

# Electric Drives in the Modernized Power Plant Tusimice II

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**Abstract** — In the paper it is presented a brief description of the technology of electricity production in the condensing power plant Tusimice II and mentioned replacement of main electric drives implemented by ŠKODA PRAHA Invest. The focus is placed on the modernization of electric drives as motors for fan mills, air and smoke fans in the boiler room, circulation pumps on absorber of desulfurization, generator and supply pumps in the machine hall, drives for the coal handling conveyors and drives in water management. It focuses also on backup resources – diesel-generators. There is also included practical experience of the implementation.

**Keywords** — the power plant, drive, mill, fan, pump, conveyor.

## I. INTRODUCTION

### A. General description of power plant

Modernization of four units with installed capacity of 4 x 200 MW ensures the future operation under current European standards until around 2035, when the excavations of neighbouring mine Libous is expected. Power plant efficiency was increased by 6 % to 39 %, leading to 14 % fuel savings per produced MWh. Emissions (NO<sub>x</sub>, SO<sub>2</sub>, dust) levels were reduced by an average of 79 %. Own consumption unit was reduced from about 18 MW to 12,7MW.



Fig. 1. View on Tusimice II

Beginning of construction	2010
Completion of modernization in	2012
Fuel	brown coal
Power-production unit	ETU II
The installed capacity of	4 x 200 MW
Desulfurized since	1997

## II. BOILER

For preparation of the coal powder 6 pieces of fan mills with powder burners are symmetrically installed. The ignition of the powder is determined by 6 stabile natural gas burners. Used fan mills provide a reliable boiler operation at all power levels within the control range 50–105 % of nominal power. The rated boiler output is dependent on the quality of fuel, burning of which ensures the operation of four, respectively five mills; one resp. two mills are in the reserve backup.

The transport of the combustion air serves for each boiler, only one air axial fan blows the air flow through the air heater type Ljungström into the air channels of the boiler.

### A. Mills and separators

A new mill is equipped with an electric motor with high performance gearbox with increased rated speed at output and with variable speed by hydraulic clutch.

Each fan mill set consists among others of fleeting founded grinding wheel on the main shaft of the gearbox, a new frontal single-end gear boxes, control hydraulic clutch and electric motor.

1) *Hydraulic clutch*: The mill drive is newly equipped with a hydraulic clutch type 750 SVTL spec with speed control. The input shaft of the hydrodynamic coupling is connected to a fixed coupling with the shaft of the electric motor; the output shaft is connected to a fixed coupling with the shaft gear. For the torque transfer the clutch utilizes the kinetic energy of fluid flowing between the drive and the driven bladed wheel, the flow quantity of oil regulates the speed of the driven parts. Controlled speed range is 76 to 100 %, corresponding to an operating range of the output speed 1106 -1455 rev / min (i.e. the speed of the milling wheel 438 -576 rpm/ min).

2) *Electric motor*: It used a new induction squirrel-cage motor type 1LA4404-4AN60:

- P<sub>n</sub> = 800 kW; U<sub>n</sub> = 6000 V; f = 50 Hz, n<sub>n</sub> = 1488 ot/min, I<sub>n</sub> = 93 A, I<sub>k</sub> = 5.5; ETA = 96.6 %; cos phi = 0.86; M<sub>n</sub> = 5134 Nm; protection class IP55; cooling own IC411; insulation class F / B thermal utilization;

- Max. permissible motor starting time is 15 s; number of starts allowed per 1 hour – 3 starts from cold / 2 starts from warm state, start-up equipment is controlled through hydraulic couplings, roller bearings with grease lubrication.

### B. Air and smoke blowers fan

1) *Air fan*: The fan is designed as a single-stage two-speed axial fan with variable pressure relief performance by turning vane impeller during the fan operation. It is of

horizontal configuration, the suction chamber at 90°. The fan is designed for conveying air and to overcome the pressure losses related with technologies up to a maximum achievable static pressure.

It used a new three-phase induction motor with squirrel-cage deep-bar type 5V 227-06/10HV:

- Rated power  $P_n = 1800/500$  kW; nominal voltage  $U_n = 6000$  V AC; speed 995/595 1/min; roller bearings, shield, bearing with thermometers.

- The electric motor is equipped with a cooling air-to-air aluminium tube, it is provided with further heating of the stator winding (during disconnection of the device).

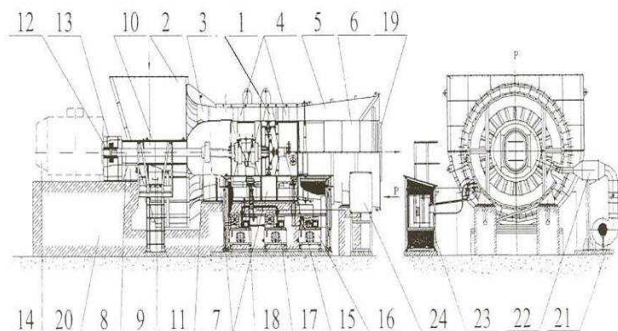


Fig.2 The arrangement of the air fan

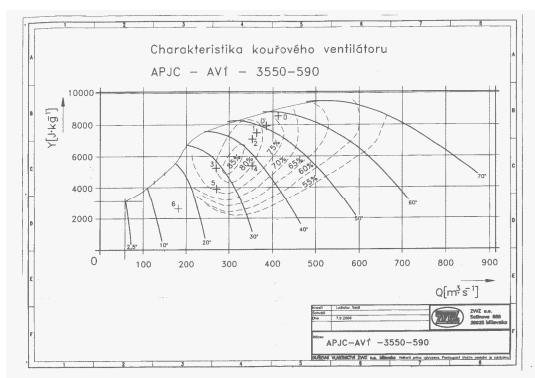


Fig.3 The characteristic of the smoke fan

Legend of air fan main parts of:

1. The impeller, 2. suction chamber, 3. input box, 4. switchbox, 5. diffuser, 6. core diffuser, 7. cases of impellers, 8. fan shaft, 10. cooling tube, 11. female coupling, 12. male coupling, 13. clutch cover, 14. drive (electric motor) 17. lubricating stations 18. main bearing 20. fan base, 22. heater of air 24. electrical cabinet

2) *The smoke fan:* The boiler will be after comprehensive renewal equipped with one smoke axial fan. The fan is designed as a two-stage pressure axial fan with power control by turning vane impeller during the fan running. It will be of horizontal configuration, the suction chamber at 90°. The fan is designed for conveying the flue gas with a maximum temperature of 200°C and to overcome the pressure drop related with technology up to the maximum achievable static pressure.

It is used a three-phase induction motor with squirrel-cage deep-bar type 5V 255-0HV:

- Rated power  $P_n = 4000$  kW; nominal voltage  $U_n = 6000$  V AC; speed 595 1/min; roller bearings, shield, bearing with thermometers

- The electric motor is equipped with a cooling air-to-air from aluminium tubes, is provided with further heating of the stator winding (during disconnection of the device).

Also these types of drives were solved as:

- Fan of recirculated flue gas  
0,4 kV 180kW
- HV source of electrical precipitator L1  
0,4kV 115kW
- MST an escalator of slag 2  
0.4 kV 15kW
- MST crusher of slag 2 0.4 kV 30kW
- MST Mixer of ash A1 0.4 kV 55kW

### III. DESUPHURIZATION

#### A. Flue system

Each installed desulphurization system consists of a heat exchanger of the raw gas, emergency cooling system, absorber (J1HTF01 BB001, BB001 K1HTF01), duct of pure gas including connection to the cooling tower system of oxidation, air circulators of absorber gypsum slurry pumps, supply of limestone slurry system process water and drain emergency suspension system as the main part of the operation of desulfurization.

The flue gas from the boilers 21, 22, boiler 23 and 24 passes through a separate boiler flue fan, which increases the pressure to overcome the pressure system of the boiler, the exhaust gas duct of the raw gas, absorber and exhaust gas duct of clean gas.

In our proposal FGD the lime is needed as alkaline reagent and process water to supply the water loss, and leads to the production of gypsum ( $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ) in the absorber unit.

#### B. Absorber

Each installed desulfurization system consists of the exhaust gas duct of raw gas, emergency cooling system, and absorber.

Reconstructed electrostatic precipitators provide concentrations of solid pollutants up to 100 mg/Nm<sup>3</sup> in the flue gas at the outlet. Dust extraction is loaded into a new desulfurization equipment in the outdoor configuration that was designed as a two-block, i.e. one desulfurization unit is used for two blocks. Related operational files limestone slurry preparation and dewatering gypsum are original. In the absorber, the flue gases are cleaned by back flow of the limestone-gypsum slurry.

The circulation pumps of the absorber (J1, K1HTF10, AP001 20,30,40,50) are installed in a building of desulfurization and used for circulation of the gypsum slurry in the absorber. Gypsum slurry is sucked from the absorber and is transported through a sieve to the injection plane using a pressure pipe.

- 10x motor of the circulated pump of the absorber  
6 kV 1250 kW
- compressor of the oxidation air

- 3x motor of oxidation air compressor  
6 kV 1000 kW

Also these types of drives were solved as:

- The limestone suspension system – pumps of limestone suspension.
- Drainage of gypsum – pumps of gypsum suspension.
- The process water system – pumps of process water.
- Drainage system – mixers of emergency drain tank of suspension.

IV. MACHINERY HALL

A. Turbine

200 MW steam turbine type KT – 200 – 17,5 is the three-body, uniform pressure condensing steam turbine with reheating for high-pressure part, with one single current high-pressure part, one with a medium current one part and one turbofan low pressure part. All turbine housings are double-walled. The output from the low-pressure part is led into the condenser.

Drive solution for positioner with a three-phase induction electric motor controlled by a frequency converter and motor for emergency, aid, lifting oil pump are used. Furthermore, the motors:

- condensate pumps
- motors for pumps embedded cooling circuit  
45 kW, 400 V / 50 Hz
- motors for water ring vacuum pump, motor power 160 kW, power supply 6 kV / 50 Hz
- motors for the supply pump, motor power 4250 kW, power supply: 6 kV / 50 Hz

1) Motors for the supply pumps

2p general repair of induction motor with squirrel cage with deep-bar type 2V 206 – 02H. Rated power: 4250 kW; nominal voltage: 6000 V; rated speed of 2980 rev / min, frequency: 50 Hz; shape of the motor: horizontal.

Direction of rotation: right, looking at the main shaft end.

Motor design: closed, IP/44, own ventilation, ring type with the circulation of cold air through a water cooler located on the engine.

Motor design: welded, coil stator winding, double-layer insulation in the class "F".

Terminations: right.

Circulated bearing lubrication from the system of hydro clutch, type designation R 17 K, the efficiency of 94 %.

B. Generator

- 4 pieces – 2-pole generator design to the end frame type according to the technical data:
- 235.3 MVA / 200 MW; 15.75 kV (± 7.5) %, PF = 0.85; 50Hz +0.5 / -1.5 %; In = 8.63 kA, 3000 rpm.
  - Design according to IEC 34.
- Cooling water 33°C inlet temperature (for warranty item).
- Degree of protection IP 44.
- Direction of rotation clockwise when viewed the turbine.
- Location of cases: bottom.
- Wake-up machine and auxiliary exciter with permanent magnets for brushless excitation system.
- Turbine-generator clutch.
- Complete excitation system consisting of two independent channel regulators. Each channel contains AVR (automatic / manual) stabilizer system and related facilities, two power units located beside the generator. The second channel is a complete replica of the first channel.

Properties of the excitation system: design according to IEC: 60146-1-1 (rectifiers, inverters), 61000-4-1÷5 (EMI), 60439-1 (ballast).

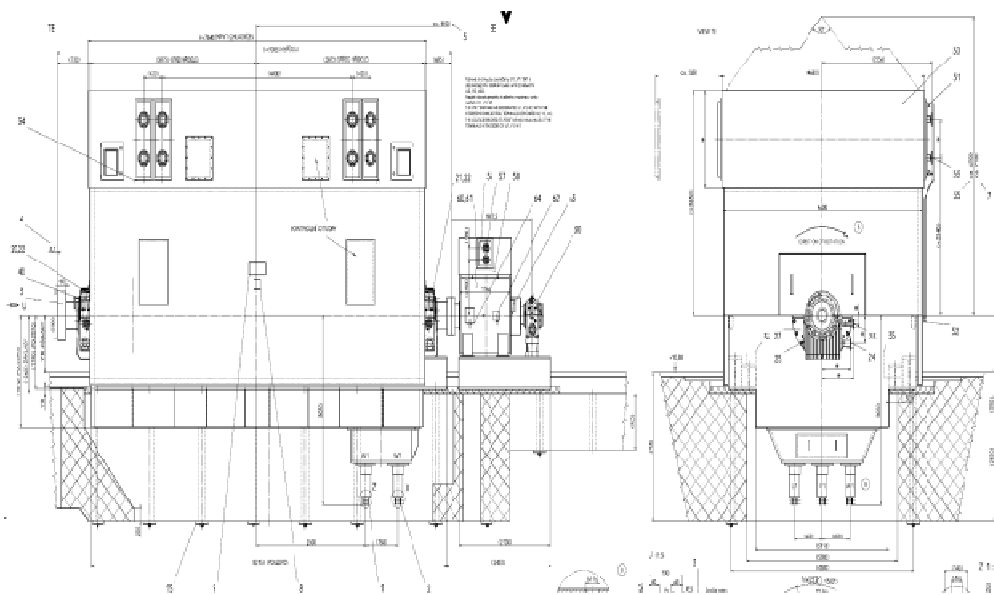


Fig.4 Diagram of the generator

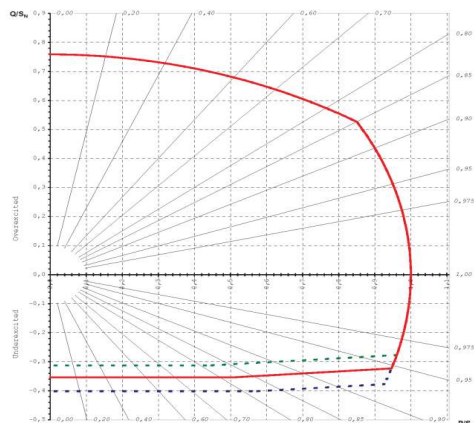


Fig.5 P-Q diagram of the generator

### V. COAL HANDLING

Belt drive, traction and stretching for coal handling links are outdated and will be replaced by a new outside the weighing conveyor drive of the traffic routes that due to minimum wear will be existing. On the weighing transport route it will be exchanged only drives of screw conveyors under the weighing tanks and also the drive for conveyor belt T41.

At the request of the operator, it was agreed that the new machines will be covered IP55 and will not be equipped with temperature monitoring bearings or winding temperature, the surface temperature during normal operation may not exceed 145 °C. 6000 V machine will be equipped with heating. It was also agreed that the new gearboxes will be designed with a service factor min. 1,8, gearboxes of inclined conveyors are equipped with reverse latch.

The concept of the drive belts has been designed to maintain the existing: drive + clutch + driving drum, for conveyors T5 and T21 drive in plug-in design + driving drum, for adjusting conveyors T2A, T2B, T4 drive + drive chain + transfer drum. Conveyors with higher performance for power requirements have been fitted with hydrodynamic starting clutch with one pre-chamber, which will be equipped with a safety switch contact and fusible plug. For conveying where calculation of free run time came 5 s and longer drives are equipped with a brake system (disk + electromagnetic brake), which prevents to smothering of chutes by transported material in a sudden loss of service.

Drives 9x belt drive of conveyor belt T3, 6000 V, 50 Hz, 160 kW, driving station.

### VI. WATER MANAGEMENT

Raw water for ETU II is transported from the raw water pumping station on the river Ohře reservoir through a pair of gravity mains pipe to the plant. This water, which is used mainly for filling tower cooling water circuit, is due to the low temperature also used for cooling of some appliances in the machine room.



Fig.6 Coal handling

- Cooling water pumping station is used for cooling water transportation for condensers TG and T-feeding pumps.
- Raw water pumping station, where three raw water pumps pump the water into reservoirs ETU II and ETU I, which are interconnected. From there the water using gravity mains is distributed over the power plant.
- Water treatment used to treat water to the required parameters for other technological units.
- Chemical water treatment.
- Block condensate management removes undesirable impurities (– ion-solute substances and released oxides of metals and alloying elements) and adjust the raw condensate to the quality suitable for its re-introduction into the pipeline of boiler feed water.
- Water used to ensure refilling water to the cooling tower circuit and collecting, treatment and reuse of liquid waste from the plant operation.

### VII. DIESELGENERATOR

2 pieces of diesel engines with an alternator form mono-block attached by flanges, firmly mounted on a rigid frame on which are also mounted cooler and the management and control panels. To prevent transfer of vibrations to the surroundings the whole aggregate (frame) is stored on silent blocks.

Aggregate type	P1650E – Standby
Rated power – stand by	1650 kVA (1320 kW)
Dimensions L x W x H (mm)	5294x2039x2307 mm
The heat dissipated by coolant	452 kW
The amount of cooling air	1410 m <sup>3</sup> .min <sup>-1</sup>
Maximum start time DG to the desired power	in 15 s
Back-up time	8 hours

### ACKNOWLEDGMENT

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### REFERENCES

- [1] The detail design project of Tusiince II power plant, electrical part