C.U.T./T.U.T. BURNING
AND
ELECTRIC POWER
GENERATION PLANT

(2000 kg/h)

PLANT GENERAL SPECIFICATION

1. GENERAL

This document describes the main characteristics and the operation of a 3.300 kW (gross capacity) electric power generation plant which utilises recovery of heat coming from 2000 kg/h C.U.T./T.U.T. (Car Used Tyres/ Truck Used Tyres) burning. This occurs with the combustion of whole tyres in a rotating furnace, from that the fumes are sucked in the steam generator. The fumes, after the filtration, are evacuated through the chimney, on them are monitored the amount of stack emission.

This specification includes all the plant technical main information, its operation description, control system and power electric distribution system characteristics.

The above described plant foresees C.U.T./T.U.T. burning with heat recovery for electric power generation only: part of this electric power is utilised by the plant auxiliaries (fans, pumps, etc.), the exceeding part of it can be given to the network or can be utilised for other technological utilities.

This plant is foreseen to be constructed inside a building. Some components, such as cooling towers and flue gas filters, shall be installed outside.

It is foreseen an emergency electrogene group (i.e. in case of network failure and turbine stop) with a power which can keep the services necessary for more critical equipment protection (furnace and boiler) working.

Since generally it is not known neither the place where the plant shall be installed nor the relative ambient conditions, some systems such as cooling towers, compress air, industrial and demi water shall be evaluated and redimensioned each time.

2. PLANT COMPONENTS

The plant consists of the following components:

- U.T. conveyor system (Car and Truck)
- C.U.T./T.U.T. furnace and afterburner
- Hot flue gas by-pass
- Recovery boiler or HRSG (Heat Recovery Steam Generator)
- System for the extraction of steel wire and ashes
- Flue gas suction and stack
- Bag filters
- Turbogenerator
- Thermal cycle components
- Power electric plant (transformers, electrical boards, cables)
- Electrogene group
- Control room (Control and supervision system)
- Demi water system
- Continuous monitoring system of stack emissions

2.1 C.U.T./T.U.T. conveyor system

The U.T. conveyor system, both for C.U.T. (car tyres) and for T.U.T. (truck tyres) to the furnace foresee a system for the stocking, singularization and movement of tyres from the discharge/collecting zone to the furnace opening.

The lines are foreseen with following characteristics:

- Steel trip for the automatic stocking
- “cascade system” for the singularization
- trip and roller for the movement to the burning

Both of lines ends with a balance that is the element for the control of the fuel load.

The system is able to assure automatically a autonomy of about 16 hours.

Normally this kind of plant needs a stocking basin for the U.T. (separated in car and trucks), with a grabbing crane for the movement of tyres to the automatic charge system: all this is excluded from the supply.

2.2 Furnace

The C.U.T./T.U.T. are burned in a cylindric rotating furnace which is made of carbon steel and internally coated with refractory material.

The rotation is carried out on rollers with bearings and is controlled by means of only one system equipped with an electric motor controlled by a frequency converter (variable speed 0÷2 rpms)

The furnace has a C.U.T./T.U.T. feeding opening with a shutter gate equipped with an actuator with local control.

The main combustion air shall enter the furnace by means of downstream fan draft.

Two fans with regulating valve, which directly send combustion air into the furnace, are foreseen: the former will be on the feeding front part which is also the fan for preheating burner, the latter on the furnace ending part which blows air between rotating and fixed part.

The furnace will be equipped with two retractable type natural gas fed burners: one is designed to dry refractory material and the other one to preheat.

2.3 Extraction of steel wires and ashes system

In the furnace lower ending part it is foreseen a hopper to extract wires and ashes which are conveyed throughout a steel conveyor belt to a wires/ashes vibrating separator. The ashes and wires are collected separately in boxes under the vibrating separator.

On the terminal parts of the vibrating separator is present a system for the cooling of ashes and wires with water atomiser.

2.4 Hot flue gas by-pass and afterburner

The afterburner consists of a steel tube internally coated with refractory material and it is equipped with a natural gas burner able to start when the temperature inside the burner decreases till under 960 °C, or to take part in heat production for steam generation with a maximum thermal load equal to 10% of plant capacity.

The flue gas by-pass is placed at afterburner outlet. It is a steel made stack internally coated with refractory material and equipped with a valve (clapet) at the top with servo control and counterweight which starts during emergency conditions under regulating system control. Its function is to “protect” the boiler and all the plants downstream of it against the thermal inertia in case of plant stop.

2.5 Heat recovery boiler

The Heat Recovery Steam Generator or HRSG produces steam by taking heat from flue gas.

The HRSG consists of radiant chamber, economiser, boiler and superheater. The superheater has a desuperheater for temperature control. The lower part of the boiler is equipped with hoppers and screws to collect, extract and discharge ashes into suitable containers.

It can produce 16 ton/h of superheated steam at 435°C and 43.5 bara through the recovery of heat from the fumes, that income at 980°C and go out at 170°C.

For the internal cleaning is foreseen a “hammer” technology for all the tube nest; for the radiant chamber walls are foreseen pneumatical vibrators.

2.6 Flue gas suction and treatment, stack

Suction and flue gas treatment system consists of all the equipment placed between the boiler Eco flange and the stack.

The flue gas treatment is divided into two bag filters groups with hoppers, rotocells and extraction screws: the first group for ashes filtering and the second one for dry desulphuration with two fans. One fan is upstream of the filters (master fan) and the other one is downstream of them (secondary fan). The master fan, equipped with regulating system must keep the furnace inlet draft constant and must overcome the furnace and boiler head losses.

The secondary fan pushes flue gas into the stack and keeps filters inlet draft throughout an automatic regulating valve on suction.

The desulphuration is obtained throughout mixing (by means of a static fluodinamic mixing) and reaction of flue gas with sodium bicarbonate (NEUTREC® process by SOLVAY) and subsequently by their filtering through bag filters.

On the flue gas treatment line some plant protection systems are foreseen:

- an emergency stack downstream of master fan in front of the filters. It will be controlled at opening in case of filtering system stop caused by bags breaking or by too high temperature of flue gas;
- a “false” air suction valve at inlet of each filters group to control temperature when it is too near the bags materials resistance limit.

A silencer is foreseen between the secondary fan and the stack which is made of steel.

The flue gas treatment system must guarantee that the emission should be in accordance with the 133 - 11.05.05 law (Dir. 2000/76/CE).

2.7 Turbogenerator

The condensing type turbogenerator which has a capacity equal to 3.300 kW at terminals is of package type, assembled and wired on a sole basis.

It is equipped with steam bleeding system to deaerator and it is designed with condenser under it, longitudinally placed in respect of the turbine axis.

The turbogenerator group includes all the services necessary for correct and safe operation (oil box with start-up pumps, working and emergency, oil refrigerators and alternator, barring device, empty system, steam seals system, speed pressure electronic control).

2.8 Thermal cycle components for condensing turbine

Thermal cycle components are all the components that contribute to convey steam to the turbine and therefore to the condensation, outgassing and boiler feeding water.

The components foreseen on plant will be the following ones:

- No.1 under-vacuum main condenser including an empty system (incondensables extraction ejectors) with condenser
- No.1 atmospheric auxiliary condenser including hydraulic control and nitrogen automatic preservation
- No.2 condensate extraction main pumps
- No.2 condensate extraction auxiliary pumps
- No.1 deareator with box for condense cumuling
- No.2 feeding pumps
- No.8 evaporative cooling towers equipped with concrete made tanks
- No.2 condensers water circulation pumps
- Turbine by-pass valve
- Valves and piping
- On site and movable instrumentation
- Chemical injection for the heat generator
- Cooling tower water treatment system
- No.2 integration to the deareator demi pumps
- No.1 emergency integration to the deareator demi pump

2.9 Electric system components

The electric system is distributed on three cabins:

- The delivery cabin where the electric boards for measurement are foreseen
- The power cabin where the following components are foreseen:
    - Start-up and operation working transformer 20KV→380V

- M.V. 6KV electric board (generator leg and Y)
- Equipment protections board and measurement converters
- Power centre board (PC)

- The electric boards room which shall be placed near control room and where are foreseen:

  - MCC boards (motor control centre)
  - Battery charger - batteries - inverter

2.10 Electrogene group

It is a diesel group with automatic start-up system which is activated when there is no other electric feeding on the plant.

It has to feed the more critical machinaries, that is the furnace and a boiler feeding pump, and to keep them working with an autonomy of two hours.

2.11 Cooling towers

For the cooling of the circulating water are foreseen forced draught cooling towers, that are able to keep the nominal temperature value all the year.

They are realised with zinced or inox steel, and are placed on a concrete basin that is the cumuling zone.

The water consumption for evaporation and dragging is about 20 m^3/h, in addition to about 10 m^3/h for drain, all is about 30 m^3/h.

2.12 Supervision and control system, control room

In the control room the following equipment shall be installed on a console:

- Supervision and control system with DCS type
- Turboalternator controls with:
  - command and control board
  - manual and automatic synchroniser
  - excitation instruments
  - measurement instrumentation (voltmeter, amperometer, power factor indicator)

2.13 Demi plant

The demi water plant (including degassing and adjustment systems) shall be able to integrate water and steam bleedings by supplying a quality of the produced water which is always constant.

This system is complete with acid and soda stocking tanks, demi water stocking tank and neutralisation system for the regeneration water.

2.14 Continuous monitoring system of stack flue gas emissions

On the furnace a continuous flue gas monitoring system is foreseen in accordance with the DMA 503 of 19/11/97 related to the actuation of European law 89/369/CEE and 89/429/CEE.

Therefore will be foreseen:

- Connections with the final chimney for the probes
- Probes + interfaces system for the analizator
- Output signal for the automatic control of the monitoring system (optional)

The principal board will be installed as next as possible to the chimney.

3. EXCLUSION

From the supply are excluded

- All the civil works (basin, building, basements, electrical cabine, etc.)
- Plant for production and net for compressed air
- Industrial water and fire net
- Bridge crane or other grabbing crane for the handling of tyres in collecting and stocking area
- Boxes for the collecting of steel and ashes
- Methane reducing station and line till the limits of the burner
- Service plane and stairs in metallic carpentry different from the expected on the components
- Drain net
- Internal and external rooms lighting

4. PLANT MAIN SYSTEMS

4.1 Fuel-air-flue gas system

It is an “open system”.

The C.U.T/T.U.T. fuel and combustion air are introduced at furnace inlet.

The hot flue gas produced in the furnace go through the boiler exchangers (superheater, piping bundle evaporator, economiser) and here they cool. Then they are intake by a fan through the ashes and desulpherating filters and finally go off the stack.

Two emergency stacks that are normally out of service are foreseen: the hot flue gas by-pass which permits to directly discharge in the atmosphere the flue gases before entering the boiler and the stack downstream the master fan which protects the filters against possible high temperatures.

4.2 Water-steam system

It is a “closed system”.

The deaerated water is pumped into the boiler through the economiser at a temperature of about 110 °C and pressure of 1.5 bar. In the boiler it is generated a steam of about 45 bara which is then superheated up to about 435 °C in the superheater.

The steam goes through the turbine generating electric power, it is discharged to the main condenser (under vacuum) and re-pumped to the deareator.

On the connecting line between the exit of the superheater and the collector to the user is foreseen the detaching for the by-pass valve, that permits the starting of the steam generator and the maintaining of the function of the steam generator if the steam user are not working.

The by-pass valve discharges in the auxiliary condenser.

From the deareator suck the feeding pumps that pump the water in the entry lines of the steam generator, with the level regulating valve.

4.3 Circulating water system

It is a “closed system”.

For the condensing of the steam in the condenser (principal and auxiliary) and for the closed cycle cooling system (oil turbogenerator and alternator refrigerant) is adopted a circulating system with cooling towers.

The system is constituted on:

- No. 8 cooling towers
- No. 8 axial fans
- N.2 vertical circulating pumps.

5. STANDARD REFERENCE DATA

5.1 Ambient and operative conditions

Max. temperature	+40	°C
Min temperature	-5	°C
Averaged relative humidity per year	60	%
Operation (46 weeks of 7 days)	7728	h
Normal winter stopping (Christmas)	2	weeks
Normal summer stopping (August)	4	weeks

5.2 Operation data

Tyres feeding system

C.U.T.

Nominal flow	2000	kg/h
Max. dia.	800	mm
Max. height	350	mm
Weight	6÷7	kg
Collection type	in bulk	
Averaged weight/volume	100	kg/m³

T.U.T.

Nominal flow	2000	kg/h
Weight	60÷70	kg
Max. dia.	1400	mm
Max. height	460	mm
Collection type	in bulk	max.

The plant is foreseen to operate at 100% C.U.T. load. The percentage of T.U.T. can be changed by the operator from 0 to 100% when T.U.T. are used instead of C.U.T.

Furnace

Opening negative pressure	-15	mm w.c.
Effective flue gas flow	200.000	Em³/h
Standard flue gas density	1.31	Kg/Nm³
Flue gas temperature	about 1000	°C
Combustion chamber max. temperature	1350	°C
Drying burner thermal capacity	300000	Kcal/h
Pre-heating burner thermal capacity	5500000	Kcal/h
Combustion air fan flow No.1 (on burner)	17.000	Nm³/h
Combustion air fan delivery head No.1	220	mm w.c.
Combustion air fan flow No.2	18000	Nm³/h
Combustion air fan delivery head No.2	350	mmw.c.
Furnace rotary velocity	0 ÷ 2	rpm
Without ashes wires extraction flow (20% weight)	about 400	kg/h
Wires weight/volume	1500	kg/m³
Ashes extraction flow (2% weight)	0.2	m³/h
Ashes weight/volume	300	kg/m³

Afterburner

Natural gas burner capacity	2500000	kcal/h
Flue gas inlet temperature	>950	°C
Flue gas outlet temperature	980 ±30	°C
Flue gas velocity	>10	m/s
Contact time	>2	seconds

HRSG

Flue gas inlet temperature	980 ±30	°C
Economiser flue gas outlet temperature	170	°C min.
Steam production	16	t/h
Superheated steam temperature	435±5	°C
Operation superheated steam pressure	45	Bar a
Design superheated steam pressure	54	Bar a
Feeding water temperature	110	°C
Flue gas side load losses (clean /dirty)	30/ 150	mbar

Turboalternator

Steam inlet temperature	430	°C
Steam inlet pressure	42	bar a
Gross electric power	3.300	kW
Voltage and frequency	6000 - 50	V - Hz

Main condenser

Flow of steam to be condensed	about 13 t/h
Condenser pressure (about 33°C)	0.07 Bar

Auxiliary condenser

Flow of steam to be condensed	about 21 t/h
Condenser pressure	Atm (+0.2 bar)

Flue gas extraction system and desulphuration

Negative pressure to be maintained at boiler outlet (Eco)	200 mm w.c.
Flue gas inlet	170 °C
Stack outlet flue gas temperature	about 160 °C
Master fan flow	75000 Em³/h
Master fan total pressure	2240 Pa
Secondary fan flow	78000 Em³/h
Secondary fan total pressure	3770 Pa

Guaranteed emission value and analysis method

	Description	DM 503 19.11.97 (Dir. 89/369/CEE e 89/429/CEE)	Directive 2000/76/CE (from 28.12.2005)	(1)
1	Carbon monoxide	50 mg/m^3 average day 100 mg/m^3 average hour	50 average day 100 average semi h	c
2	dusts	10 mg/m^3 average d 30 mg/m^3 average h	10 average day 30 average semi h	c
3	Organic substances	10 mg/m^3 average d 20 mg/m^3 average h	10 average day 20 average semi h	c
4	Hydrochloric acid	20 mg/m^3 average d 40 mg/m^3 average h	10 average day 60 average semi h	c
5	Fluoridric acid	1 mg/m^3 average d 4 mg/m^3 average h	1 average day 4 average semi h	c
6	SO2	100 mg/m^3 average d 200 mg/m^3 average h	50 average day 200 average semi h	c
7	NO2	200 mg/m^3 average d 400 mg/m^3 average h	200 average day 400 average semi h	c
8	Cd + Tl	0.05 mg/m^3 average h	0,05 average h	p
9a	Hg	0.05 mg/m^3 average h	0,05 average h	p
10	Sb+As+Pb+Cr+Co+Cu+Mn+ Ni+V+Sn	0.5 mg/m^3 average sum h	0.05 mg/m^3 average sum h	p
11	PCDD + PCDF	0.0000001 mg/m^3 average 8h	0.0000001 mg/m^3 average 8h	p
12	IPA (idroc. pol. arom.)	0.01 mg/m^3 average 8h	0.01 mg/m^3 average 8h	p
	Temperature	yes	yes	c
	Oxygen	yes	yes	c
	Volumetric flow	yes	yes	c
	Pressure	yes	yes	c
	Amount of water steam	yes	yes	c

(1) C = continuous registration
P = periodical registration

Demi plant

Average exercise integration	5 m³/h
Water quality (with mixed bed column)	0.1 μS/cm

Cooling tower

Heat to be used	7.000.000 Kcal/h
Cooling water flow	1000 m³/h
Inlet water T (nominal)	36 °C
Outlet water T (nominal)	28 °C
w.b. ambient T (nominal)	24 l °C