

CONSUMPTION OF OWN SERVICES IN A THERMOELECTRIC POWER STATION

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Abstract: At the Rovinari thermoelectric power station, the electricity generation technology is the one under condensation. The CTE's own electricity consumption depends on many factors (fuel type, initial steam pressure, type of turbogenerators and their power, how to drive power pumps, etc.) and is between 5 and 10% of the total production of electricity. After 1989, the electricity production of the power plant decreased considerably (over 40%), amid the drastic drop in industrial consumption. After 2000 the production of C.T.E Rovinari had an increasing tendency exceeding the threshold of 5000 GWh / year.

Key words: thermoelectric power, electricity, consumption, energy

1. INTRODUCTION

Electricity is obtained by transforming the thermal energy of the steam into mechanical energy, by relaxing in the turbines of the blocks, followed by the transformation of the mechanical energy into electricity by driving the electric generators. The electrical energy obtained at the generator terminals is subjected to the process of raising the working voltage in the transformers present in the Rovinari electric station. The electricity produced in the plant has the following characteristics:

Table 1.1. Characteristics of electricity produced in C.T.E Rovinari

Feature	Generator	Transformer
Apparent power [MVA]	388	400
Voltage [kV]	24	400
Frequency ([Hz]	50	50

The processes encountered here are of great complexity, summing up a substantial number of successive phases as a result of the simultaneous action of two aspects:

- outside the water / steam circuit, there are a number of related circuits of other working fluids (cooling water, flue gas, oil, etc.);

- C.T.E. Rovinari is the second largest thermoelectric power station in the country, with four boiler - turbine - operating generator blocks in the same enclosure, together with their auxiliary installations (reducing - cooling stations, recirculation and supply pumps, cooling towers, preheaters, fans). air and gas, chimneys, electro-filters, etc.). At the thermoelectric power stations the electricity is used for:

- preparation and introduction of the fuel in the boiler furnace;
- introducing air into the furnace and extracting the flue gas from the furnace;
- introduction of water in the boiler;
- maintaining the vacuum in the turbine condenser;
- water supply to the turbine;
- water supply of the boiler;
- order of thermal equipment;
- ventilation of rooms; - lighting; and so on

2. CONSUMPTION OF OWN SERVICES

In the case of operating at a partial load P , the consumption of own services can be calculated with the relation:

$$P_{sp} = (0,4 + 0,6P/P_j)P_{SPmax}$$

P_{SPmax} - maximum power of own tasks;

Pj - the power installed in the boiler.

For supplying their own service systems, low transformers, distribution systems and large relays are provided, as well as for industrial enterprises with the same power and impedance. In contrast to the industrial enterprises in the power plants, there are also sources independent of the energy system for supplying the control system, certain important devices and the safety lighting.

As independent sources are used: batteries and Diesel groups with fast start, not too high power (below 200 KW). For the safe operation of the mechanisms of its own services it is necessary that, the characteristics of the engine correspond to the operating conditions of the mechanism (self-starting after a decrease of the voltage in the network for the main mechanisms, cooling mode suitable for the environment, simple devices of starting, safe construction, operation lightweight, low cost and low operating costs). From this point of view the asynchronous motors with the rotor in short circuit are the most used.

They meet all the above conditions with the disadvantage that at startup the current can be 6 ... 10 times higher than the nominal one, and the starting torque is lower than the nominal one. Increasing the starting torque and decreasing the starting current (is smaller) is achieved by improving the construction of the rotor (with double cage or high bars). In addition to this type of engine the following types of engines are used:

- synchronous motors with the advantage of better efficiency and the possibility of carrying the excitation for stability in case of voltage drops during breakdowns;
- DC motors, especially the bypass motor with the advantage of a adjustments within wide speed limits, small energy losses.

They are used to operate the fuel transporters in the form of dust and to drive the lubrication and sealing pumps, spare in case of stopping the turbogenerators on during breakdown. Their disadvantage is that they require special start-up systems, permanent maintenance of the collector and they have higher prices, their supply is made from accumulator batteries. Two alternating

voltage stages are used to supply the own service receivers, namely:

- a) medium voltage gear, for supplying units with a power of 160 KW or for smaller groups of receivers;
- b) low voltage gear, for powering small receivers, including motors with unit power below 160 KW.

According to P.E. 113/77 the receivers are divided into four categories: In the category "O" (vital) include:

- "O" a) receivers whose supply interruption of more than 1 second leads to the trigger of the block, turbine or boiler.

For DC "O" life receivers, at least two normal power supplies from the battery pack are provided, at least two normal power supplies from the battery pack are provided, by means of current conversion devices (eg : inverters) and power supplies from the "O" category AC beacons.

- "O" b) all receivers that only allow short-term interruptions (10 and 20 seconds), otherwise accidents can occur or serious damage to the main units in the boiler (boiler, turbine).

For these receivers, three power supplies are provided, one of which will be a normal source, the second an independent backup source and the third a safe power supply (eg Diesel group with automatic start-up).

In category I (main) are included all the receivers where the interruption of the power supply for longer than 3 seconds directly affects the operating regime of the boiler - turbine - generator blocks, which may lead to their stopping. For these receivers, the supply is provided from a normal source and from an independent backup source with the automatic activation of the backup source in the event of a normal source fall.

Category II (secondary) includes all receivers whose temporary interruption of the order of 15 ... 20 seconds does not immediately affect the operating regime of the boiler (eg unloading, crushing, transport, etc.). For these receivers a normal and a backup source are provided.

Category III (auxiliary) includes all receivers that do not affect the operating regime of the plant (eg lifting facilities, workshops, laboratories, etc.).

The supply of these receivers is made from a single power supply. The transformer station reduces the voltage from 110 kV to 6.3 kV. In order to ensure the continuity of the supply and the safety in operation, two transformers of 110 / 6.3 kV are provided, thus achieving the redundancy of the supply. The supply of the transformers is carried out through different LEAs, thus avoiding the possibility of falling power simultaneously to the 110/6 kV transformers.

The choice of transformers that supply their own services from a power point of view is made in such a way as to ensure:

- feeding the pregnancy for the maximum possible duration;
- starting the engine that determines the most difficult conditions, considering the other engines in function;
- auto-supply of the main engines under the most difficult conditions.

The choice of the power of the transformers according to the conditions of a long-term load depends on the adopted power scheme. If there is a power reserve itself, the power of the transformers is determined by the power of the connected motors, taking into account the load coefficient, the efficiency and the power factors of the motors:

$$S_{tr} = \frac{K_{lm}}{\eta_n \cdot \cos \varphi_n} \cdot \sum P_1 + K_2 \cdot \sum P_2$$

S_{tr} - power of the transformer [KVA];

$\sum P_1$ - the sum of the power of the motors connected to 6 kV [KW];

K_{lm} - the average load coefficient of the engines, the value of this coefficient for the power stations with average parameters is 0.6-0.65, and for those with very high parameters it is 0.90;

η_n - the average efficiency of the engines, which can be taken by 0.9 for predetermined calculations;

$\cos \varphi_n$ - the average power factor;

K_2 - the load coefficient of the transformers of 6 / 0.4 kV; $K_2 = 0.7$ is chosen.

As with 6 kV consumers, 0.4 kV consumers are equally distributed on transformers. On a 330 MW group, at nominal load, it operates with the units connected to 6 kV and presented in table 1.2:

Table 1.2 Aggregates connected at 6 kV

Nr. engines	Name	Short	Power [kW]	In [A]	cos φ
2	Air fan	VA	3100	357	0,85
2	Combustion gas fan	VG	6500	700	0,85
4	The fan dies	MV	1150	134	0,85
2	Power pump	EPA	7200	778	0,85
1	Condensate electric pump tr. I	EPCB1	500	60	0,82
1	Condensate electric pump tr. II	EPCB2	300	37,8	0,82
2	Circulation pump	EPC	500	60	0,82
2	Electric tower pump	EPT	1250	154	0,85
2	Bagger electric pump	EPB	250	31,5	0,82
2	Bagger washer pump	EPSB	250	31,5	0,82

The sum of the 6 kV motor powers on an energy group is:

$$\Sigma P = 2P_{EPA} + 2P_{VA} + P_{VG} + 4P_{MV} + 2P_{PT} + 2P_{EPC} + 2P_{EPCB1} + 2P_{EPCB2} + 2P_{EPB} + 2P_{PSB} [\text{kW}]$$

$$\Sigma P = 36900 \text{ kW}$$

The power factor is calculated as the average of all power factors $\cos \varphi_n = 0,83$

Is chosen: $K_{lm} = 0,75$; $\eta_n = 0,9$

In normal operating mode, 4 transformers of 6 / 0.4 kV are connected, each with an apparent power of 1 MVA.

$$K_{lm} = 0,7$$

To supply its own services a power is required:

$$S_{tr} = \frac{0,8}{0,9 \cdot 0,835} \cdot 36900 + 0,7 \cdot 4000 \approx 39600 \text{ KVA}$$

A transformer with a power of 40 MVA is chosen for its own services. For the transformers in the 110/6 kV transformer station, the following specifications must be made: - feeds the own consumers of the groups only when they are not in operation, the maximum consumption under these

conditions in start-up regime being much reduced; - supplies consumers with general services. The most disadvantageous situation for the 110/6 kV transformer is when there is only one transformer in operation, which supplies both sections I and II for general services and both buses A and B for own services. In the group start-up regime, the consumption of own services is given according to table 1.3:

Table 1.3. Consumption of own services in start-up regime

Nr.	Name	Abbreviation	Power engines [KW]	In [A]	cos φ
1	Air fan	VA	3100	357	0,85
1	Combustion gas fan	VG	6500	700	0,85
3	The fan dies	MV	1150	134	0,85
1	Power pump	EPA	7200	778	0,85
1	Condensate electric pump tr. I	EPCB1	500	60	0,82
1	Condensate electric pump tr. II	EPCB2	300	37,8	0,82
1	Circulation pump	EPC	500	60	0,82
1	Electric tower pump	EPT	1250	154	0,85
1	Bagger electric pump	EPB	250	31,5	0,82
1	Bagger washer pump	EPSB	250	31,5	0,82

The required consumption is the following:

$$S_{ir} = \frac{0,8}{0,9 \cdot 0,835} \cdot 14000 + 0,5 \cdot 4000 \approx 16900 \text{ KVA}$$

It was also taken into account that the 6 / 0.4 kV transformers operate at low load due to the low consumption and on the low voltage side.

3. CONCLUSIONS

The elements that are absolutely necessary for a safe and economical operation of the boiler, namely: the mechanisms driven by electric motors and steam turbine, the receivers of electricity of all types, the electrical networks in the cable, the

distribution installations, the downstream transformers, the independent energy sources. of system, as well as control installations - represents the system of own services of the power plants.

The supply of general services (installations that serve all energy groups, such as coal house, hydro-technical facilities, ash circuit, etc.) and of the own services of each group (when the group is not in operation - does not produce electricity), realizes from the energy system, through a transformation station.

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