



**Centro Sviluppo  
Materiali S.p.A.**

***CSM TECHNOLOGIES***

***FOR***

***ENERGY & MATERIAL  
RECOVERY  
FROM INDUSTRIAL WASTE***

***AND FOR***

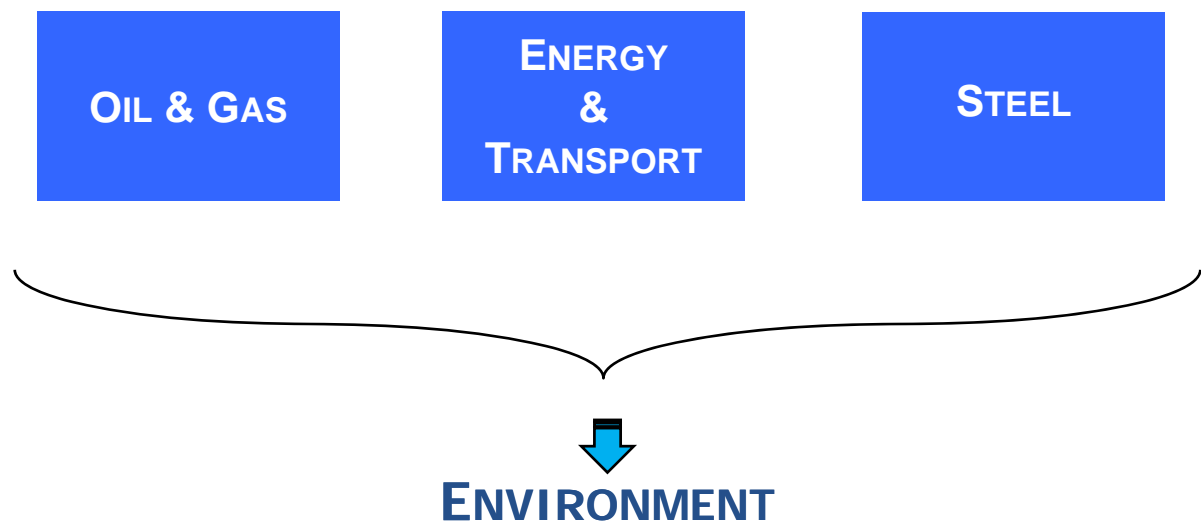
***INERTIZATION  
OF HAZARDOUS WASTE***

**[www.c-s-m.it](http://www.c-s-m.it)**

## CSM FOR THE ENVIRONMENT SECTOR

Centro Sviluppo Materiali S.p.A. (CSM) has been engaging for several years in the development of innovative technologies for the material and energy recovery from industrial residues and for the inertization of hazardous waste. This capability is based on its own well established know how on materials and processes for high temperature treatments, typical for iron and steel industry, on advanced alloys, ceramic materials and coatings suitable for critical working conditions, as in airspace and power generation sectors, on combustion processes and components for industrial heating furnaces.

So CSM is qualified to offer solutions for environmental problems within its three Business areas.



- **DEVELOPMENT OF TREATMENT TECHNOLOGIES FOR MATERIAL & ENERGY RECOVERY FROM INDUSTRIAL RESIDUES OR FOR INERTIZATION OF HAZARDOUS WASTE**
- **OPTIMIZATION OF INDUSTRIAL PROCESSES TO MINIMIZE MICROPOLLUTANTS: DIOXINS, PCBs (POLYCHLORINATED BIPHENYLS), PAHs (POLYCYCLIC AROMATIC HYDROCARBONS), ...**



**Plasma  
Torches**



**Rotary Kiln  
Gasifier**



**Rotary Kiln  
Pyrolyser**



**Electric Arc  
Furnace**



**Flameless  
Burners**

## **EXAMPLES OF APPLICATIONS**

### **MATERIAL RECOVERY**

- Recovery of metals from powders of electric arc furnaces in steelworks
- Utilization of slags of electric arc furnaces in steelworks
- Regeneration of exhausted catalyzes
- Treatment of fine fraction of ASR (automotive shredder residue) for its use in bituminous conglomerates productions
- Treatment of Stabilized Organic Component of MSW (municipal solid waste) for its use in environmental restorations

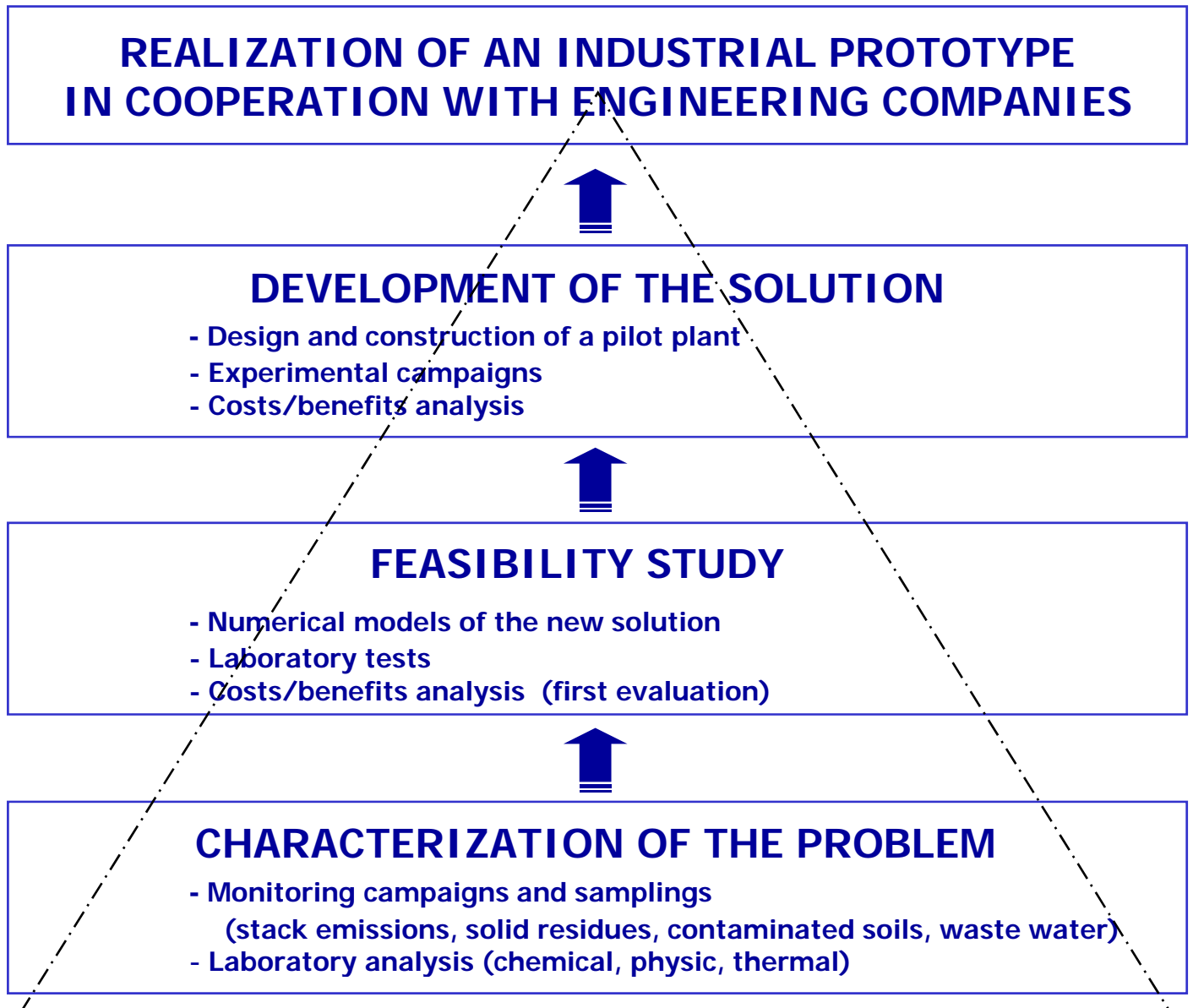
### **ENERGY RECOVERY**

- Gasification of ASR (automotive shredder residue) with electric and thermal power production
- Gasification of industrial sludge
- Pyrolysis of oils containing PCBs (Polychlorinated biphenyls) with production of hydrogen and carbon powder

### **INERTIZATION**

- Vitrification of asbestos containing waste
- Vitrification of municipal solid waste incinerator fly ash
- Inertization of contaminated soils (heavy metals and persistent organic pollutants)
- Reduction and inertization of sewage sludge

## THE CSM OFFER LEVELS



## **CSM TECHNOLOGIES AND FACILITIES**

- *PLASMA TORCHES*
- *PLASMA TORCH MOBILE PLANT*
- *GASIFICATION WITH DISTRIBUTED INJECTION*
- *ROTARY KILN GASIFIER*
- *HIGH EFFICIENCY INDIRECT HEATING*
- *ROTARY KILN DRYER AND PYROLYSER*
- *ELECTRIC ARC FURNACE*
- *OTHER SERVICES:*
  - *OPTIMIZATION OF EXISTING WASTE-TO-ENERGY PLANTS*
- *OTHER FACILITIES:*
  - *COMBUSTION STATION*

## PLASMA TORCHES

### DEFINITION OF PLASMA TORCH

Plasma torches consist of a heating device supplied with an inert gas which flows through an electric arc. The gas undergoes the breaking of molecular and atomic bonds assuming the so called state of "plasma" formed by a mixture of ions, electrons and neutral particles. The plasma reaches extremely high temperatures (7,000÷10,000 °C) and it is then able to supply heat with a very high intensity by radiation.



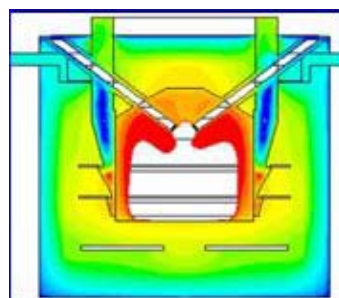
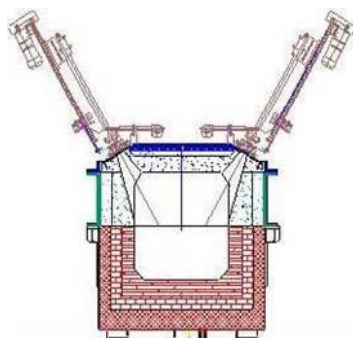
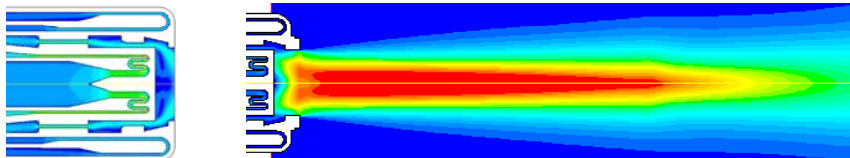
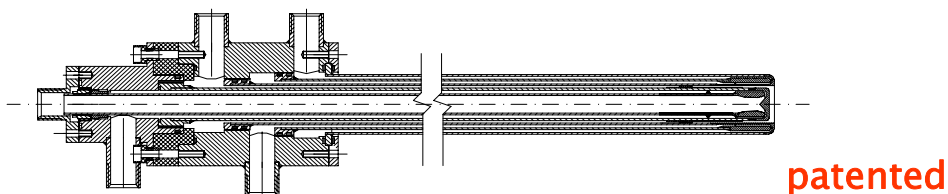
*1500 A CSM Plasma Torches*

### PLASMA TORCHES AND REACTORS DESIGN

Centro Sviluppo Materiali S.p.A. (CSM) has developed an own transferred arc plasma technology; high efficiency and reliability make this technology particularly suitable for treatments of waste.

CSM can study and optimize internal design of the inertization reactor on base of the typology of waste to be treated.

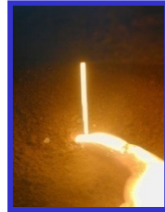
Torches and reactors designs are developed by means of CFD (Computational Fluid Dynamics) software package.



## **PLASMA TORCHES**

### **FIELDS OF APPLICATION**

- Vitrification of hazardous inorganic waste  
(for example: municipal solid waste incinerator fly ash; asbestos containing waste).
- Pyrolysis of hazardous liquid organic waste  
(for example: oils containing PCBs - polychlorinated biphenyls).



Municipal solid waste incinerator fly ash



Asbestos containing waste

### **MAIN ADVANTAGES**

- High temperatures and high thermal fluxes produced allow high destruction efficiency for hazardous organic compounds and absence of micropollutants as PCDDs (dibenzo-p-dioxins) and PCDFs (dibenzofurans); moreover the inorganic residue is melted and it becomes glass after cooling (toxic heavy metals are solidified in it).
- Plasma torches do not produce flue gas and then the syngas obtained from applications on organic waste consist only of the dissociated elements of the treated materials without dilution with the exhaust gas or with Nitrogen present in the air; it is possible transform the waste into a syngas with low levels of char (carbon solid residues) and of tar (condensable heavy hydrocarbons).
- The high power density and the low quantity of gaseous products to be treated allow carrying out extremely compact plants, very suitable to application with low room available (i.e. ships, small islands, villages, hospitals).

## PLASMA TORCHES

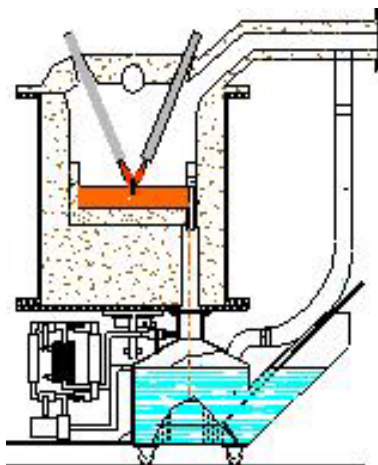
### CSM PILOT PLANT

At CSM Rome headquarters are available two plasma reactor plants completely designed and constructed by CSM.

The first one is a 500 kW pilot plant extremely flexible, on which since several years experimental campaigns are carried out for industrial and institutional customers to assess and widen plasma torch employment on different waste: domestic and industrial, solid and liquid, special and hazardous, organic and inorganic.



*Plasma inertization reactor (left) e post-combustion camera (right) of the CSM 500 kW Plasma Torch Pilot Plant*



Torch type	Transferred arc
Maximum power	500 kW
Maximum current	1000 A
Torch length	1000 mm
Torch movement	On three axis
Reactor diameter	600 mm
Reactor height	800 mm
Waste maximum flow rate	50 kg/h
Flue gas maximum flow rate	500 Nm <sup>3</sup> /h

*Reactor schematic section (left) and main characteristics (right)*

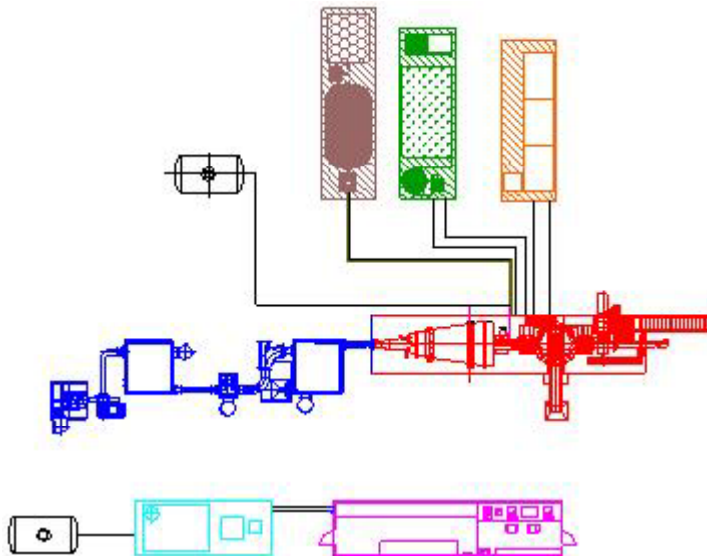
## PLASMA TORCHES

### CSM MOBILE PLANT

The second CSM transferred arc plasma torch plant is a 1 MW mobile plant designed specifically for Asbestos-Containing Waste (ACW).

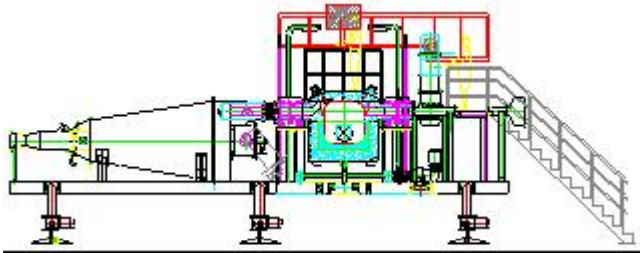
The whole system consists of six modules easily transportable which allow the outdoor use without the need of ancillary services. To work, the plant needs electric energy, in case produced by a generator, and tanks of LPG, Argon and water.

- *Process Module 1 – ACW feeding system, torch reactor, post-combustor and quencher*
- *Process Module 2 – Flue gas filtering and deacidification*
- *Auxiliary Module 1 – Industrial water system*
- *Auxiliary Module 3 – Torch electric supply system*
- *Auxiliary Module 4 – Electric boards and control box*

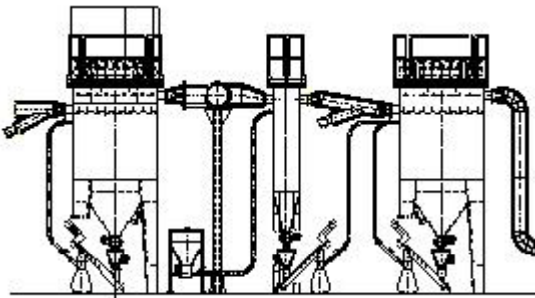


**1 MW CSM Plasma Torch Mobile Plant**

## PLASMA TORCHES



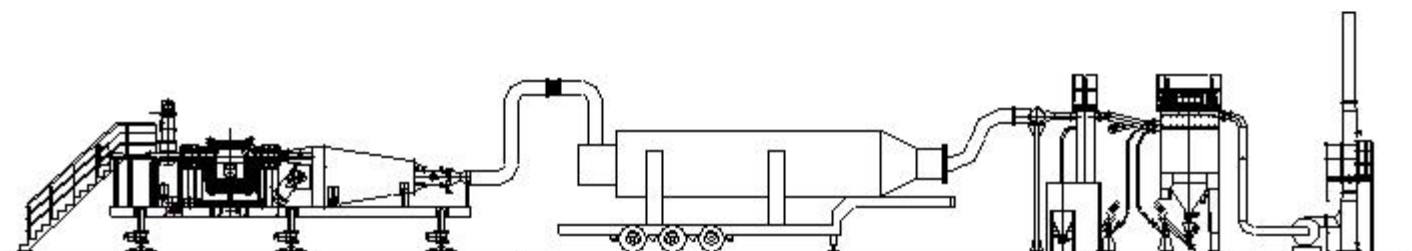
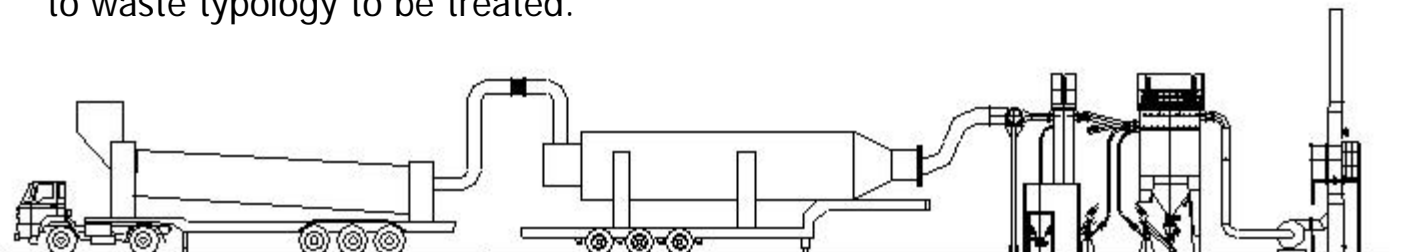
■ *Process Module 1 – ACW feeding system, torch reactor, post-combustor and quencher*



■ *Process Module 2 – Flue gas filtering and deacidification*

It is possible to replace the plasma torch unit with other modules based on several thermal treatment technologies (for examples: rotary kiln reactor). This allows to increase flexibility and to fit the mobile plant to other waste typologies which can cause an emergency.

Also the flue gas system can be completed with additional modules according to waste typology to be treated.



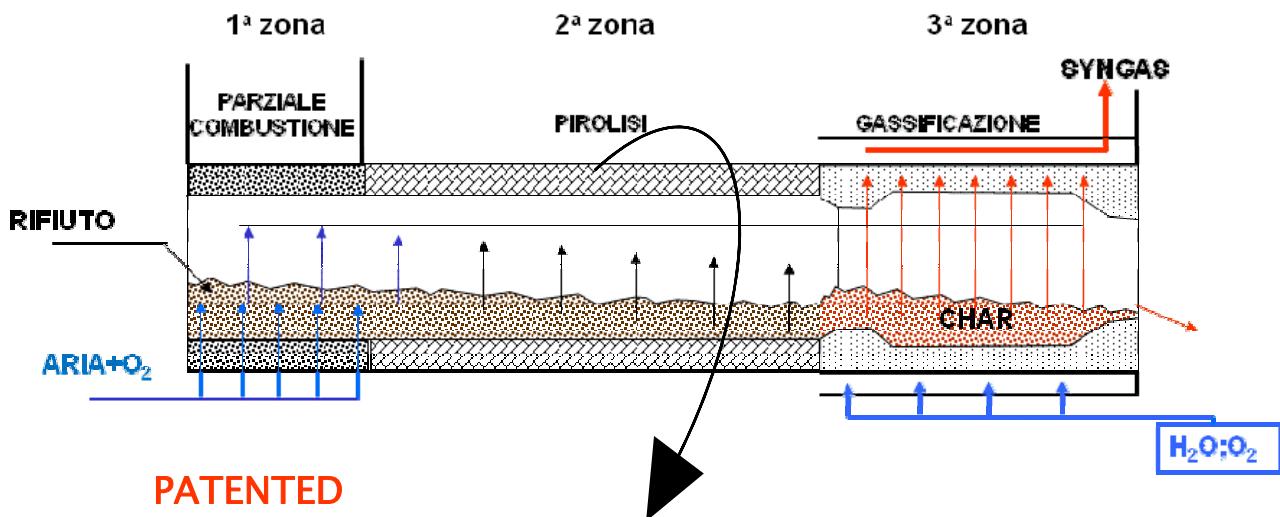
## ***GASIFICATION WITH DISTRIBUTED INJECTION***

### **WORKING CONDITIONS**

CSM has developed a proprietary gasification technology based on a rotary kiln which has several work sections; innovative devices allow a distributed and optimized injection of oxidizing agents (Air/Oxygen/Steam).

The reactor is designed to have long permanency time and a good contact between solid mass and gas. Oxidizing agents and reaction products have to cross a high layer of material during the rotation of the kiln. These conditions favour the production of CO in comparison with CO<sub>2</sub>.

In the last section there is a further injection of oxidizing agents for the gasification of the char produced in the previous pyrolysis section.



### **FIELDS OF APPLICATION**

- Devolatilization of organic compounds and production of controlled composition solid products which are reutilized in specific uses.
- Production of syngas with good calorific value and low levels of tar and particles.

## **ROTARY KILN GASIFIER**

### **PILOT PLANT**

At CSM Rome headquarters is available a rotary kiln gasifier pilot plant which was designed, constructed and proved for ASR (automotive shredder residue).

The plant is able to treat 150 kg/h of waste with a produced thermal power of 750 kW.



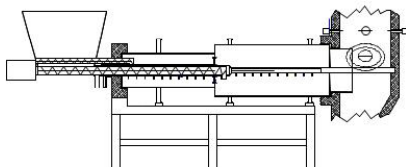
*Feeding system (left) and process reactor (right) of the CSM rotary kiln gasifier pilot plant*

Thermal power	0.75 MW
Process temperature	600÷900 °C
Waste maximum flow rate	150÷200 kg/h
Reactor diameter	2.5 m
Reactor length	11 mm

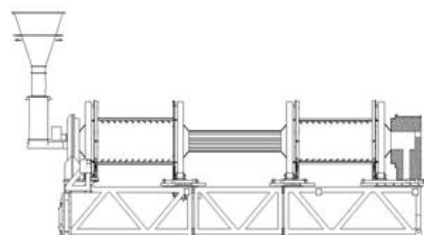
*Gasification reactor main characteristics*

### **DEVELOPMENT OF CUSTOMIZED SOLUTIONS FOR SPECIFIC WASTE**

CSM studies and characterizes each waste to find the best process parameters (treatment temperatures and times, typology and quantity of oxidizing agents, process kinetics). Successively details of the new gasifying reactor are developed: feeding system, treatment reactor shape and dimensions, injection devices for oxidizing agents.

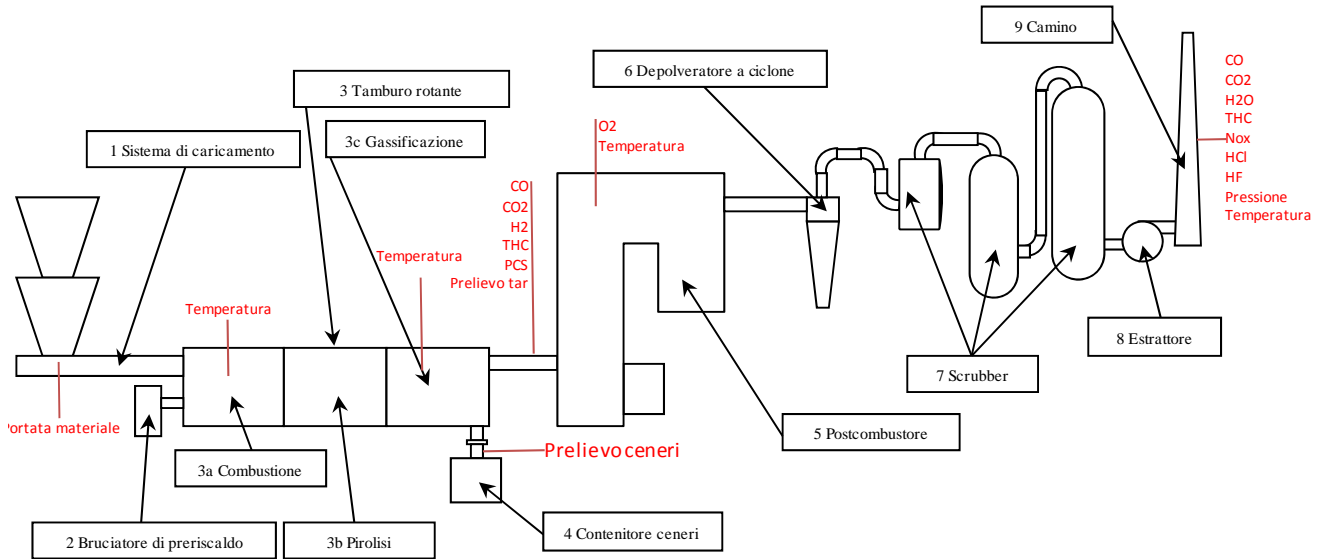


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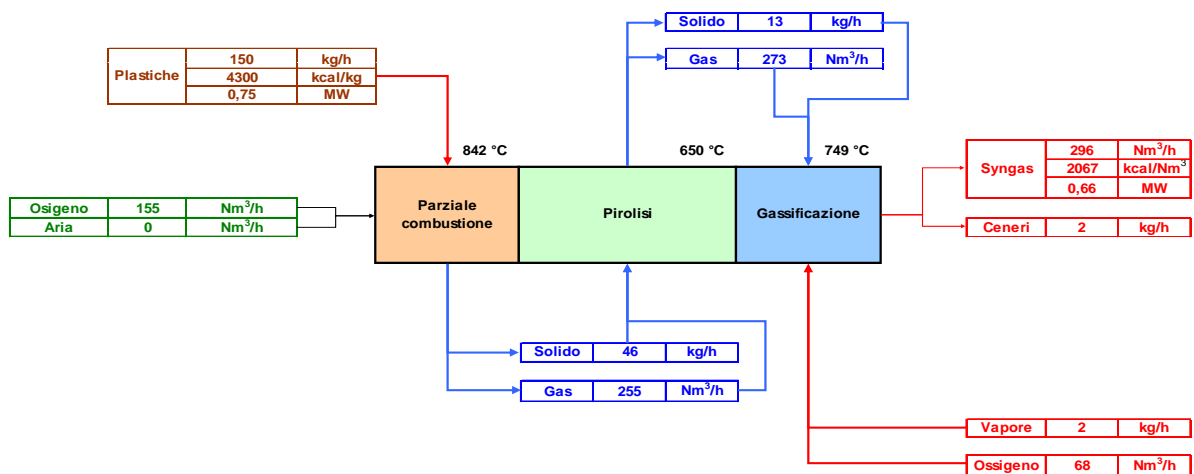


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## ROTARY KILN GASIFIER



*Schematic of the CSM pilot plant with instruments for the syngas characterization*

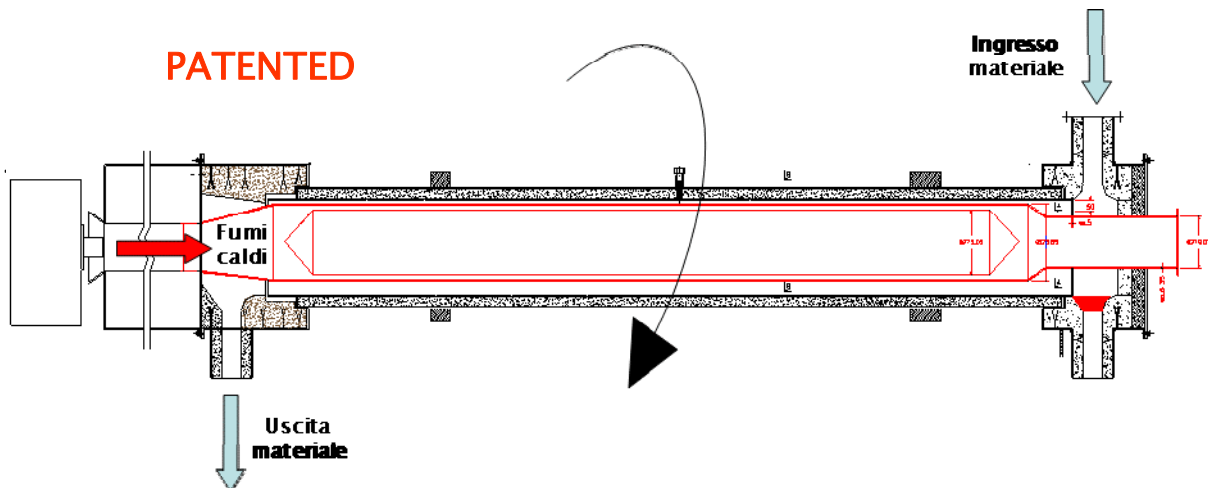


*Schematic of the CSM numerical model for mass and energy balances*

## ***HIGH EFFICIENCY INDIRECT HEATING***

### **WORKING CONDITIONS**

CSM has developed a proprietary indirect heating technology, based on metal radiant tubes, which offers heat fluxes with high density and efficiency.



### **FIELDS OF APPLICATION**

- Pyrolysis of waste with high volatile matter and production of syngas
- Drying of waste with high moisture
- Regeneration of industrial catalysts.

## ***ROTARY KILN DRYER AND PYROLYSER***

### **PILOT PLANT**

At CSM Rome headquarters is available a rotary kiln dryer and pyrolyser pilot plant, on which several experimental campaigns are carried out on different waste.

The plant is able to treat 50 kg/h of waste with a produced thermal power of 750 kW.



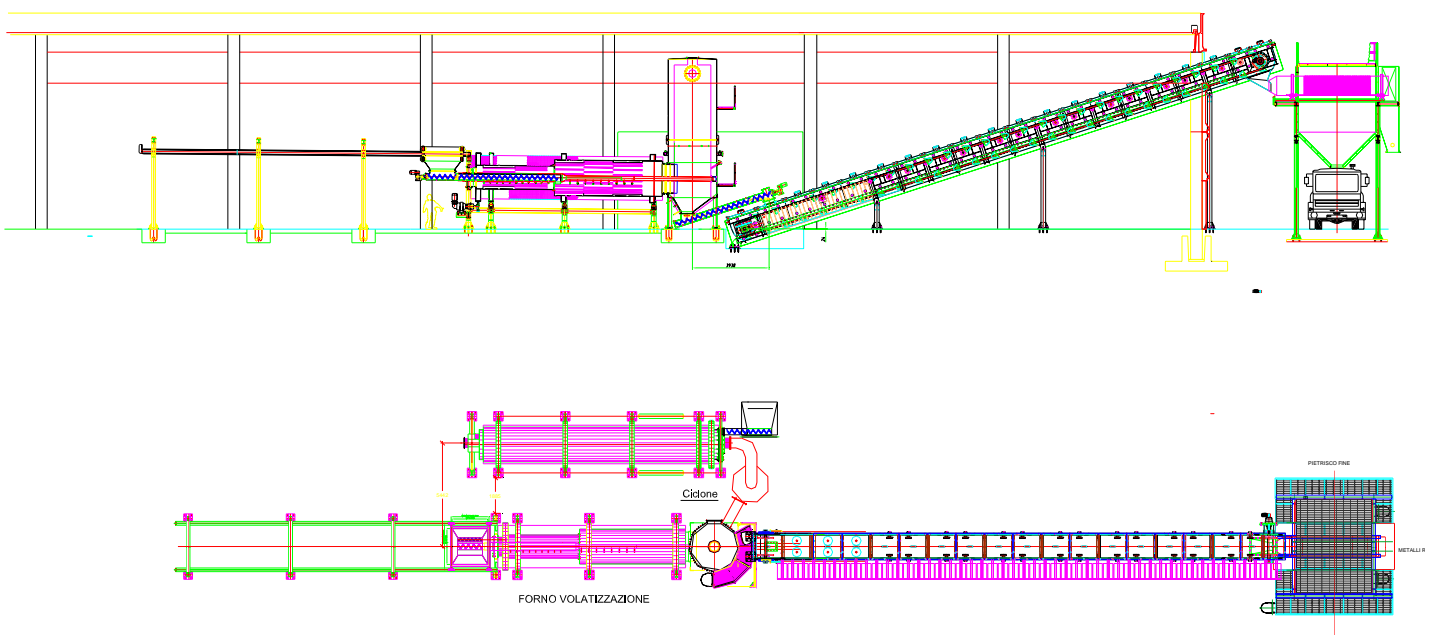
Burner power	120 kW
Waste maximum flow rate	60 kg/h
Flue gas maximum flow rate	150 Nm <sup>3</sup> /h
Reactor wide	400 mm
Reactor length	6000mm

# REALIZATION OF INDUSTRIAL PROTOTYPES

## MATERIAL AND ENERGY RECOVERY from ASR (automotive shredder residue)



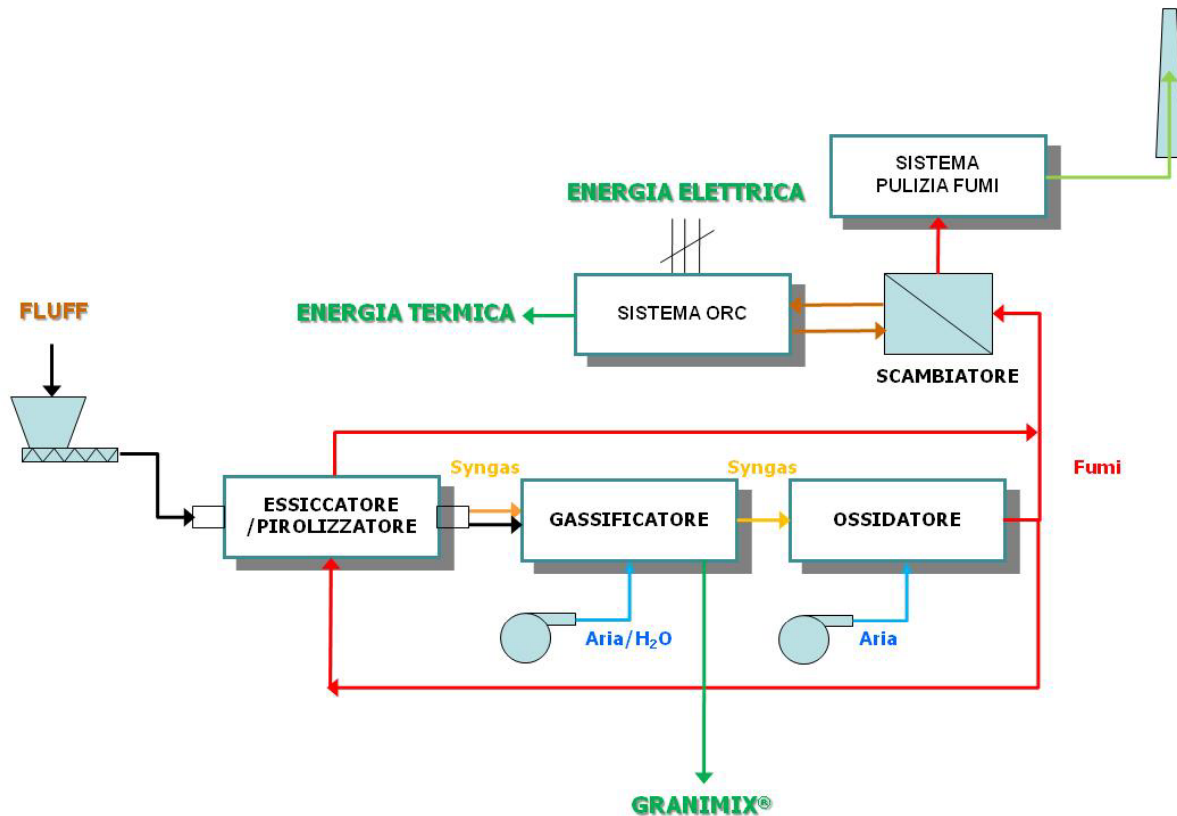
*2.5 t/h ASR industrial plant*



*Industrial plant drawing*

## REALIZATION OF INDUSTRIAL PROTOTYPES

### MATERIAL AND ENERGY RECOVERY from ASR (automotive shredder residue)



*Flow sheet of the industrial plant*

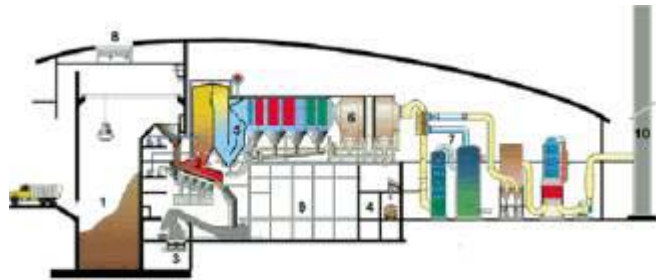
### GRANIMIX®

By-product (according to Art. 5 of the Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste) utilizable in the production of bituminous or cementitious conglomerate as partial substitute of natural inert.



*Samples of bituminous conglomerate produced using GRANIMIX® and used in environmental and technological tests.*

## OPTIMIZATION OF WASTE-TO-ENERGY PLANTS

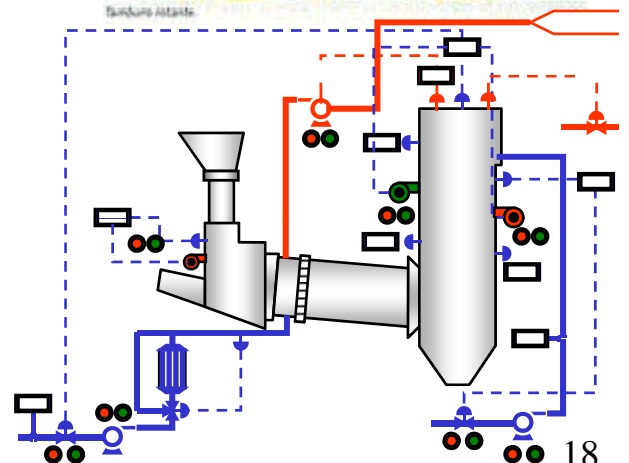
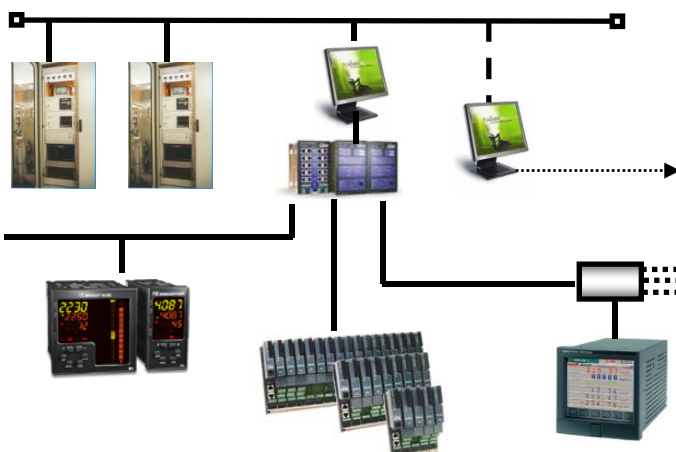


CSM is involved in activities which concern all the units of existing waste-to-energy plant for MSW (municipal solid waste):

- ❑ Combusting chamber
- ❑ Steam generator
- ❑ Rotating machines (turbine and alternator)
- ❑ District heating pipe network
- ❑ Flue gas treatment system (macro-pollutants and micro-pollutants)
- ❑ Fly ash inertization
- ❑ Analysis laboratories

### *Combustion Process Control*

- ❑ Supervision and Data Acquisition System
- ❑ Combustion chamber control
- ❑ Post-combustor chamber control
- ❑ Exhaust gas recirculation control
- ❑ Exhaust gas emission control

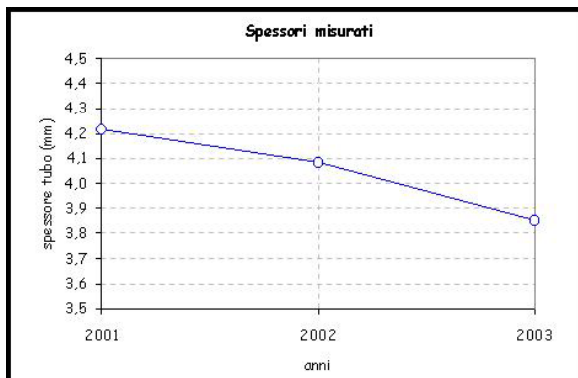
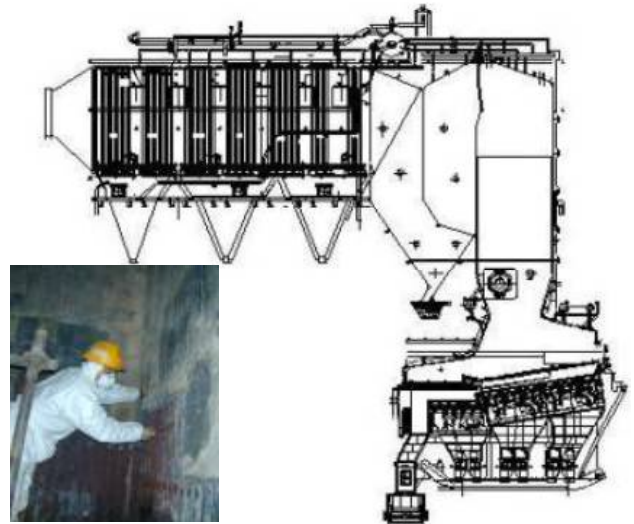


## OPTIMIZATION OF WASTE-TO-ENERGY PLANTS

### Inspection campaigns in combusting chamber, boiler, turbine

CSM carries out periodic inspection campaigns, using all the available Non-Destructive Techniques, with the aim to identify most critical components and to estimate their *residual life*.

- ❑ Ultrasonic thickness measurements
- ❑ Non-Destructive controls
- ❑ Videoendoscopic measurements
- ❑ Thermographic measurements



In case of accidental breaks CSM carries out *failure analysis* on damage parts:

- ❑ Scanning Electron Microscopy (SEM)
- ❑ Optical microscopy analysis
- ❑ Fractographic analysis
- ❑ Microstructural analysis

