

Safety first Quality always



Coke



Grupo
THERMOJET®

Thermojet began in the **year 2000**, when the engineer and entrepreneur Ricardo Leite Passos gathered a group of colleagues to acquire the **Special Heating and Cooling Division** of the company **Brasimet**, where they worked. The colleagues became partners. They brought with them a remote history, from the **Lindberg** company, which in **1977** had introduced convective heating in South America, and had been incorporated by Brasimet.

By the time of its foundation, Thermojet primarily served glass and steel industries, offering thermal input at the start-up and shutdown, with a heating characterized by the **equalization of temperatures** over long stretches and **high thermal uniformity**, far superior to that provided by the then known methods.



Born with the excellence of the companies from which it originated, Thermojet grew at a rapid pace, **doubling annually in size** in each of its first 10 years. Meanwhile, it began to carry out major works in plants with a capacity of **tens of millions of tons per year**, which it attends in an agile way with its **more than 250 combustion sets**.

Simultaneously, Thermojet extended its portfolio to offer a variety of **solutions in Thermal Engineering**, such as the preservation of refractories, mobile system for monitored oxyfuel combustion and computer simulation, among others.

In 2005, Thermojet filed its first **patent** application. It thus formalized the innovative vocation that continues to this day, materialized in a **division specially dedicated to the development of technology**, **Aestus**, which has among its products the development of the **software**

COBRA for the management of refractory preservation in coking plants, efficient heating and cooling stations, and the consistent patent registration of burners and auxiliary devices, as a result of R&I investments amounting to 2% of revenue.

In 2014, through the incorporation of Brazilian national leader **4Pipe**, Thermojet Group's portfolio integrated products and services for **cleaning and inspection of pipelines**.

At present Thermojet features a vast history of services for industries in various segments throughout **South America, Central America and the Caribbean**, as well as operations in China and the **partnership with Glass Service**, based in the **Czech Republic**, which has developed and used since 1990 a **computational fluid dynamics software**, CFD, refined in the simulation of refractory lined equipment.

Services

Thermojet has specialized teams in several applications of Thermal Engineering, as well as consultants and **innovation** partners for the development of **tailor-made solutions**:

- Controlled drying and heating
- Accelerated or controlled cooling
- Mobile system for monitored oxyfuel combustion
- Monitored hot-hold
- Expansion and contraction control
- Monitored draining and filling of glass ovens
- Monitored thermal comfort
- Generation of hot gas at specific flow and temperature
- Refractory diagnosis
- COBRA: Management of refractory preservation
- *Jetwelding*[®] ceramic welding
- Heat treatment
- Computational simulation of heat exchange
- Tailor-made special services

Global presence



Having units in Brazil, Colombia and Argentina, Thermojet serves the whole **South America, Central America and the Caribbean**. It is also based in **China** and represents Glass Service and Flammatec companies based in the **Czech Republic** and global reference in burners, accessories and advanced solutions for the glass industry.

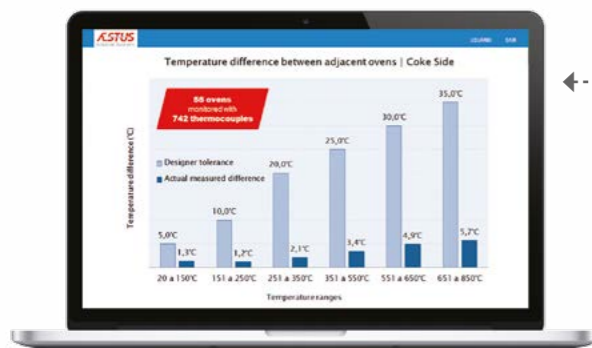
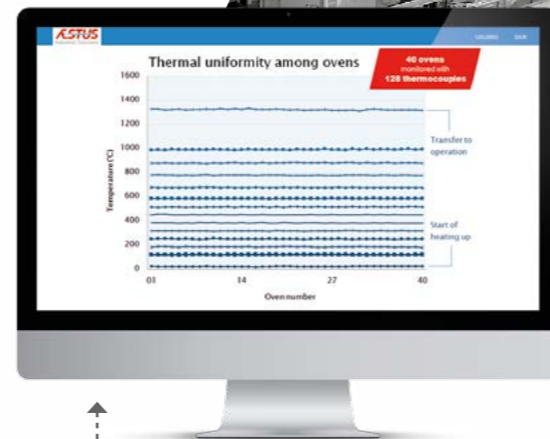
Coke

Control and uniformity at starting-up.

We started our activities in coke plants with the drying and heating for starting up the ovens. At first, they were small-scale operations. This scenario changed since 2006, and today we count the drying and heating of more than **1,000 ovens, by-product and heat-recovery**. We thus consolidated ourselves as **the most experienced company in Brazil** for the thermal input to the start-up of coking plants, with emphasis on the **uniformity of temperatures** and consequent softness of expansion provided.

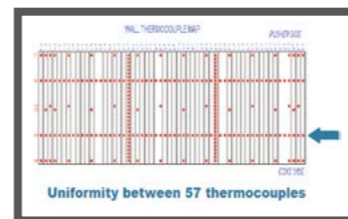
In the same year of 2006, we established a technological partnership with **Glass Service**, which is based in the **Czech Republic**. Since then, we have been licensed to use its **computational fluid dynamics software, CFD**, with which, in our **technology division, Aestus**, we conduct studies of heat distribution and expansion levels of coke ovens, simulating the heating conditions.

For **full control** over **drying**, heating and expansion, we work with **comprehensive monitoring**. In a heat-recovery battery of **40 furnaces**, for example, while monitoring **128 thermocouples**, we delivered a **profile of high thermal uniformity** and, in a by-product battery of **55 ovens** monitored with **742 thermocouples**, we smoothly attended to the designer's specification, obtaining a **5.7 °C difference between adjacent furnaces against a tolerance of 35.0 °C** at temperatures above 650°C.



Real data

AESTUS
Industrial Solutions



Progressively, we added new activities and today we count on specialists and operational teams for a complete package of solutions in the **preservation of coke oven refractories**:

- **Refractory Diagnosis**: assessment of the general condition of the battery.
- **Software COBRA** (Coke Oven Batteries Refractory Assistant): Management of refractory preservation.
- **Jetwelding®** ceramic welding.

In a project executed with Thermojet package of Coke Battery Refractory Management solutions, a potential gain of up to **10 years of preserved life was estimated**. The work, entitled "**Refractory Maintenance of Coke Oven Batteries**", was presented at the **46th Reduction Seminar, ABM Week 2016**.

Heat-recovery coke oven batteries

Thermojet performed the **drying and initial heating**.

Coke plant with a capacity of 1.55 million tons of coke per year and 198 MW.

 **320 ovens**

 **90 burners**
simultaneously 24/7

Heat-recovery coke oven batteries

Thermojet performed the **drying and initial heating**.

Coke plant with a capacity of 1.8 million tons of coke per year and 490 MW.

 **432 ovens**

 **160 burners**
simultaneously 24/7

By-product coke oven batteries

Thermojet performed the **drying and initial heating**.

Coke plant with a capacity of 22 million tons of coke per year.

 **135 ovens**

 **Up to 62 burners**
simultaneously 24/7

Services

- Controlled drying and heating
- Accelerated or controlled cooling
- Door heating stations
- Monitored hot-hold
- Expansion control
- Controlled thermal comfort
- Refractory diagnosis
- COBRA: Management of refractory preservation
- **Jetwelding®** ceramic welding
- Computational simulation of heat exchange
- Tailor-made special services

THERMOJET

Refractory diagnosis

Count on 30 years of experience.

As part of our package of solutions for the **preservation of coke oven refractories**, we conduct an **evaluation of the general condition of the batteries** in Refractory Diagnosis. Through a planned set of inspections and following the routine schedule of each oven, we apply advanced features and the experience of our teams to quickly obtain data that allow to **systematically classify the furnaces by level of criticality of damage**, following an **objective standard**. The assessment made in the Refractory Diagnosis becomes the referential condition from which to **manage and maximize the life** of the refractory lining.

Systematic
classification

Inspection with
cameras and
special
endoscopes

High
Resolution
Images

Objective
standard

Up to

10 years

of preserved service life

Thermojet solutions for **preserving the lining of coke oven batteries**:

DIAGNOSE
REFRATÁRIA

Evaluation of the general
condition of the batteries

COBRA

Management of refractory
preservation


JETWELDING

Ceramic welding: high
durability repair

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Heat-recovery coke oven batteries

We performed **refractory diagnosis with the software COBRA**.

 Agility: **112 days**

 **8.640** items inspected

 **4.752** photos

 **276** videos

 **864** inspection maps

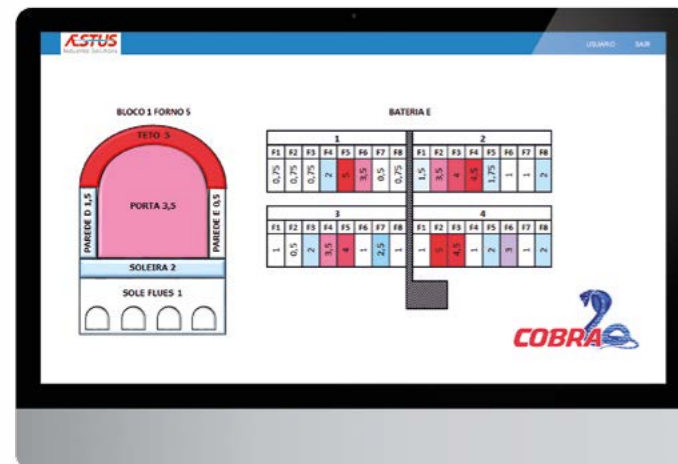
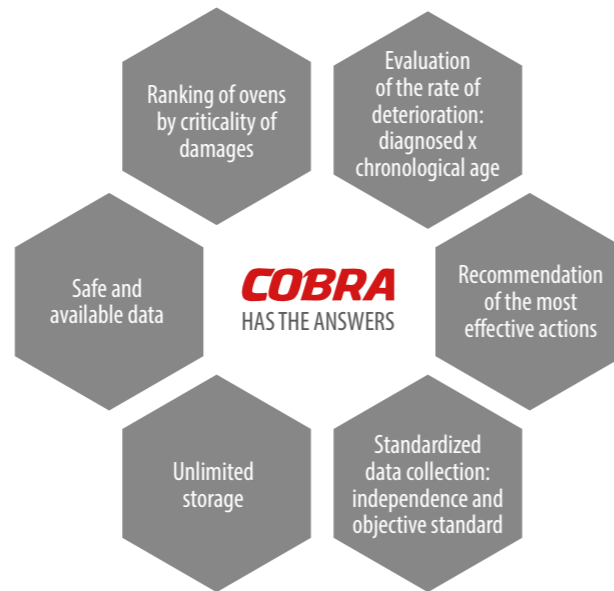
COBRA

AESTUS
Industrial Solutions

High availability with resource saving.

Developed by our technology division, **Aestus**, and named from the acronym **Coke Oven Batteries Refractory Assistant, COBRA** software organizes and processes the large volume of data obtained in Refractory Diagnosis.

Its **periodical infographic reports** allow for the **agile interpretation** and **systematic identification** of the most critical regions, to rationalize the use of maintenance resources. Preservation plans point to **corrective and preventive actions recommended to maximize the life of refractory lining with efficient use of material and labour.**



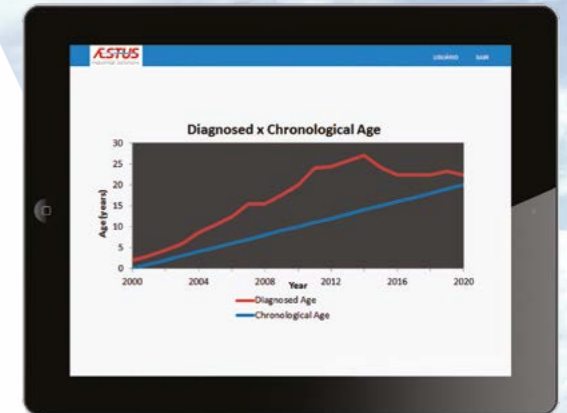
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Thermojet solutions for **preserving the lining of coke oven batteries**:



DIAGNOSE
REFRATÁRIA

Evaluation of the general condition of the batteries

COBRA

Management of refractory preservation

JETWELDING

Ceramic welding: high durability repair

Heat-recovery coke oven batteries

We performed refractory diagnosis with the software COBRA.

- Agility: **112 days**
- 8.640** items inspected
- 4.752** photos
- 276** videos
- 864** inspection maps

THERMOJET

Jetwelding® ceramic welding

JETWELDING

Postponement of stops, prolongation of life.



Developed by professionals with around 30 years of experience



Synergy with our research department in Thermal Engineering



Partnership with the best universities in Brazil



Experienced operators with a history of repairing more than 1,200 ovens



The best ceramic welding technology

Technical features

- Application **without aqueous vehicles**, normally harmful to refractories
- Type of maintenance with the **longest service life** for refractories
- **Durability** of the repair, in conditions of operation free of accidents and chemical contaminations, possibly superior, in time, to the very life of the refractory of the substrate
- **Composition of welding material almost identical** to that of the substrate

There are no practical limits to welding in terms of:

- **Temperature:** repairs under up to 1,550°C
- **Types of refractory:** SiO₂, silica-alumina, high alumina, zirconite, electro-fused
- **Application reach:** up to 12 m between operator and region to be repaired
 - Today, more than **80% of coke ovens** in Europe and the Americas are routinely repaired with ceramic welding.
 - The repair method was extended to aluminium furnaces, ceramic blast furnace burners (Brazil) and reheating fu.
 - One of the great advantages of ceramic welding is to **run hot**, with the **oven in normal operation**, without cooling.

Repairs under up to

1.550° C

Physical-chemical process

- **Exothermic oxidation reactions** produce heat and melt the welding and substrate materials using pure or dilute oxygen.
- The metal **oxides** produced in the reaction are **compatible** with those of the substrate, avoiding contamination.

Extensive repair welding

- **Large surfaces** can be welded, gaining time compared to the **time-consuming** replacements of bricks on walls.
- Pure welding can be carried out or **in conjunction with zero expansion bricks**.

Bottom repair

Main recovery method with many advantages:

- Repair **speed**
- **Little labour** involved
- **Safety** (reduced risk of accidents or incidents)
- **Hot repair:** no need for cold rooms or oven cooling
- **Routine** repair, no preparation time needed

Extensive bottom repair (through hole)

- There is no history of repairs on large extensions with ceramic welding that have collapsed.
- **Speed** about **70% greater** than that of a **parts replacement repair**.
- In no time the furnace cooling is required.
- There is a recorded case of **repair intact for over 25 years** (ACME Steel, Chicago USA, 1975-2000).
- There are **no reported incidents and / or accidents**.

Case of repair intact for over

25 years

ACME Steel, Chicago EUA, 1975-2000

THERMOJET

Thermal comfort



Regulatory compliance and productivity

To meet strict regulation of working conditions, our technology division, Æstus, developed **Mobile Units for Thermal Comfort (MUTCs)** with high capacity of directed cooling.

Our equipment is presented in portable modules, directing high flows of fresh and cooled air to the work fronts, with streams that reach **long distances**, deepening in closed environments.

As a result, we provide adequate **health, safety and productivity** conditions to operational teams.



Fresh and cooled air at long distances



As a result, we provide adequate **health, safety and productivity** conditions to operational teams.



Health



Safety



Productivity

Reheating furnaces

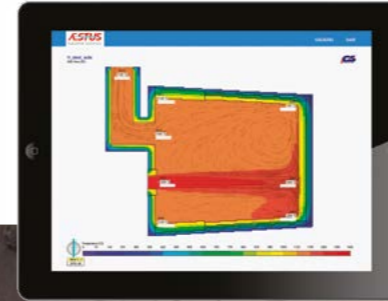
We performed **thermal comfort services at the Rolling Hot Strip**, passing to the modality of contract given the success of the operations

Rolling Hot Strip with capacity of

4 million
tons of hot rolled coils
per year



Computational simulation of heat exchange



Refinement of processes and equipment

We offer the **detailed assessment** of thermal processes by modelling and simulation of industrial equipment.

Using a computational fluid dynamics (CFD) software developed and implemented since **1990** by our partners of Glass Service, based in the **Czech Republic**, we carry out scenario studies for heating or hot-hold activities, in search of the **optimal operational parameters** that result in the desired outputs for each process, whether contributing to the **reduction in fuel consumption** or to obtaining a **high level of thermal soak**, for example.



Computational Fluid Dynamics

CFD

Using computational fluid dynamics software, **CFD**, developed and implemented since **1990** by our partners of Glass Service, based in the **Czech Republic**, we carry out scenario studies for heating or hot-hold activities, in search of the **optimal operational parameters** that result in the desired outputs for each process, whether contributing to the **reduction in fuel consumption** or to obtaining a **high level of thermal soak**, for example.

The studies also allow the evaluation of the **design of furnaces and regenerators** to **select the most efficient scenario**.



Detailed assessment

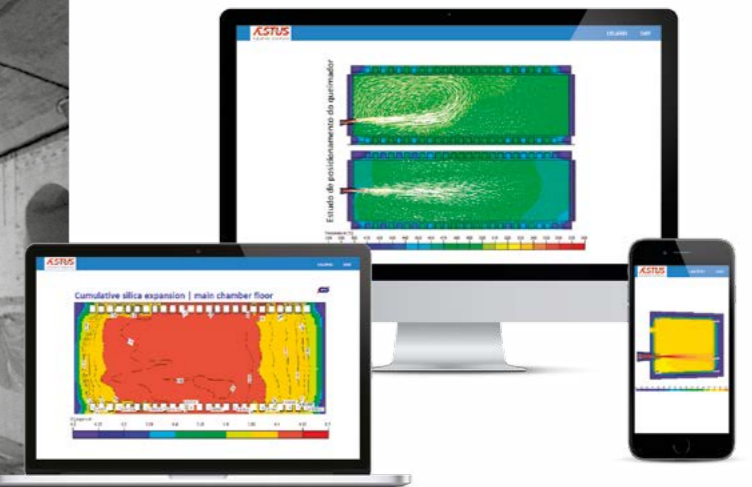
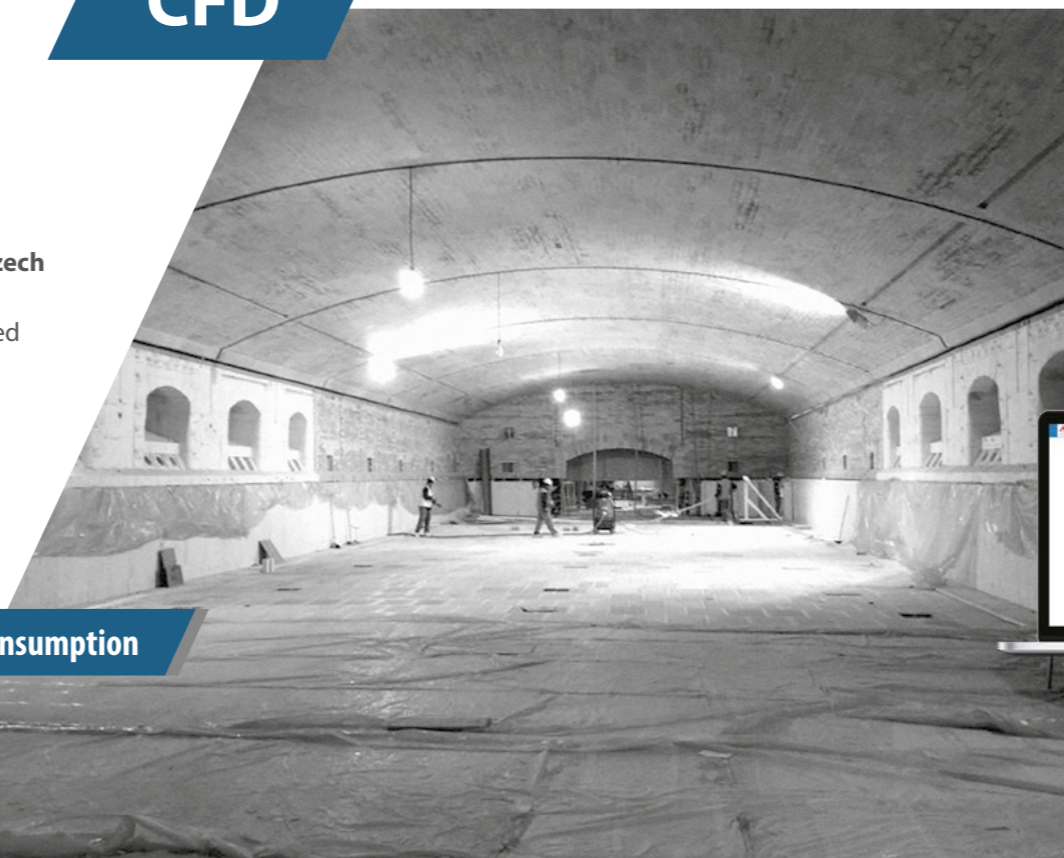
Reduction in fuel consumption



CFD simulation of heating up a float furnace

We developed a study to determine the most efficient **burner configuration** resulting in **uniformity of temperatures** in the melting zone, with **reduced fuel consumption**.

Furnace capacity **900** tons/day





www.thermojet.com

+55 12 2126 9800

Headquarters: Pindamonhangaba SP | BRAZIL

+55 12 2126 9800

solutions@thermojet.com

Avenida Felix Galvão Cruz Simões, 375

Industrial Feital CEP: 12441-275 Caixa Postal nº 521

Thermojet Argentina | Buenos Aires

+54 03407 42 5346 | +54 03407 42 1218

consultas@thermojet.com.ar

Av. Central Acero Argentino Este, 610

Parque Industrial Comirsa, San Nicolás de Los Arroyos,
Buenos Aires | Argentina.

Thermojet Colombia | Sogamoso

+57 317 665 1515 / +57 098 772 4848

ingenieria@thermojetcolombia.com.co

Calle 54 N° 10E - 65

Sogamoso, Boyacá | Colombia. Postcode: 152210

Thermojet International | Cartagena de Indias

+57 315 297 8935

comercial.tecnico@thermojetcolombia.com.co

Km 6 Vía Momonal | Edif. Comfenalco | Ofc. 308

Cartagena, Bolívar | Colombia. Postcode: 130013

Thermojet China | Shanghai

+86 158 2168 23 65

2366 Jin Qiao Lu | Bld. 1, 527

Pudong Xinqu, Shanghai Shi, China. Postcode: 201203

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www.gsl.cz

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