

The following results were obtained at a factory in South Africa where both bituminous coal and lignitic spent bark fibers are used as fuel for two separate boilers.

#### SPENT BARK FIBER ASH ANALYSIS ON AIR-DRIED BASIS

	SPENT BARK FIBRES - BOILER UNTREATED	SPENT BARK FIBRES - BOILER TREATED WITH RSAcat®
Moisture %	3.1	0.3
Volatiles %	12.7	9.0
Ash %	14.6	91.1
Fixed Carbon %	69.6	-0.4
Total Sulphur S %	0.01	<0.01
Gross Cal. Value mj/kg	24.74	1.44
Total Carbon C %	74.25	7.40

The following results were obtained from:

#### BITUMINOUS COAL ASH ANALYSIS ON AN AIR-DRIED BASIS.

	COAL ASH BOILER - UNTREATED	COAL ASH BOILER - TREATED WITH RSAcat®
Moisture %	0.5	1.3
Volatiles %	1.4	26.6
Ash %	66.2	74.9
Fixed Carbon %	30.0	-2.8
Total Sulphur S %	0.41	0.01
Gross Cal. Value mj/kg	5.59	1.94
Total Carbon C %	29.15	9.77

#### COST OF RSAcat®

When Managers, Engineers and Accountants consider whether they should use **Chinco** or not, it is very important that they remember not to only compare the single advantage of "Saving in fuel" cost to the purchase price of **Chinco** directly, but that all the additional advantages of using **Chinco** are to be taken in to consideration especially the reduction of harmful and highly corrosive sulfuric acid emissions affecting health, roofs, vehicles, plant and equipment!

#### SUMMARY

- Chinco** changes the Base to Acid [B/A] ratio to reduce the formation of slagging and ash deposits, hence assists in controlling convection to take place efficiently, allowing design draft parameters to be obtained, prevents overheating of the tubes and assists in ensuring that boiler flue gas draught is maintained to prevent unwanted condensation with its resultant corrosion to take place. Condensation enhances fouling and slagging.
- Fuels are burnt more efficiently reducing the Carbon in ash radically, particularly under very difficult conditions such as when high moisture is present in lignitic fuels such as in brown coal and bark fibers.
- SO<sub>2</sub> and CO levels in exhaust gases are reduced greatly with improved combustion of the coal with the **Chinco** catalyst.
- The cost of **Chinco** is negligible compared to the advantages gained. In most cases the savings in fuel alone, off sets the cost of using **Chinco** catalyst.
- Manganese is preferred over iron oxide as a combustion catalyst. The reason for this is that iron catalyzes formation of sulfur trioxide from sulfur dioxide. Manganese does not catalyze sulfur trioxide formation. This applies especially to high sulfur coal fuel.

#### ACKNOWLEDGEMENTS

[1] - STUDIED ON THE FIXATION OF SULPHUR DIOXIDE BY NOVEL MANGANESE (II)-SCHIFF BASE COMPLEXES AND THE THERMAL STABILITY OF THE FORMED SO<sub>2</sub> - ADDUCTS. A CASE OF CONVERSION OF THE COORDINATED SO<sub>2</sub> TO SULPHATE

- Marcelino Maneiro, Beatrice Fernande,<sup>3</sup> Esther Gomez-Forneas,<sup>a</sup> M<sup>a</sup> Jesus Rodriguez-Douton,<sup>3</sup> Rosa Pedrido,<sup>b</sup> M. Jose Romero,<sup>b</sup> Manuel. R. Bermejo<sup>b</sup>
- <sup>a</sup>Departamento de Quimica Inorganica, Facultade de Ciencias, Universidade de Santiago de Compostela, E-27002 Lugo, Spain.
- <sup>b</sup>Departamento de quimica Inorganica, Facultade de Quimica, Universidade de Santiago de Compostela, E-15782 Santiago de Compostela, Spain.

[2] - Marks' Standard Handbook for Mechanical Engineers Tenth Edition. Eugene A. Avallone Theodore Baumeister III

# Chinco Fireside Treatment

W e ' l l N O x y o u r S O x o f f !

#### STEAM BOILERS: Problems and solutions

The three distinct and major problems in boilers when using fuels containing high levels of contaminants such as sulphur, phosphor, calcium, silica and iron are:

- Black smoke caused through un-burnt carbon, and acidic SO<sub>2</sub> emissions.
- Superheater, waterwall and firetube deposits and corrosion,
- Poor combustion and low efficiency due to low quality coals.

**Chinco** is a composite of natural, environmental friendly, substances, forming a highly effective catalyst. The **Chinco** Fireside Catalyst was developed in South Africa and has been researched and perfected over the past 10 years to overcome most of these costly problems. The poorer the quality of the fuel the more effective and successful the **Chinco** results have been.

#### EMISSIONS-SO<sub>x</sub>

The emission of Sulphur Dioxide (SO<sub>2</sub>) into the atmosphere is a major global environmental problem. It is a serious threat to both human health and the environment. "Recent epidemiology studies have found an association between human mortality and Sulphur Dioxide pollution among city populations in Spain". [1]

The National Pollutant Inventory (NPI) fact sheet issued by the Australian Government Department of Environment, Water, Heritage and Arts, has ranked SO<sub>2</sub> 4th out of 400 environment hazards. The total hazard score, taking both human health and environmental criteria into account, and on a health hazard rating of 0-3 Sulphur Dioxide (SO<sub>2</sub>) registers 1.5 where a score of 1 represents harmful to health and 3 represents a very high hazard to health.

On the environmental rating of 0-3 SO<sub>2</sub> registers 1.3 where 0 represents a negligible hazard and 3 represents a very high hazard. From the above it is very clear and important that SO<sub>2</sub> emissions from boiler flue stacks must be measured, controlled and reduced to the absolute minimum levels, within our restraints and capabilities.

Over the years the tendency in industry has been to treat the symptoms rather than the causes. There are many different methods of cleaning exhaust gases. Mostly the methods used are by mechanical means such as scrubbing, filtering, diluting, electrostatic precipitators, etc. These means are not only extremely expensive to install, but are equally very costly and time consuming to maintain with the resultant down time being very undesirable. Even with the existence of these mechanical devices in place, there remain inefficiencies and the industry still cannot meet the standard determined by the authorities.

A large proportion of SO<sub>2</sub>, which would normally be expelled into the atmosphere, is bound to the thermally stable Manganese (11) and the other metal complexes in the **Chinco** catalyst, and is present in the ash in the form of an environmentally friendly Manganese Sulphate. This reduces the SO<sub>2</sub> levels in exhaust gases to within the legal required levels. This is even more noticeable in brown coal due to the higher levels of Manganese (11) sulfate monohydrate that is present in brown coal.

**Chinco** removes the SO<sub>2</sub> flue gases during the combustion process. This is achieved by the binding of Sulphur Dioxide (SO<sub>2</sub>) to the transition metal complexes in the catalyst makeup. Manganese is one of the main constituents. The other metal complexes in the makeup ensures that the Manganese remains thermally stable and ensuring the binding with the SO<sub>2</sub> at much higher temperatures. "It is well known that some types of tetra dentate ONNO Schiff base ligands tightly coordinate the Manganese ion in a square-planar geometry which yields very stable complexes. These Manganese Schiff base complexes are suitable systems to bind SO<sub>2</sub> without de-composition." [1]



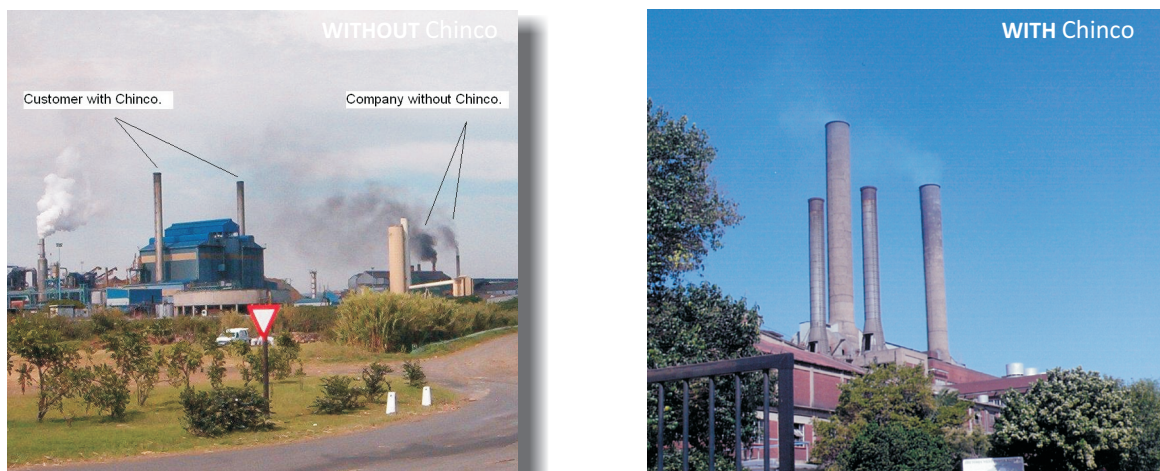
#### REDUCING SMOKE EMISSIONS THROUGH THE STACK

Boiler plants are operated as safely and efficiently as possible and it is of prime importance that the following criteria are all met and complied with without exception:

- Exhaust gas emissions are operated and maintained within legal limits.
- Design temperatures and pressures are constantly maintained as far as practically possible.
- The un-burnt carbon in the ash after combustion is as low as possible.
- Blockages and scaling in the flu gas passageways are controlled and kept to the minimum in order for the draft temperatures and velocities to be maintained within the design criteria.

Chinco with the Mn blend dramatically reduces carbonaceous effluents or smoke through more efficient combustion processes. The multi mineral content of RSACat® has many benefits even for equipment with poor control of air/fuel ratios. The manganese yields all the advantages of low excess operation whilst magnesium gives protection during periods of excess air operation. The unburnt carbon/coal in ash will be reduced considerably through the improved combustion process. Samples taken before use of Chinco and then taken during use of the catalyst indicate a major reduction in normally wasted un-burnt carbon/coal in the ash after combustion.

Adjustments and fine tuning e.g. the height of the coal bed etc, during use of Chinco can be very beneficial, ensuring fuel savings due to the improved combustion being created. Carbon being a significant component of particulate emissions will be reduced with the use of Chinco combustion catalyst, resulting in the reduction of both the particulate and opacity through the smoke stack. Un-burnt carbon will reduce because of the improved combustion, which in turn means less black smoke!



### BLOCKAGES and SLAGGING

Pulverized coal boilers can be designed for either dry-ash or slag-tap operation. The dry-ash type is particularly suited for coals with high ash-fusion temperatures. The ash impinging on the water-cooled furnace walls can be readily removed. The slag-tap furnaces use coals having low ash-fusion temperatures and are designed to have high temperatures near the furnace floor, thus keeping the ash molten for tapping.

When sintered or fused ash forms deposits on furnace walls, boiler surfaces, and superheated tubes, it reduces heat absorption, increases draft loss and could cause overheating of tubes. Two general types of slag deposition can occur on furnace walls and convection surfaces. Slagging takes place when molten or partially fused ash particles entrained in the gas strike a wall or tube, the surface becomes chilled, and solidifies. Coals, with low ash-fusion temperatures i.e. those that are plastic or semi molten at temperatures less than 2000°F [1093°C], have a high potential for slagging. Although normally confined to the furnace area, slagging can occur in the convection sections if proper design and operating parameters are not observed.

When Chinco is added, slagging and fouling in the exhaust flue gas passageways is reduced by manipulation of the base to acid ratio. The result is that design draft pressures, flows, and temperatures are far more constant preventing the formation of condensate.

Condensate is one of the main causes of blockages. By preventing blockages and unwanted back pressures ensures that the excess air-containing oxygen is properly maintained to reduce carbon to ash ratios, and unwanted carbon monoxide in the exhaust flue gases. The catalytic action of Chinco changes the ash 'Base to Acid' ratio in such a manner that slagging and deposition on furnace walls and convection surfaces are reduced substantially.

### FOULING

Fouling occurs when the volatile constituent in the ash condense on fly-ash particles, convection tubes, and existing ash deposits at temperatures which keep the volatile constituent liquid and allow them to react chemically to form bonded deposits. "Slagging and fouling characteristics can be evaluated from the chemical composition of the ash by empirically determined relationships." [2]

When applied directly to the combusting coal Chinco appreciably raises the fusion temperature of the metallic complexes, thus forming a dry and friable compound readily removed by soot blowers and gas streams. This protects boiler metal surfaces since only molten slag is corrosive. Refractory is also protected from disintegration!

### COAL ASH

Coal ash is classified as lignitic by definition if the MgO + CaO is greater than Fe<sub>2</sub>O<sub>3</sub>. Whilst if it is smaller the ash is bituminous. Bituminous coal ash is usually acidic where as lignitic fuel ashes can be highly alkaline. The fouling criteria suggest that an alkaline (Lignitic) ash requires higher amounts of sodium than are required in acidic (Bituminous) ash to produce the same degree of boiler fouling. This is consistent with the relationship between the ratio of basic oxides to the acidic oxides in ash and its fusion characteristics. One of the parameters used to evaluate the effect of an ash on furnace slagging and deposition on both furnace walls and convection surfaces include:

$$\text{Base/Acid Ratio B/A: } \frac{\text{Fe}_2\text{O}_3 + \text{CaO} + \text{MgO} + \text{Na}_2\text{O} + \text{K}_2\text{O}}{\text{SiO}_2 + \text{Al}_2\text{O}_3 + \text{TiO}_2}$$

Acid formation in the flue gas passageways are greatly reduced and diluted due to the lower SO<sub>2</sub> levels when using Chinco. Should condensation take place corrosion of the metal surfaces in the exhaust flue gas passageways is prevented. This applies especially at the cold end of a boiler. When the advantages above are considered, the added advantages such as reduced downtime, less break downs and maintenance are obvious.

### BACK CORONA

Back corona is a phenomenon that occurs within electrostatic precipitators [ESP] filtering dust that has high resistivity. As a layer of dust with high resistivity (=10<sup>10</sup> ohm-cm) builds up, a high E-field may develop within the dust layer. If the E-field reaches 10-20 kV/cm, microdischarges may develop within the dust layers which in turn generate large numbers of positive ions which drift toward the negative corona-generating electrodes. This reduces the negative space charge in the air region, reducing precipitator collection efficiency and increases odds of sparkover. Back corona is a severe problem in ESP's with certain types of high resistivity dust.

By adding Chinco manganese composite to the combustion fuel, the efficiency of an electrostatic precipitator will improve in collecting the resulting fly ash. Manganese as a flame suppressant in the fuel will reduce back corona discharge that could otherwise occur in an electrostatic precipitator.

### HIGH ASH COALS

Coals with the smallest percentages of ash have the greatest value not only because of the higher heating values but also because they offer least resistance to the passage of air and its proper distribution through the fuel bed. High ash coals require higher air draught which results in more leakage through the furnace walls. The greater draught is required because the ash may form an insulating layer around the coal preventing oxygen in the air from reaching the coal. The ash may also clinker and clog the fuel bed. The latter would be particularly bad if coal is mixed with one or more of; peat, bark fibers, wood fibers, and bagasse, whilst using as a mixed fuel on a boiler grate. The clinkering and clogging would be so bad that firing and maintaining combustion in such a boiler would be extremely difficult.

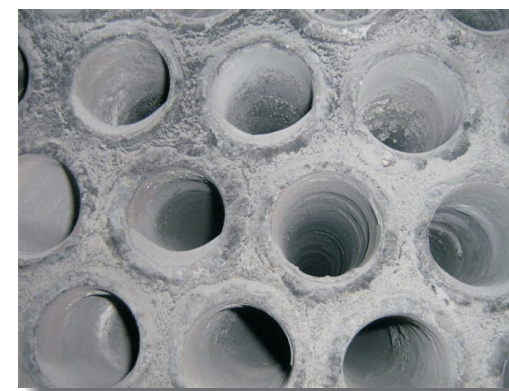
During tests carried out in bagasse/coal mixed boilers in South Africa the problem of continuous clogging and choking off of the boiler was prevented by adding the Chinco catalyst at the point of combustion. Whereas the boiler required restarting at least once per week without the catalyst, it ran continuously for the full term of three months without a single stoppage or downtime to restart whilst administering Chinco.

### PULVERISED COAL BOILERS

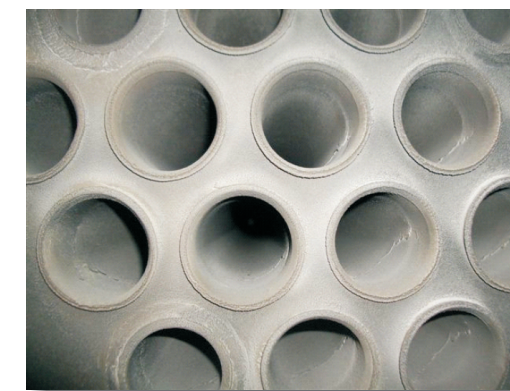
The preferred use of high ash coal, including brown coal, is via pulverized coal boilers. This is done so that particles can combust rapidly and completely whilst in suspension instead of particles remaining in direct contact with one another. Primary air enters the pulveriser at temperatures of 340°C (650°F) or higher, depending on the amount of moisture in the fuel and also the type of pulveriser. The pulveriser provides the active mixing necessary for drying. The percentage of volatile matter in the fuel has a direct bearing on the recommended primary-air-fuel ratio and temperature for combustion.

Considering the conditions prevailing in a furnace whilst firing pulverised fuel, it stands to reason that by administering Chinco directly into the pulverised fuel combustion chamber, the effect and result would be even more efficient in pulverised coal boilers than on grate fired stokers. This is due to the fact that conditions are closer to perfect for ideal combustion and that grate clogging and clinkering are reduced to an absolute minimum.

The success of the Chinco combustion catalyst is not only the critical proportionate mix of the various minerals in Chinco, but also the unique administering system of Chinco. If it were administered directly onto the coal instead of being introduced the unique Chinco way, the same catalytic action may not take place.



AFTER 3 MONTHS OF STEAMING  
(Without Chinco)



AFTER 11 MONTHS OF STEAMING  
(With Chinco)

### OTHER FUELS

Chinco has not only proven to be a very efficient and effective additive in burning acidulous bituminous coal, but is also very efficient and effective when used for combustion of highly alkaline lignitic spent bark fibers from Mimosa trees, containing approximately 60% moisture on an oven dried basis, sugar cane bagasse and sunflower seed husks.