ELECTRIC ENERGY GENERATION

PLANT THROUGH ELT COMBUSTION

(SCRAP TYRES) (FLUFF) (PDF/SRF)

GENERAL SYSTEM SPECIFICATION

1. SCOPE

This document describes the main characteristics and operation of the electricity generation plant through the recovery of heat from the thermal destruction of ELTs (End of Life Tires) located inside the MARANGONI TIRE plant in Anagni (FR).

The unit has a power of approximately 3300 kW net of the turbolaternator users (approximately 15 kW).

This document contains in principle all the technical information of the system, the description of its operation, the characteristics of the regulation system, the electrical power distribution system, the type of instrumentation to be used, the final tests to be performed.

2. GENERALITY

The plant in question is built in an area adjacent to the Marangoni Tire factory in Anagni (FR). The machines are located partly inside a new building and partly outside.

An area of the area is intended for the storage of tires in reinforced concrete tanks.

The plant has the typical characteristics of a power plant for the production of electricity, where the fuel consists of End of Life Tires (ELTs).

The combustion of whole tires takes place inside a rotating oven (thermo-destructor) and the heat generated is transformed into steam in a recovery boiler.

The steam is then sent to a condensing turbo-alternator for the production of electricity.

The production voltage is 6 kV and is raised to 20 kV for feeding into the grid.

3. SYSTEM COMPONENTS

The plant consists of:

- ELT conveying lines (Car and Giant)
- PFU thermodistructor
- Afterburner with methane burner
- Discharge and wire / ash separation system
- Hot smoke by-pass chimney
- Recovery boiler and methane burner

- Master fan, cold smoke by-pass and smoke duct up to the filters
- Bag filters for dedusting and desulfurization
- Final chimney tail fan
- Turbogenerator
- Thermal cycle components
- Power electrical system components
- Control room (control and supervision system)
- Continuous monitoring system of chimney emissions
- Water demineralization plant

3.1 ELT conveying lines

The PFU conveying system, both PFUV (Car) and PFUG (Giant, i.e. truck), mobilizes the tires from the storage tanks to the thermodistructor mouth.

An overhead crane operates on the storage tanks to move the tires towards the singling lines consisting of steel slatted belts and roller conveyors.

Two scales (one for each type of ELT) weigh the tires before entering the kiln to allow adjustment of the thermal load.

3.2 Thermodistructor

The thermo-destructor, in which the ELTs are thermo-demolished, is a cylindrical rotary-type furnace made of steel and internally lined with refractory.

The rotation takes place on rollers with bearings and is controlled by a single system equipped with an electric motor controlled by a frequency converter (variable speed 0 ÷ 2 rpm).

A second fixed speed emergency motor is installed capable of rotating the oven at 0.2 rpm. approximately.

The furnace is equipped with a PFU inlet, from which the combustion air is sucked in due to the depression generated by the fan located downstream of the boiler (master).

There are two fans with a regulation damper for the delivery of combustion air directly into the thermo-destructor, one on the feed head which is also the fan for the burner.

preheating, and one on the terminal part of the oven, which blows the air in correspondence with the gap between the rotating part and the fixed part.

The oven is equipped with two burners fueled by methane gas, one for drying the refractory and one for preheating, both of the retractable type.

The terminal part of the furnace has a hopper in the lower part for the extraction of the wires and the ashes, which are conveyed, by means of a steel conveyor belt, to a vibrating wire / ash separator.

The storage of the ashes and wires takes place directly in containers (drive-over type) positioned under the vibrating separator.

3.3 Afterburner and hot fumes by-pass chimney

The afterburner is made up of a steel tube lined internally with refractory, and is equipped with a methane gas burner, able to activate when the temperature inside the afterburner drops below 960 ° C, or to contribute to production. of heat for the generation of steam for a maximum thermal load equal to 10% of the system capacity.

The post-combustion burner is equipped with its own fan for the combustion air.

There are expansion compensating joints on the afterburner.

The fumes by-pass chimney is located in the upper part of the afterburner on the side where the fumes descend.

The chimney is made of steel internally lined with refractory and will be equipped at the top with a valve (clapet) with actuator and counterweight (opens by "system block" command) which intervenes in emergency on command of the control system. The function is to "protect" the boiler and all the systems downstream of it from the thermal inertia of the thermo-destructor in the event of a system block.

The particular shape of the afterburner has been designed to favor a precipitation of heavier powders before entering the boiler. These powders will be collected together with those of the boiler.

3.4 Recovery boiler

The recovery boiler produces steam by drawing heat from the fumes.

It is a boiler equipped with a radiant chamber with 2 smoke passes, superheater, evaporator and economizer.

The radiant chamber is designed for the installation of a modulating methane gas burner for heat integration and for maintaining the nominal temperature (as an alternative to that on the afterburner).

The superheater is equipped with an overheater for temperature regulation.

The lower part of the boiler is equipped with hoppers with augers and redlers for collecting, extracting and discharging the ashes into big-bag containers.

The boiler will be cleaned entirely with hammers: pneumatic strikers are present for the walls of the radiant chamber.

3.5 Fume extraction and treatment, final chimney

The fumes extracted from the boiler by the fan are conveyed to pass through a bag filter for dedusting.

Following the desulphurization takes place for the mixing (through fluid dynamic static mixer) and the reaction of the fumes with sodium bicarbonate, NEUTREC process- (SOLVAY), and subsequent filtration through bag filters.

On the flue gas treatment line there are some system protection systems:

- a cold smoke by-pass (also called emergency chimney n.1) downstream of the master fan before the filters; it is used during the start-up of the system (methane) or it is commanded to open by blocking the filtration system due to the breaking of sleeves or very high fumes temperature (by opening the by-pass the feeding of the tires is blocked);
- a modulating "false" air intake valve at the inlet of the filter group for temperature regulation if the latter is too close to the resistance limit of the materials of the sleeves;
- a fire-fighting system upstream of the ash filter consisting of the introduction of CO into the fumes duct with manual control.

A silencer is provided between the tail fan and the chimney.

The plant operates in compliance with Legislative Decree 133/2005.

3.6 Turbogenerator

The turbogenerator, of the condensing type, with a power of approximately 3300kW, is of the package type, pre-assembled on a single base.

The turbogenerator is equipped with a bleed for heating the condensate in the degasser.

The condenser is positioned below, parallel to the longitudinal axis of the turbine, offset by 300 mm.

3.7 Main components of the thermal cycle

Components of the thermal cycle are defined as all those that contribute to the conveyance of steam to the turbine and therefore to the condensation, degassing and water supply for the boiler.

The components installed on the system are the following:

- 1 main vacuum condenser complete with vacuum system (non-condensable extraction ejectors) with small condenser
- 1 auxiliary atmospheric condenser equipped with hydraulic guard
- 2 main condensate extraction pumps
- 2 auxiliary condensate extraction pumps
- 1 steam condenser sleeves with extractor
- 1 degasser with condensate storage tank
- 2 feed pumps
- 2 water circulation pumps to the condensers
- 8 evaporative cooling towers (in 4 cells)
- turbine bypass valve
- valves and piping
- field and transduced instrumentation
- boiler water chemical injection system
- tower water treatment plant
- 2 demi water integration pumps to the degasser
- 1 emergency demi water pump to the degasser

3.8 Power electrical system

For the electrical system there is a "delivery cabin" near the porter's lodge and an electrical cabin on the ground floor of the shed.

In the delivery cabin there are the panels for the measures for the purchase and sale of energy:

- MT 20KV electrical panel
- Main transformer 6KV→20KV
- Transformer for starting and operating the thermal destruction system 20KV→380V
- Unit transformer and 20V power plant operation→380V

- MT 6KV electrical panel (riser and generator star center)
- Machine protection panel and measurement converters
- Power Center Panel (PC)

The other components are installed in rooms located on the upper floor:

- MCC panels (motor control center)
- Battery charger - batteries - inverter

The passage of the connection cables between the delivery substation and the electrical substation takes place inside underground conduits.

3.9 Generator set

It is a diesel fueled unit with a power of approximately 500 kVA with an automatic starting system due to the lack of any other electrical power supply to the system.

It has the function of powering the machinery necessary to bring and maintain the entire system in a safe condition, with an autonomy of 2 hours.

The generator is equipped with a 120-liter tank on board. Outside the room there is a 1000-liter underground diesel tank with power supply system with electric and manual pump.

3.10 Cooling towers

For the cooling of the circulating water in the main condenser, forced draft evaporative towers are used, capable of maintaining the nominal temperature values for about the whole year.

They are made of galvanized steel and stainless steel, and are placed above a reinforced concrete tank which constitutes the accumulation and the intake area for the circulation pumps.

The water consumption due to evaporation and dragging is about 20 m^3/ h, in addition to about 10 m^3/ h of purge.

For the integration of the water, a new well was dug capable of maintaining a water requirement of approximately 50 m^3/ h (the excess part is used for demineralization and open cycle cooling).

3.11 Regulation and supervision system

A dedicated room on the ground floor was created for the control room.

Inside the control room, the following are installed on a lectern desk:

- Supervision and control system with keyboard commands
- Controls for turbo-alternator (manipulators) with:
  - command and control panel
  - manual and automatic synchronizer
  - tools for arousal
  - measuring instruments (voltmeter, ammeter, cosphimeter)

Furthermore, there is a separate panel containing the smoke filter control system.

3.12 Continuous monitoring of stack emissions

A complete smoke monitoring system is installed on the incineration plant, as required by Legislative Decree 133/2005

Therefore on the plant there are:

- connections on the chimney for the probes
- probes + interface system with analyzers
- output signal for automatic control of the fumes treatment system (if any)

The main switchboard was installed near the fireplace.

4. MAIN SYSTEMS OF THE PLANT - DESCRIPTION

4.1 Fuel-air-fumes system

It can be defined as an "Open System"

The ELT fuel and the combustion air are introduced at the inlet of the thermo destructor.

The hot fumes generated in the thermo-destructor pass through the boiler exchangers (superheater, tube bundle evaporator, economizer) cooling down and are then sucked in by the master fan and pumped through the dust collector and desulphurizer to then exit the chimney, pushed by the tail fan.

There are two emergency fireplaces, both normally out of service: the "hot fumes by-pass" which allows the fumes to be discharged directly into the atmosphere before entering the boiler, and the "cold fumes by-pass" located downstream of the fan master, which protects the bag filters from any high temperatures.

4.2 Water-steam system

It can be defined as a "Closed System".

The degassed feed water, at a temperature of about 110°C and at a pressure of 1.6 bara, it is pumped, through the economizer, into the boiler where the steam is generated at about 45 bara and is then superheated up to about 430°C in the superheater.

This steam feeds the turbine and the steam supplement valve to the degasser.

On the steam line there is a disconnection for the by-pass valve, which has the purpose of allowing the boiler to be started in addition to the function of bypassing the turbine in the event of a block.

The by-pass valve discharges the aged steam into the relative auxiliary condenser fed, as circulation water, by the outlet of the main condenser.

The feed pumps suck from the degasser which pump into the boiler feed line, equipped with level control valves.

4.3 Circulating water system

It is a "closed system"

To condense the vapor in the condensers (main and auxiliary) and for the closed-cycle cooling systems (turbine oil refrigerants and alternator refrigerants) a circulation system with forced ventilation cooling towers has been adopted.

The system consists of:

- 8 evaporative cooling towers grouped on 4 cells
- 8 axial fans (one for each tower)
- 2 vertical water circulation pumps
- a tank common to the 4 cells in reinforced concrete

4.4 Demi plant

There is a water demineralization system, able to guarantee the flow rate and the sufficient qualities for the system.

The storage tank (about 20m_3/ h) for the plant was placed in the same room as the plant.

There is also a waste water neutralization system that allows the drainage of the regeneration water of the resins directly into the black water.

4.5 Industrial water system

Well water is used to replenish the water in the demineralisation system and in the tower circuit. This water is also used for the cooling of the compressors and for the refrigerants of the sampling stand.

Since the well water circuit is pressurized by electric pumps, in the event of a power failure, automatic switching on a plant line connected to other wells is envisaged.

4.6 Compressed air system

There is an air pressure level of 7 bar.

For instrument air and filter cleaning there is an absorption dryer capable of guaranteeing a dP = - 20 ° C.

5. REFERENCE DATA TABLES

5.1 Environmental and operating conditions

Maximum temperature	+ 40 ° C
Minimum temperature	- 5 ° C
Annual average relative humidity	60%
Operation (46 weeks of 7 days)	7728 hours
Regular winter stops (Christmas)	2 weeks
Regular summer stops (August)	4 weeks
Seismic zone	S = 9 2nd degree

5.2 Operating data

Tire feeding system

PFUV

Nominal flow	2000 kg / h
Effective range	2000 kg / h approx
Max diameter	800 mm
Max height	350 mm
Weight	6 ÷ 7 kg
Accumulation type	bulk
Average weight / volume	100 kg / m³
Autonomy	about h

PFUG

Nominal flow	2000 kg / h
Effective range	2000 kg / h approx
Max diameter	1200 mm
Max height	460 mm
Weight	60 ÷ 70 kg
Accumulation type	In stacks of 5 pcs max
Autonomy	about h

The system is designed for 100% PFUV default operation. The percentage of PFUG can be varied by the operator from 0 to 100% to replace the PFUVs.

Thermodistructor

Depression in the mouth	- 12 mmca
Effective smoke flow	about 200000 Em³ / h
Standard smoke density	1.31 kg / Nm³
Nominal flue gas temperature	About 1000 ° C
Max design combustion chamber temp	1350 ° C
Preheating burner thermal power	5500000 kcal / h
Combustion / preheating air blower capacity	17200 Nm³ / h
Combustion / preheating air fan prevalence	220 mmca
Exhaust head seal air flow	18000 Nm³ / h
Thermal destruction rotation speed	0 ÷ 2 rpm
Extraction flow wires without ash (20% weight)	About 450 kg / h
Wire weight / volume	1500 kg / m³
Ash extraction rate (5% weight)	About 120 kg / h
Ash weight / volume	300 kg / m³
Autonomy of the wire collection box	about h
Autonomy of the container ashes	about h

Afterburner and recovery boiler

Post-combustion burner power	2500000 kcal / h
Flue gas inlet temperatures in the boiler	980 ± 30 ° C
Smoke speed in the post-combustion chamber	> 10 m / s
Contact time	> 2 seconds
Economizer outlet fumes temperature	170 ° C
Superheated steam production nomin.	16.5 t / h
Superheated steam temperature	435 ± 5 ° C
Superheated steam pressure in operation	45 bar a
Superheated steam pressure draft	54 bar g
Feed water temperature	About 110 ° C
Smoke side pressure drops (clean / dirty)	30/150 mmca
Big-bag autonomy for ash storage	About 1 m³

Turbo-alternator

Steam inlet temperature	430 ° C
Steam inlet pressure	42 bar a
Gross electrical power	3300 MW
Voltage and frequency	6000 - 50 V - Hz

Main capacitor

Steam flow to condense	about 13 t / h
Condenser pressure	0.07 coffin

Auxiliary condenser

Steam flow to condense (max)	about 21 t / h
Condenser pressure	atm (+0.2 barg)

Smoke extraction and desulfurization system

Depression to be maintained at the boiler outlet (echo)	approximately mmca 200
Inlet fumes temperature	170 ° C
Chimney outlet fumes temperature	About 160 ° C
Master fan flow rate	44000 Nm^3 / h
Master fan total pressure (RPM)	Pa
Tail fan flow max	49000 Em^3 / h
Tail fan total pressure	Pa

Chimney emissions values and type of analysis

SUBSTANCE	**Legislative Decree 133/2005 (Directive 200/76 / EC)**	**DETECTION**
CO	50 medium g 100 medium seeds h	c
Total powders	10 medium g 30 medium seeds h	c
Organic substances	10 medium g 20 medium seeds h	p
HCl	10 medium g 60 medium seeds h	c
HF	1 medium g 4 medium seeds h	p
SO2	50 medium g 200 medium seeds h	c
NO2	200 medium g 400 medium seeds h	c
Cd + Tl	0.05 average h	p
Hg	0.05 average h	p
Sb + As + Pb + Cr + Co + Cu + Mn + Ni + V + Sn	0.05 mean sum h	p
PCDD + PCDF (in ng / Nm3)	0.1 average 8 h	p
IPA (Hydroc. Polycicl. Aromatic)	Not indicated	p

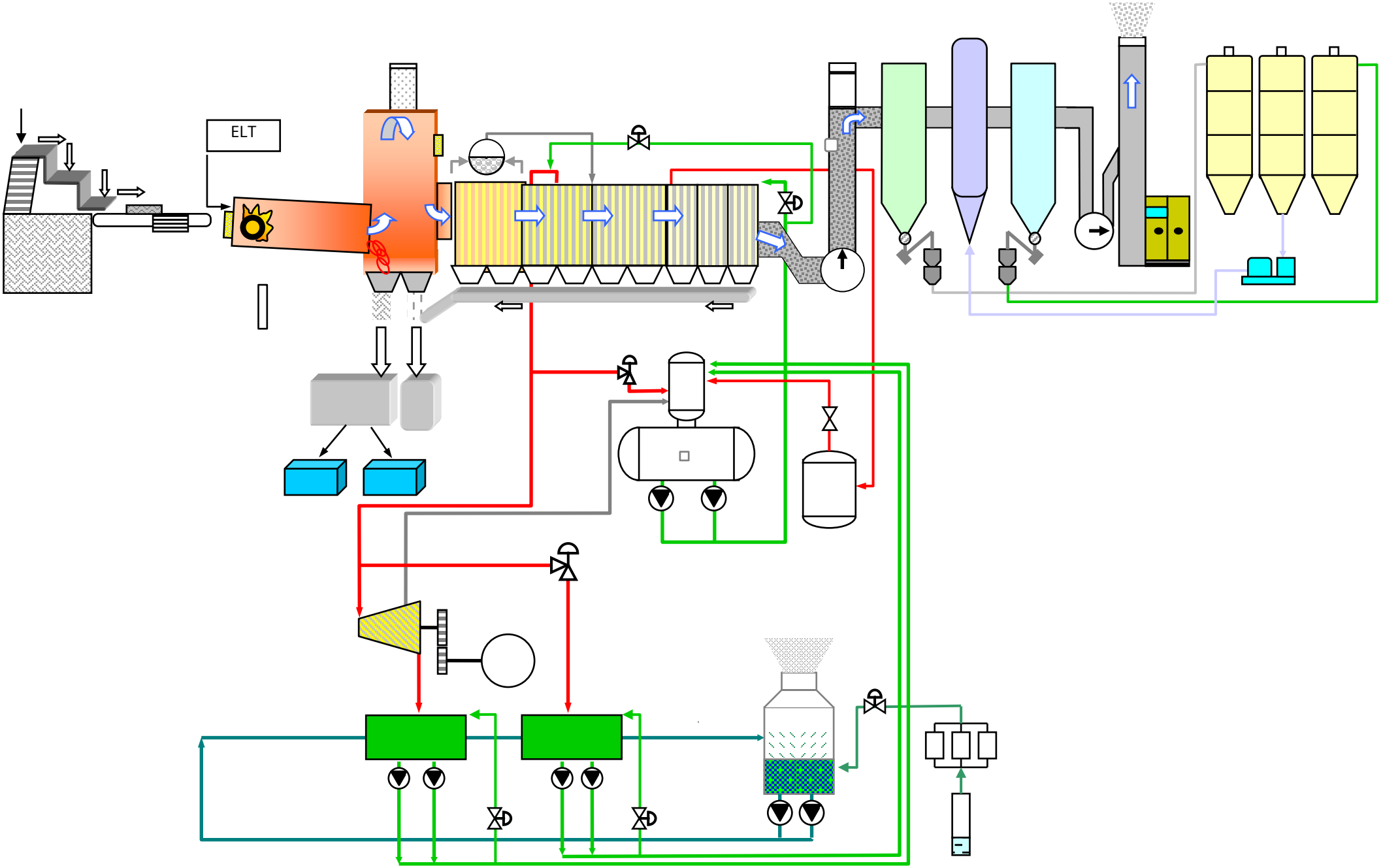
LEGEND: **C.** = Continuous registration
P. = Periodic registration

Demi plant

Production	5mm^3 / h
Quality	0.1 µs / cm

Cooling towers

Heat to be disposed of	7000000 kcal / h
Cooling water flow	1000 m^3 / h
T water inlet (nominal)	36 ° C
T water outlet (nominal)	28 ° C
T room bu (nominal)	24 ° C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