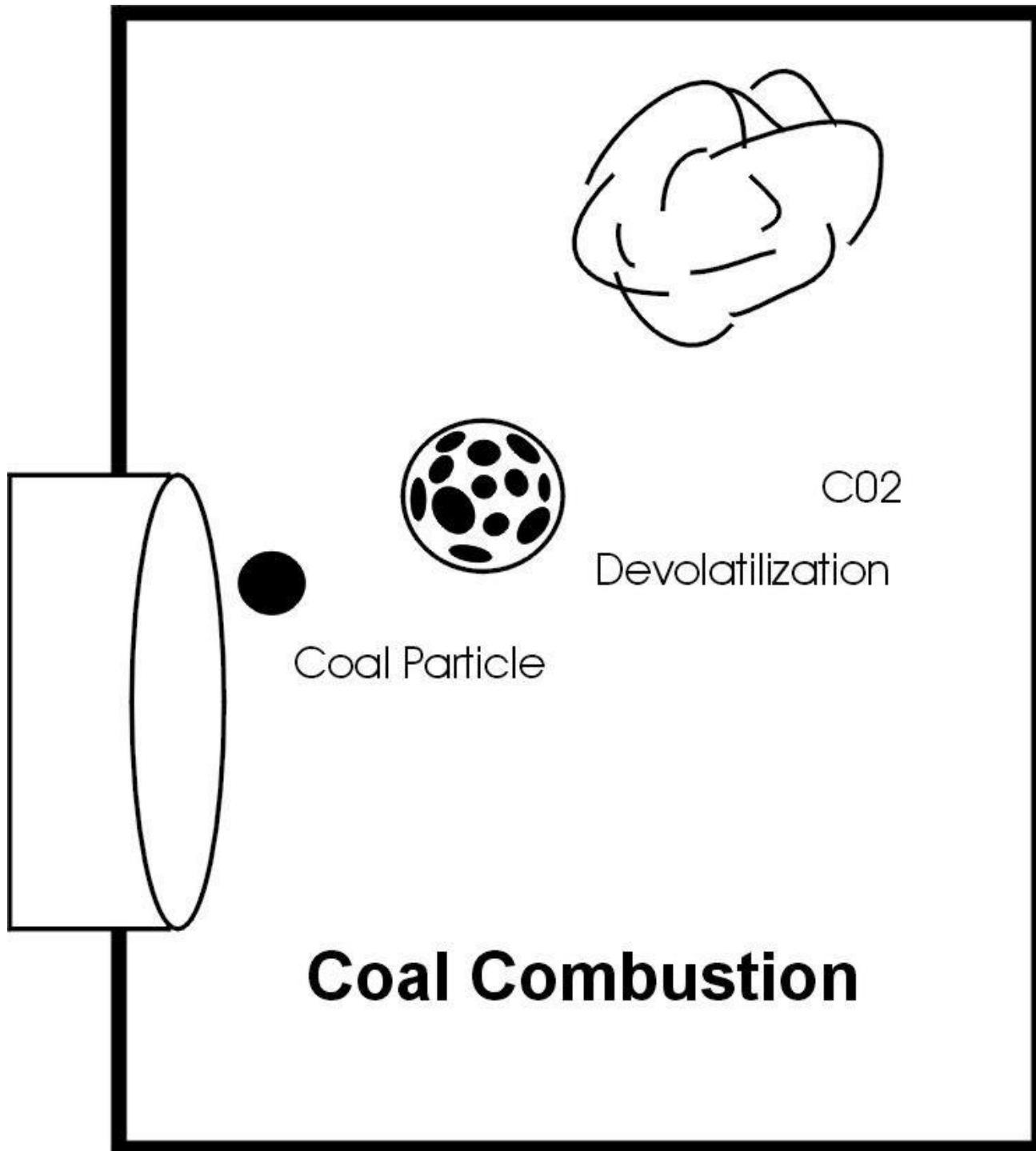


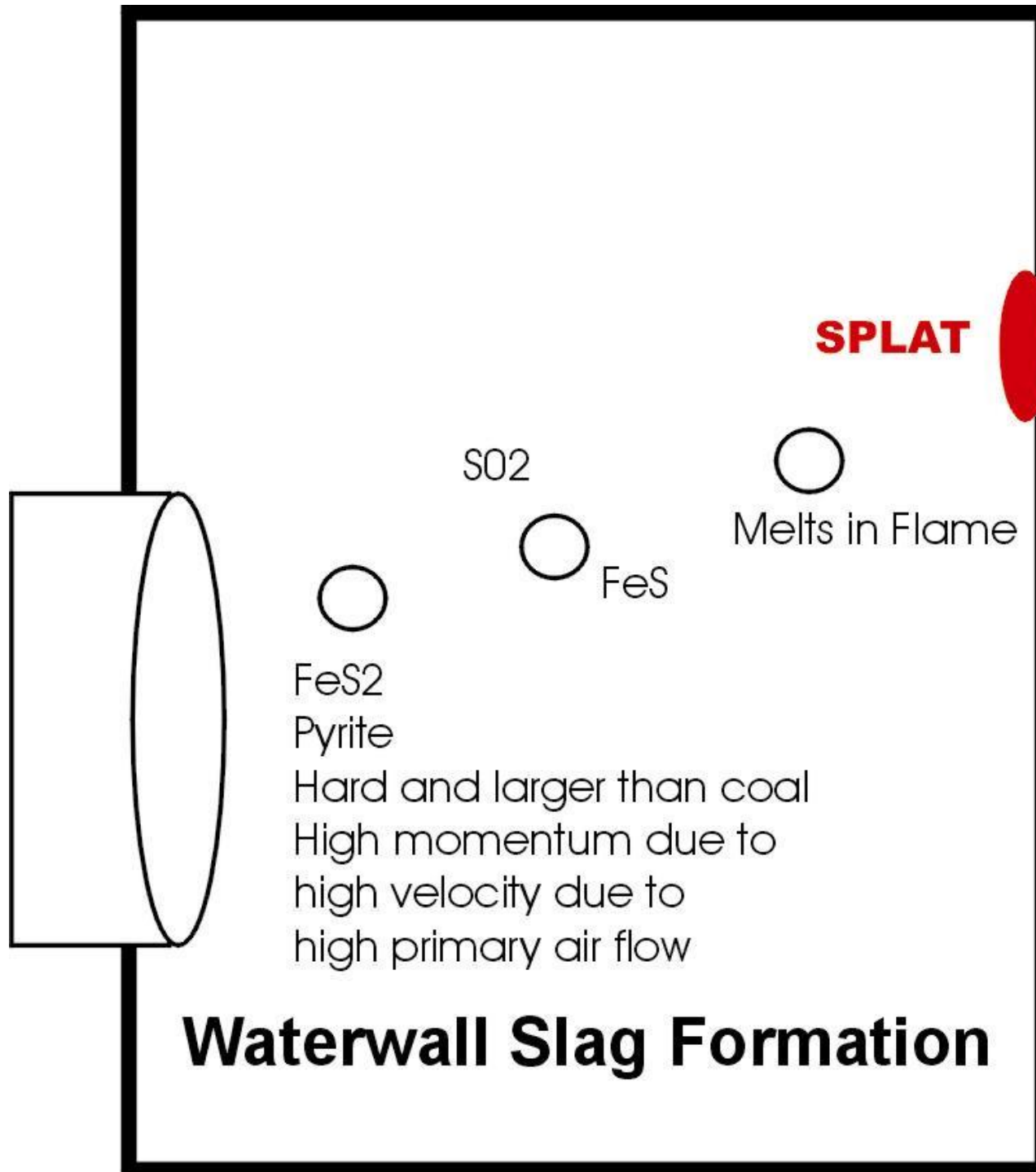
Ohio Style



Texas Style

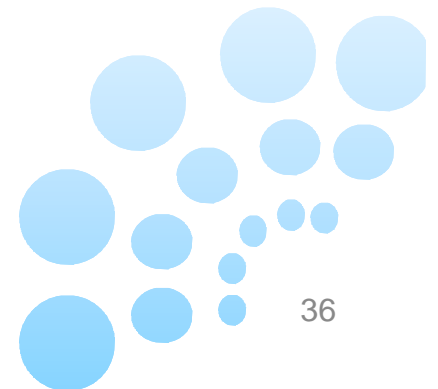
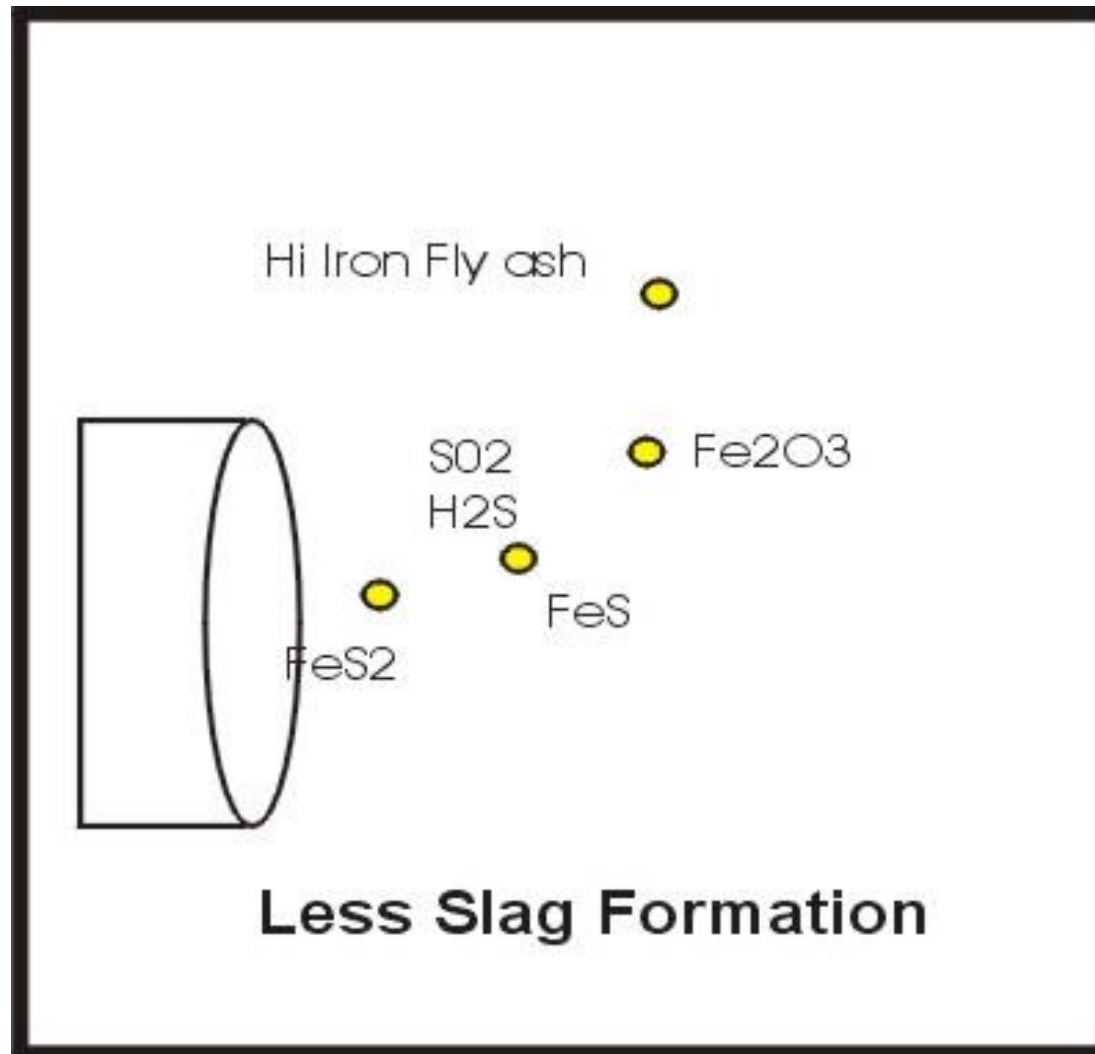




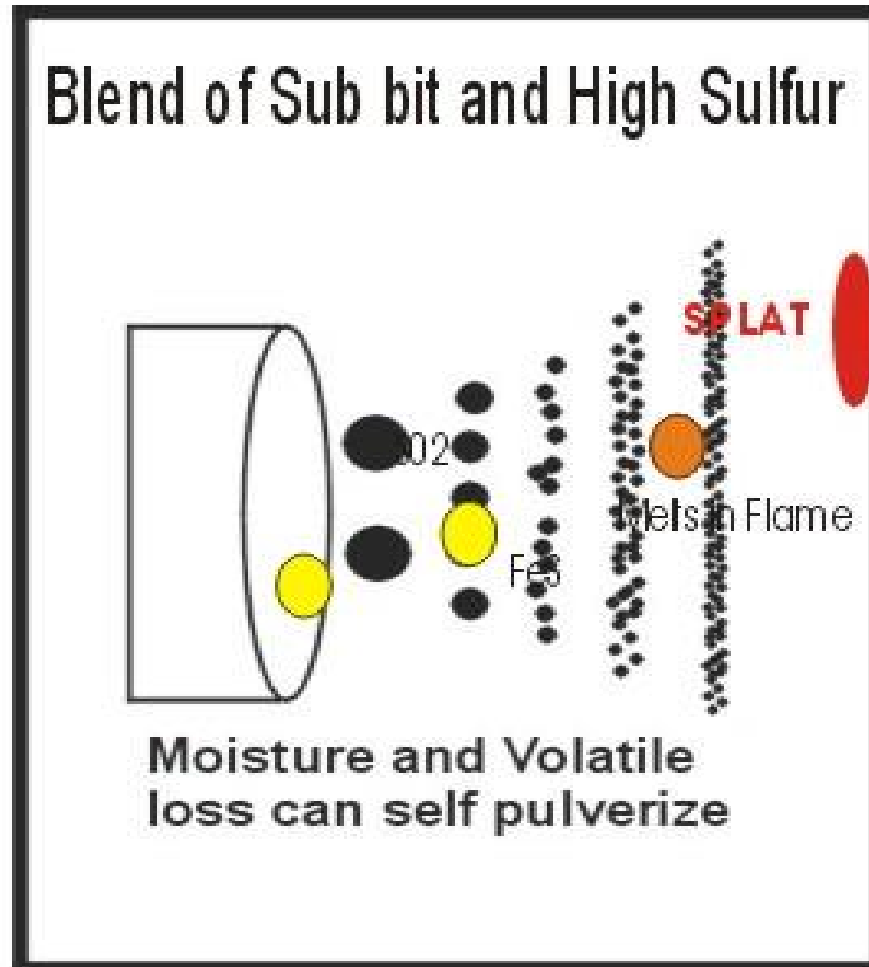


Waterwall Slag Formation

Coal Combustion

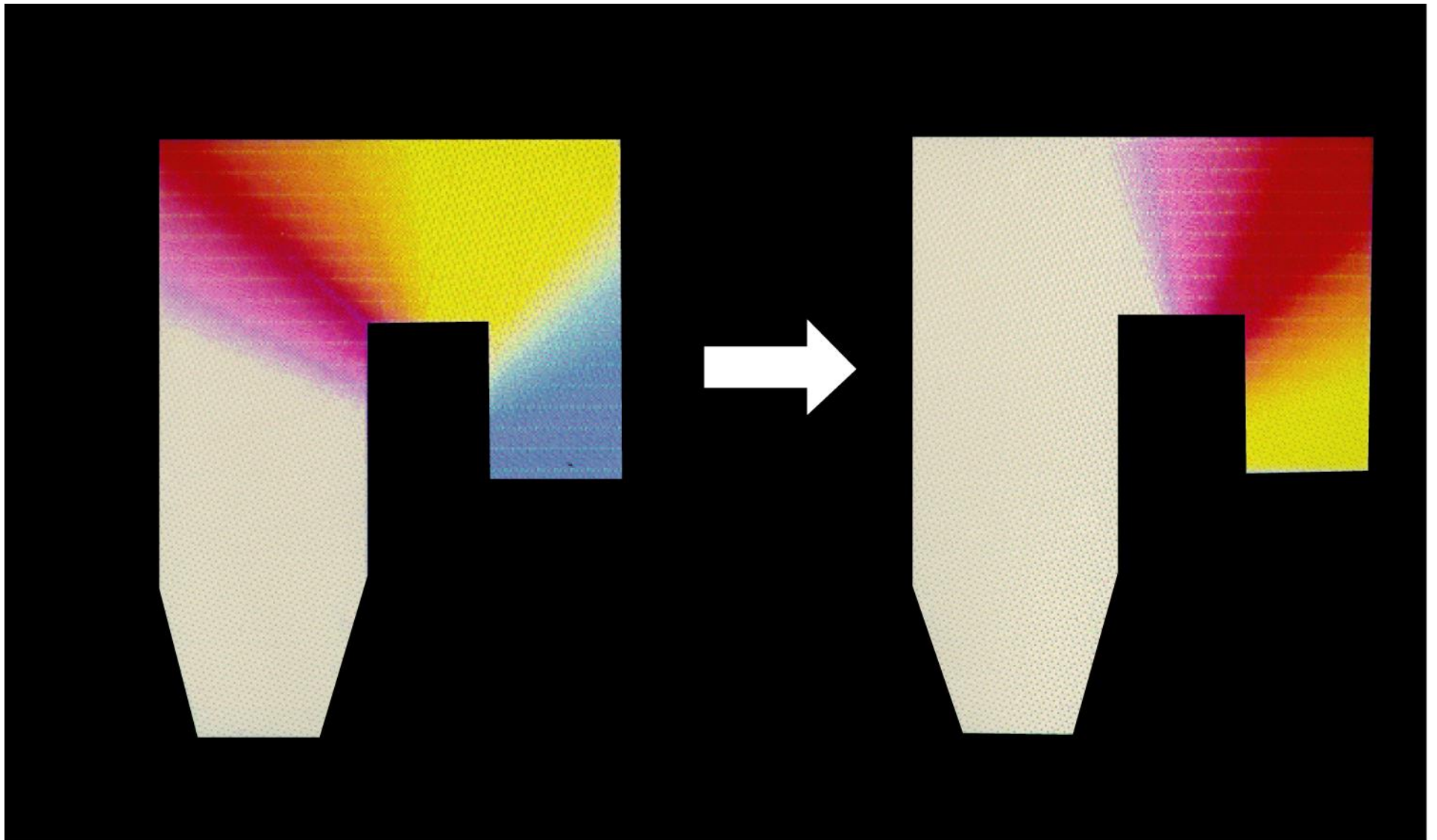


Coal Combustion



**Most Slag
Starts on
walls**





Waterwall deposits force heat to convection pass.



**Then goes
To the
Superheater**



**Fusion Temperatures
or
Cone melt down
test**

Why are we using fusion temperatures?



Test for stoker type boilers

No mineralogical data

Not the same reactions for all coals

Initial Deformation

Softening ($H=W$)

Hemispherical ($H=1/2W$)

Fluid



Physical Test

Oxidizing verse Reducing

Combustion Conditions

Poor Lab to Lab

Ash Chemistry

Major & Minor Elements

SiO₂

Al₂O₃

TiO₂

Fe₂O₃

CaO

MgO

K₂O

Na₂O

Minerals include

Quartz

Pyrite

Clays and shales

Carbonates



FeS_2





Acid Oxides Basic Oxides

SiO₂

Al₂O₃

TiO₂

Fe₂O₃

CaO

MgO

K₂O

Na₂O

Glass Formers

Fluxes

Role of Iron

Acid

Base

Fe₂O₃

FeO

Fe₃O₄

Oxidized

Reduced

Good

Poor

**Slag is a build up
of rate process
so,
the amount of
ash should matter.**

Lb. of ash/MBtu

$$= \%ash / (Btu/10,000)$$

Lb. of element/MBtu

$$= \%ash / (Btu/10,000) \\ \times (\%Element/100)$$

**Many slagging concerns
have been addressed using
Ash Loading and Elemental
loading levels; especially**

Fe_2O_3 , CaO , Na_2O

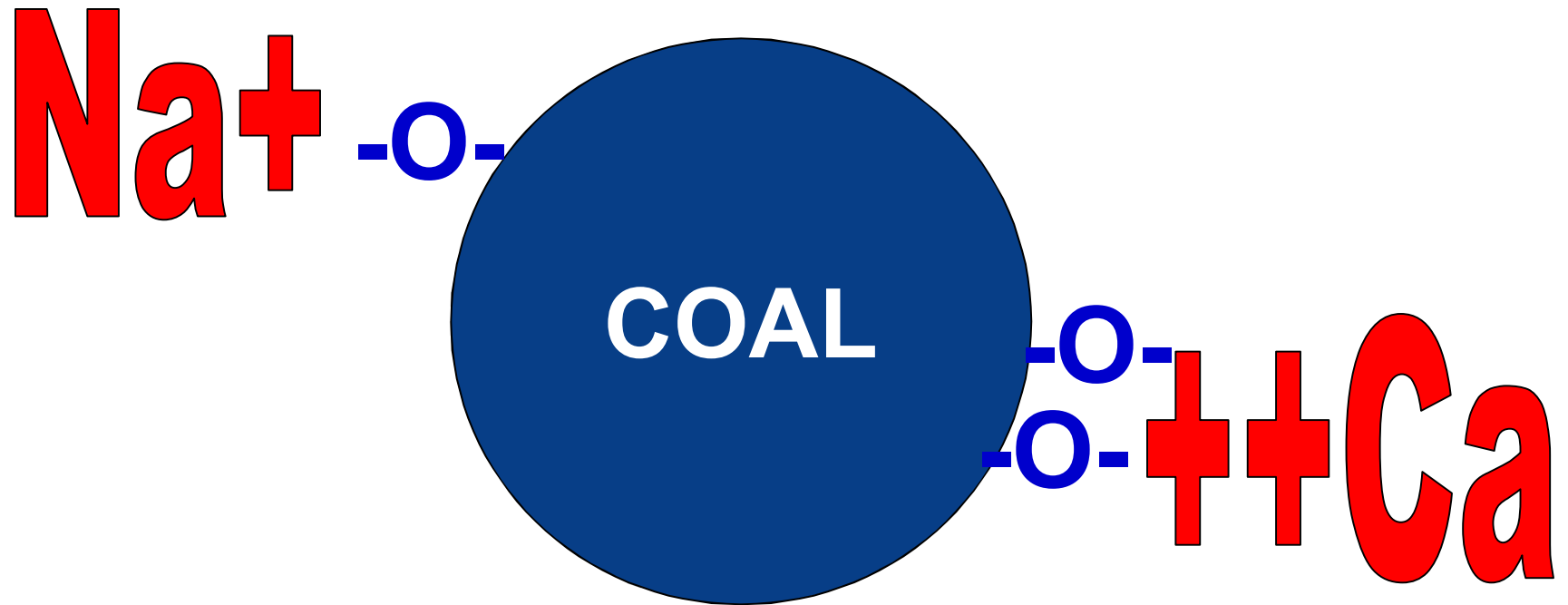
**Experience suggests that
rating sub-bituminous coals
using iron, calcium, and
sodium loading levels
correlates better than fusion
temperatures**

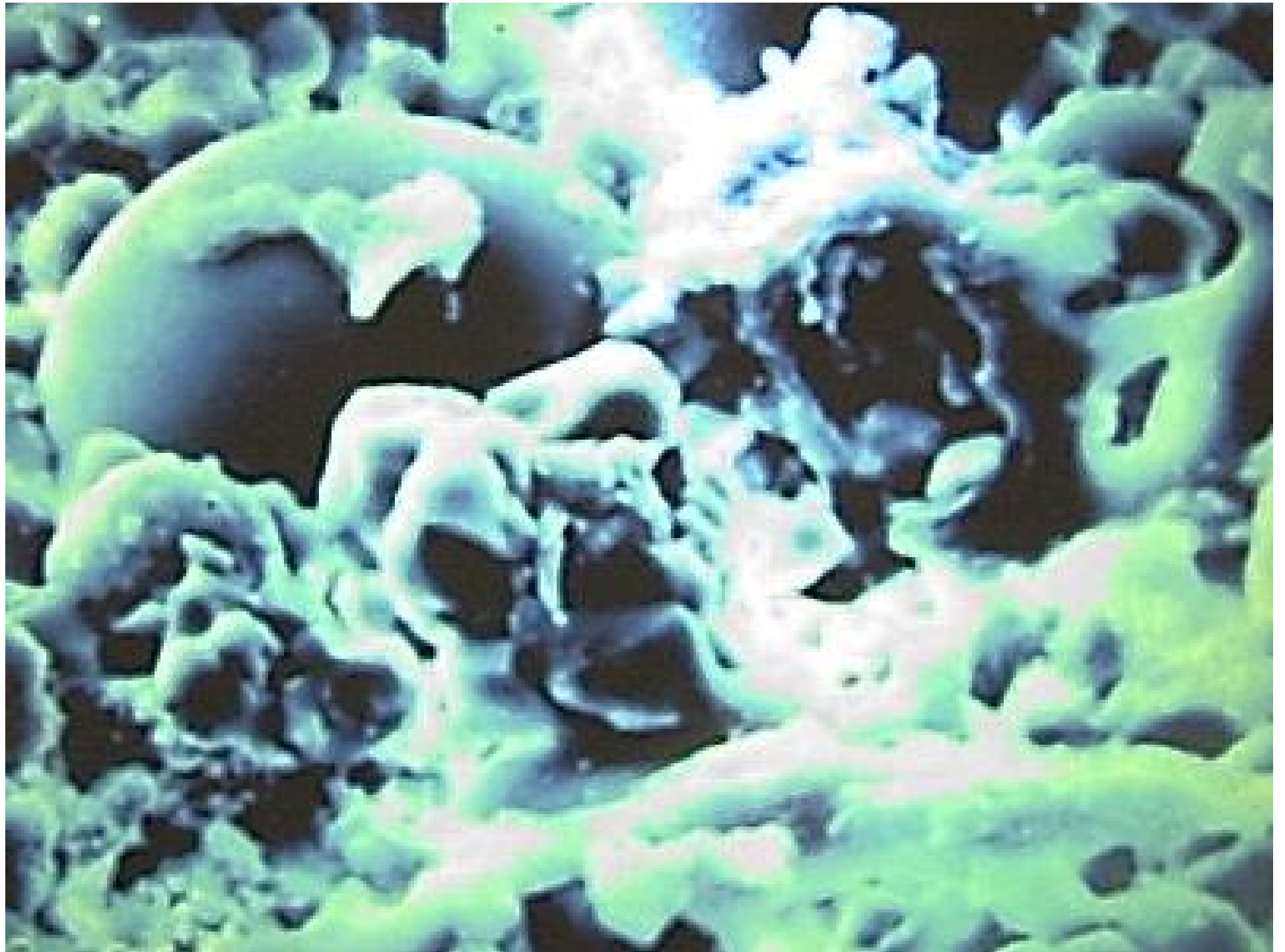
Ash Deposits

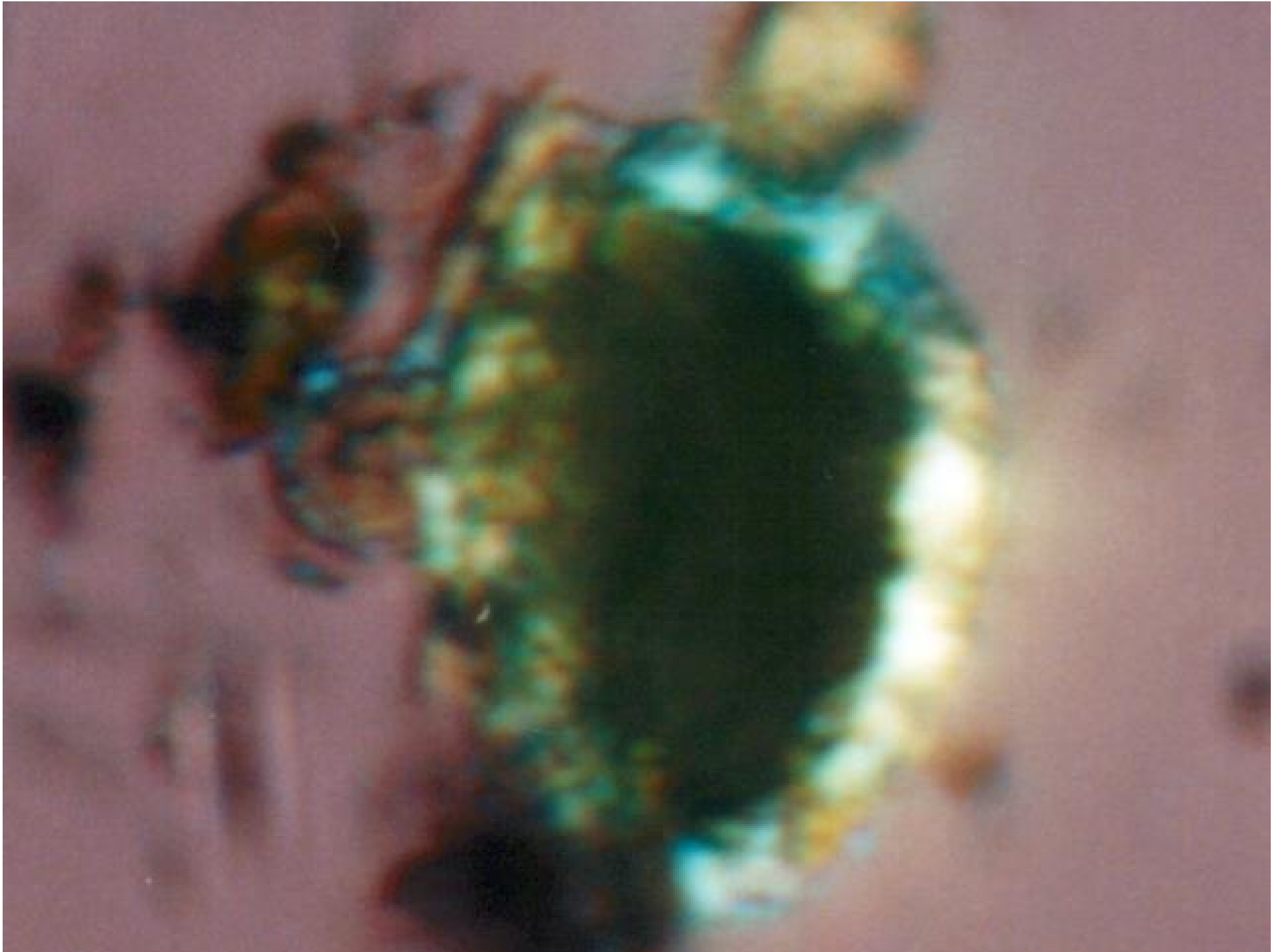
Slagging - Molten

Fouling - Sulfate Salts

Organically Bound Alkalis



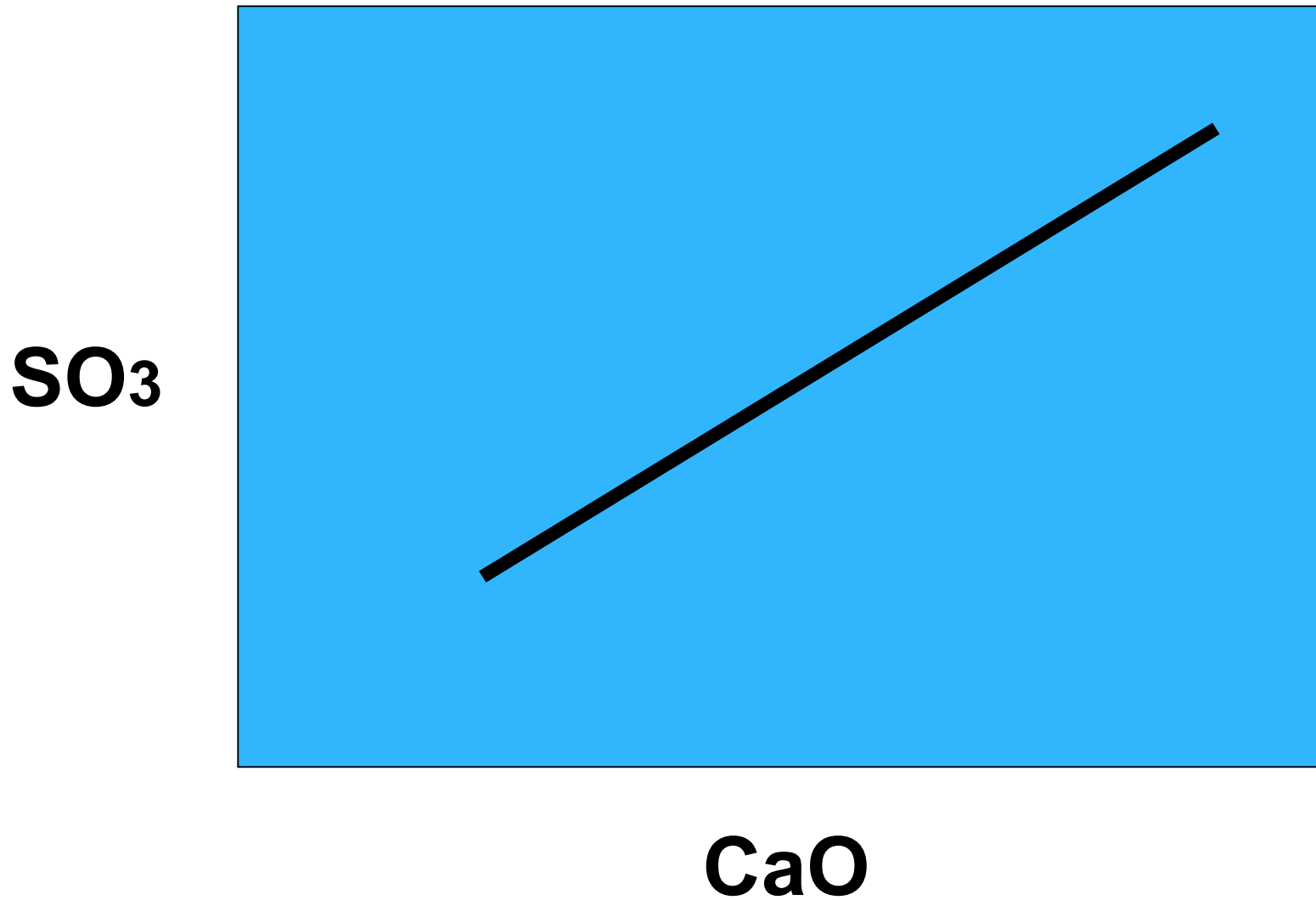




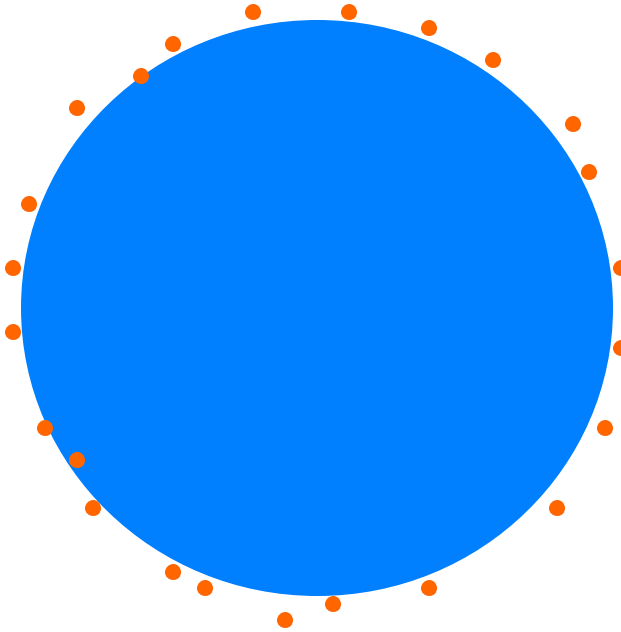


**Think Fluid Bed Boiler
&
Fouling Deposits**

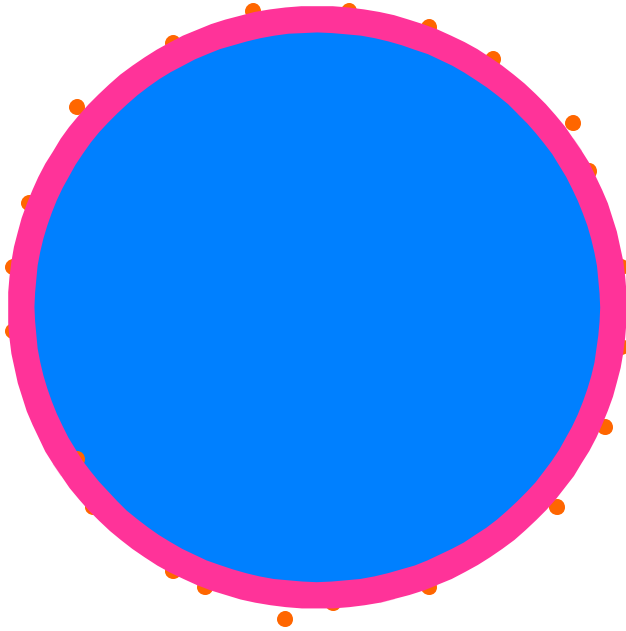
What does the SO₃ represent?



Sodium Condenses on Surface



Causing a Molten Layer on Surface





Thank You



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Understanding the business of coal