THE ENERGY PERFORMANCE OF THE MAIN CONSUMERS OF THE INTERNAL SERVICES AFFERENT OF AN ENERGY BLOCK BY 330 MW

POPESCU N.*, DINU R.C.*, MIRCEA I.*, BRATU C.*
*University of Craiova, Faculty of Electrical Engineering, Decebal no.105, Craiova
npopescu@elth.ucv.ro

Abstract: Energy perfomance of the electricity consumers is driving at identifIcation of the points from technological process in which, on the basis of some real energy consumptions, the installation operation allows the obtaining of some good or very good results as nearer by rated values for that it was designed. Energy performance determination achieves after elaboration of real energy balance based on actual measurements of the energy consumptions specific to the energy installation. In this paper, the authors determine the energy performance of the main industrial installation that consume electric energy and that make part of the internal services of an energy block by 330 MW. Starting up from catalog data, the data measured and calculated, concerning to electric energy absorbed (consumed) from main receivers, the losses in these installation was calculated for three characteristic tasks: 96%, 82% and 65%. The following categories of industrial energy installation was analysed: the conveyer belts that ensure the supply with coal to the coal mills, the fan of air necessary to combustion into boilers and the fan of burnt gas.

Keywords: energy performance, energy installation, conveyor belt, coal mill, fan.

1. INTRODUCTION

Simple energy balance (termoenergetice and electric power), real and optimized, which elaborate by the units beneficiary of the objectives of investment with technological character refer to equipment, that have an annual consumption of primary energy by minimum 300 GJ, as well to installation, division plants and enterprises.

The main types of energy balances are as follows [3], [4]: *the balance of project*, that uses the values agreed upon by the project as energy calculation elements; *the balance of homologation,* that has right purpose the confirmation of the effective realization of the energy and technological parameters specified in the project; *the balance of reception,* drawed out under the concrete conditions of realization of the technological scheme, of the raw materials, of the fuels and real "utilities"; *the real balance,* that draws out with the purpose to confirm the maintainment in time of the technological and energy parameters of the equipment/installation at the reference values and to bring out in evidence the deviations causes and the possible measures that are imposed to be taken; *the optimized balance*, that elaborates of every time when the real balance elaborates too.

The real energy balance shall be elaborated periodically, as follows: at the level of equipment and installations, to every five years and whenever these were suffered constructive or functional modifications; at the level of the workshoops, plants and enterprises, at every 5 years. If in the respective years, the equipment or the installation have not coinstituted the object of some constructive or functional modifications, then the real energy balance of these is confirmed or, according to case, is updated by the introduction of the applied measurements effects.

Irrespective of the balance shape, the maxim limit of error, shall not exceed: ± 2.5% in the case of the balance in that the main sizes are determined by measurements; ± 5% in the case of the balances in that the some sizes cannot be measured directly, but they can be deduced with precision by measuring of the other sizes

2. PRESENTATION OF THE MAIN CONSUMERS OF INTERNAL SERVICES

The energy block by 330 MW is equipped with the following basic equipment: a steam boiler of 1035 t/h, 192 bar, 540/540°C tower type, with forced circulation; a steam turbine by 330 MW, 182, 535/535°C; an electrical generator by 330MW/388MVA, 24 kV, 50 Hz; and a transformer by 400 MVA, 24/400kV. Each of these equipment and, especially the boiler, are served by specific installation that ensurre their good operation and that, in the whole, compose the internal services of the energy block.

In this paper, the main electrical equipment thsat compose the internal services of the boiler are analysed from point of view of the energy efficiency and they are: conveyer – belts that ensure the coal supply of the coal mills, fans of air necessary to the fuel burning in the boilers and fans of burned gas.

For to can set off the energy efficiency of the internal services consumers mentioned above, the energy indicators for the analysed blocjk by 330MW are presented below (figure 1 and 2).

The geometrical characteristics and the parameters measured for all three duties of the conveyer – belts (that ensure the continuous supply operating systems which provide tape conveyors with lignite to the mills that served the power block boiler) are presented in table 1.

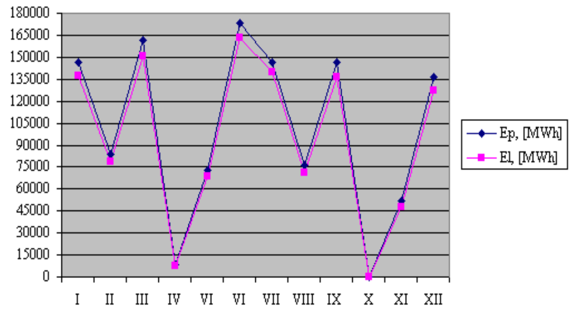

Fig.1 - The monthly variation of the energy produced and delivered by the power group of 330 MW

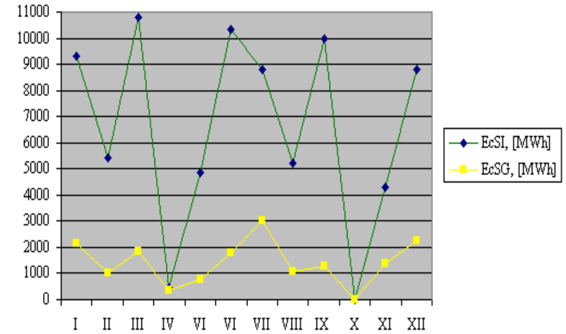

Fig. 2 - The monthly variation of the energy consumed by the internal services and of the energy consumed by the general services of the power group by 330 MW

Table 1. Sizes given and measured for the establishment of the real energy balance to the conveyer - belts of the power group by 330MW

Item	Size measured		Symbol	U.M.	Duty value		
					a	b	c
1.	Maximum hour fuel consumption of the Power Group	B1	$D_{căr,h}$	[t/h]	90,89	73,07	71,34
		B2			93,62	63,77	64,09
		B3			-	-	-
		B4			88,29	65,10	65,30
		B5			88,29	62,78	64,49
		B6			83,10	70,08	-
		Total			434,19	334,80	265,22
2.	The density of coal transported		ρ	[kg/m^3]	850	850	850
3.	Horizontal projection of the belt	B1	L_0	[m]	21,75	21,75	21,75
		B2			23,089	23,089	23,089
		B3			12,914	12,914	12,914
		B4			22,089	22,089	22,089
		B5			23,089	23,089	23,089
		B6			12,314	12,314	12,314
4.	Width necessary to the conveyer - belt		B	[mm]	1150	1150	1150
5.	Type of cross-section of the belt		-	-	trough with two rolls		
6.	Rollers diameter		d_{role}	[mm]	120	120	120
7.	Training trough guide length		L_g	[m]	3	3	3
8.	Reductor efficiency		η_R	-	0,80	0,80	0,80
9.	Speed of displacement of the belt (in usual values)		w	[m/s]	2,5...3,0		
10.	Coefficient depending on the belt inclination angle		K_a	-	1		
11.	Coefficient depending on the cross-section shape of the belt bearer branch		k	-	3,48		
12.	Coefficient of friction between belt and rolls from bearings of sliding		f	-	0,050		
13.	Coefficient depending on the belth width		K_4	-	0,10		

To ensure the flow of air to burn fuel, boiler 1035 t/h is provided with two air fans (VA1 and VA2) each sized for 60% of air flow required boiler operation at rated load. In parallel operation at rated load of the boiler, each circulating fan provides 50% of the total quantity of air.

The two fans are located outdoors on concrete foundation, behind the boiler. Are axial, horizontal axis located parallel to the rear of the boiler front, drawing air directly from the atmosphere and are equipped with silencer and displayed on the suction pipe and circulating anti-pumping protection.

Adjusting the fan parameters (pressure, flow) depending on the load boiler is made using the apparatus by turning co-director of the 23 pallets moving from fully closed position (-87°) to position supradeschis (+40°) through a mechanism actuator (drive unit director).

Fan air performance can be modified depending on the angle adjustable mounting of the rotor blade so as to better adapt to the needs of the boiler.

When operating in parallel fans may appear different loading of the two fans (defective latches gas separation circuit, opening different folders devices, circuits unbalanced gas) which results due to specific shape of the characteristic curve flow -pressure operation of the fans under one destructive unstable (pumping). To prevent long periods of operation under unstable periodic destructive fan monitoring is required to alert the control room operator (CCT) and make necessary orders for load balancing (ie equal openings guiding devices).

The measured parameters are presented in Table 2, the main characteristics of air fan (motor drive) are: axial fan with horizontal operating position and direct drive electric motor, power 3100kW, voltage 6000VA, 50Hz, rated current 357A, 742 speed rev/min, yield 0,95 and cos φ=0,88.

Also, the boiler of 1035 t/h is provided with two fans fume (VGA1 and VGA2) each sized for 60% of flue gas flow results for boiler operation at rated load. In parallel operation at rated load of the boiler, each exhaust fan provides 50% of the total flue gas.

Table 2. Sizes measured data and drawing real power balance air fan in the group of 330 MW power

Item	Size measured	Symbol	Value function under					
			VA1			VA2		
			a	b	c	a	b	c
1.	Current absorbed from mains, [A]	I_{abs}	185,4	153,4	135,2	203,4	155,2	151,4
2.	The pressure difference, [mmH_2O]	H (Δp_a)	345	285	250	350	295	260
3.	The coefficient of excess air	λ	1,365	1,483	1,777	1,365	1,483	1,777
4.	Moisture contained in air, [g/kg]	x	10	10	10	10	10	10
5.	Efficiency air fan	η_{VA}	0,43	0,42	0,39	0,44	0,425	0,400
6.	Performance electric motor drive	η_{em}	0,92	0,90	0,88	0,93	0,91	0,90
7.	Power absorbed by the motor drive, [kW]	$P_{m,el}$	1695,53	1402,88	1236,43	1860,14	1419,34	1384,59
8.	Yield air fan drive motor	η_{tra}	0,99	0,99	0,99	0,99	0,99	0,99
9.	Fuel consumption, [kg/s]	B_c	121,38	93,77	74,52	121,38	93,77	74,52
10.	Lower calorific value of fuel used, [kJ/kg]	H_i	8206	8944	9210	8206	8944	9210

The two fans for conveying flue gases for the group are located behind electro at the rate 11,38 m, metal building located on a side of the chimney, the axis parallel to the front of the boiler. Are axial, vertical, with the suction pipe and the engine and drive the bottom discharge pipe at the top. Setting the device manager (the vortex) is a considerable improvement of the regulation by rolling, to which has the advantage of much better performance at partial load.

The measured parameters are presented in Table 3, while the main characteristics of gas fans are axial fan with vertical operating position and direct drive electric motor, power 3200kW, 6000VA voltage, frequency 50Hz, rated current 361A, speed 7600 rev/min, yield 0,95 and cos φ = 0,88.

Table 3. Sizes and measured data for real electric gas fan drawing sheet of the group energy of 330 MW

Item	Size measured	Symbol	Value function under					
			VG1			VG2		
			a	b	c	a	b	c
1.	Current absorbed from mains, [A]	I_{abs}	245,2	206,8	202,3	237,20	203,20	201,60
2.	The pressure difference, [mmH_2O]	H (Δp_{ga})	225	185	185	220	180	180
3.	The coefficient of excess air	λ	1,522	1,671	2,041	1,522	1,671	2,041
4.	Moisture contained in air, [g/kg]	x	10	10	10	10	10	10
5.	Efficiency flue gas fan	η_{VG}	0,36	0,305	0,30	0,365	0,31	0,31
6.	Performance electric motor drive	η_{em}	0,91	0,90	0,89	0,92	0,90	0,89
7.	Power absorbed by the motor drive, [kW]	$P_{m,el}$	2242,41	1891,23	1850,08	2169,25	1858,31	1843,68
8.	Transmission efficiency flue gas fan motor	η_{tra}	0,99	0,99	0,99	0,99	0,99	0,99
9.	Fuel consumption, [kg/s]	B_c	121,38	93,77	74,52	121,38	93,77	74,52
10.	Flue gas temperature to chimney, [°C]	$t_{coș}$	168,50	176,80	153,40	176,50	164,20	159,60
11.	The ambient temperature, [°C]	t_{ma}	11,70	11,70	8,00	11,70	11,70	8,00

3. METHODOLOGY FOR ACHIEVING THE REAL ENERGY BALANCE

Considering the number of drive motors for each type of consumer services in the internal part and their specific parameters, (Table 4) could be determined hourly electricity losses in the drive motors for the three operating modes [6].

Table 4. Nominal parameters of the motors drive consumers subject to the analysis of internal services

No. crt.	Consumer	Power installed in engine P_i, [kW]	Number of engines	Total power installed in engines P_{it}, [kW]	Tated number of rotations n_s, [rot/min]	Power factor cos φ_n	Nominal yield η_n, [%]
1.	Exhaust fan 1	3200	1	3200	670	0,88	94,00
2.	Exhaust fan 2	3200	1	3200	670	0,88	94,00
3.	Air fan 1	3100	1	3100	740	0,88	91,00
4.	Air fan 2	3100	1	3100	750	0,88	90,00
5.	Conveyer belt type Redler -plate 1	11	1	11	1500	0,85	89,00
6.	Palette knife of the conveyer belt 1	11	1	11	1500	0,85	89,00
7.	Conveyer belt type Redler - craper wall 1	0,75	1	0,75	1000	0,70	71,00
8.	Conveyer belt type Redler - plate 2	11	1	11	1500	0,85	89,00
9.	Palette knife of the conveyer belt 2	11	1	11	1500	0,85	89,00
10.	Conveyer belt type Redler - craper wall 2	0,75	1	0,75	1000	0,70	71,00
11.	Conveyer belt type Redler - plate 3	11	1	11	1500	0,85	89,00
12.	Palette knife of the conveyer belt 3	11	1	11	1500	0,85	89,00
13.	Conveyer belt type Redler - craper wall 3	0,75	1	0,75	1000	0,70	71,00
14.	Conveyer belt type Redler - plate 4	11	1	11	1500	0,85	89,00
15.	Palette knife of the conveyer belt 4	11	1	11	1500	0,85	89,00
16.	Conveyer belt type Redler - craper wall 4	0,75	1	0,75	1000	0,70	71,00
17.	Conveyer belt type Redler - plate 5	11	1	11	1500	0,85	89,00
18.	Palette knife of the conveyer belt 5	11	1	11	1500	0,85	89,00
19.	Conveyer belt type Redler - craper wall 5	0,75	1	0,75	1000	0,70	71,00
20.	Conveyer belt type Redler - plate 6	11	1	11	1500	0,85	89,00
21.	Palette knife of the conveyer belt 6	11	1	11	1500	0,85	89,00
22.	Conveyer belt type Redler - craper wall 6	0,75	1	0,75	1000	0,70	71,00
	Total	12670,50	22	12670,50	-	-	-

Parameters determining the efficiency of conveyor belts supposes an algorithm which can be calculated using the electrical power required to drive motor Redler bands [7].

1. Determine comsumul load of the conveyor belt with a relationship 1:

$$P_1 = 0{,}01 \cdot K_0 \cdot L_0 \cdot w \cdot r_{sp} \ \ [\text{kW}] \qquad (1)$$

where:
K_0 - coefficient depending on the length of the transport band determined from the length of the conveyor belt diagrams L_0;
L_0 - horizontal projection of bandwidth, [m];
w - speed of the tape, [m/s];
r_{sp} - specific resistance, [daN/m], determined from the charts, depending on roll diameter expressed in mm.

2. Calculate power consumption horizontal laxity of the material transported, the relation 2:

$$P_2 = 0{,}003 \cdot K_0 \cdot L_0 \cdot f \cdot D_{car} \ \ [\text{kW}] \qquad (2)$$

where:
f - friction coefficient values between 0.025 and 0.05 for roller bearings for roller bearings;
D_{car} - carrying capacity of the tape, [kg/s], determined by the relation 3:

$$D_{car} = \frac{1}{3600} \cdot K_\alpha \cdot k \cdot w \cdot \rho \cdot (0{,}009 \cdot B - 0{,}5)^2 \ [\text{kg/s}] \quad (3)$$

where:
K_α - coefficient depending on the angle α of the tape;
k - coefficient determined by the branch-bearing cross-sectional shape of the strip. For three roller conveyor chute k = 4;
ρ - density of coal transported, [kg/m^3];
B - width of the conveyor belt, [mm] (table 1).

3. Determine the required electrical power to be consumed to move material vertically, with the relation 4:

$$P_3 = 0{,}003 \cdot D_{car} \cdot H \ \ [\text{kW}] \qquad (4)$$

where:
H - vertical projection of bandwidth, [m].

4. Determine the power consumption to overcome friction between the belt conveyor and discharge chute guides, the relationship 5:

$$P_4 = K_4 \cdot w \cdot L_g \ \ [\text{kW}] \qquad (5)$$

where:
K_4 - coefficient depending on the width, the conveyors values 0.05 for B≤1000 mm and 0.1 mm for B>1000 mm;
L_g - gutter length guide, [m]. If the system of bands analyzed, Lg = 0.

5. Calculate the electrical power needed to overcome resistance wiper strip, the relationship 6:

$$P_5 = 0{,}002 \cdot w \cdot B \ \ [\text{kW}] \qquad (6)$$

6. Calculate the electrical power needed to overcome resistance band arresters type two drums, the relationship:

$$P_6 = K_5 \cdot w + 0{,}001 \cdot K_6 \cdot D_{car} \ \ [\text{kW}] \qquad (7)$$

where:
K_5 and K_6 - coefficients depend on the bandwidth. For widths of 1800 mm, K5 = 2.1, and K6 = 5.6.

7. Determine the total electric power for driving the band, the relation 8:

$$P_a = \sum_{i=1}^{6} P_i \ \ [\text{kW}] \qquad (8)$$

8. Calculate the power consumption of the engine driving the relationship 9:

$$P_m = (1{,}0 - 1{,}2) \cdot \frac{P_a}{\eta_R} \ \ [\text{kW}] \qquad (9)$$

where:
η_r=0,98 - output gear (table 1)

For fans of air and gas, the balance is made using the following algorithm [2], [3], [4]:

1. Calculate the active and reactive power absorbed by engine relations 10 and 11:

$$P_{abs} = \sqrt{\frac{3 \cdot U_n^2 \cdot I_{abs}^2}{1 + tg^2(\arccos \varphi_{mas})}} \qquad (10)$$

$$Q_{abs} = P_{abs} \cdot tg(\arccos \varphi_{mas}) \qquad (11)$$

where:
U_n – rated voltage, [V];
I_{abs}, $\cos\varphi_{mas}$ – input current of the motor network, [A] (measured current) and power factor measurement.

2. Calculate the corresponding active power loss absorbed active power and active power losses varying relations 12 and13:

$$\begin{cases} \Delta P_{abs} = \dfrac{P_{motor}}{\eta_{mas}} - P_{motor} \\ P_{abs} = \dfrac{P_{motor}}{\eta_{mas}} \end{cases} \Rightarrow$$

$$\Delta P_{abs} = P_{abs} - P_{abs} \cdot \eta_{mas} \qquad (12)$$

$$\Delta P_{\text{var}\,abs} = \Delta P_{abs} - \Delta P_{ct} \qquad (13)$$

where:

ΔP_{ct} – constant active power losses in the engines, [kW] determined the relationship:

$$\Delta P_{ct} = \Delta P_{nom} - \Delta P_{\mathrm{var}\,nom} \text{ [kW]} \tag{14}$$

where:

ΔP_{nom} - rated active power losses in the engines, [kW] determined the relationship 15;

ΔP_{varnom} – nominal variable active power losses in the engines, [kW] determined the relationship 16:

$$\Delta P_{nom} = \frac{P_{it}}{\eta_n} - P_{it} \text{ [kW]} \tag{15}$$

$$\Delta P_{\mathrm{var}\,nom} = \frac{\Delta P_{nom} - \Delta P_{abs}}{1 - \left(\frac{I_{abs}}{I_n}\right)^2} \text{ [kW]} \tag{16}$$

With real measurement results made available three-phase analyzer Fluke 435 power quality in the cells 6kV, 0.4 kV electric motors which are powered drive consumers analyzed, it was possible to draw real balance for a month running (Table 5). To exemplify the results are presented for the balance mode b (82%) considered that the long-lasting regime.

4. INTERPRETATION OF RESULTS AND CONCLUSIONS

Throughout the review period in which fans and conveyor belts were analyzed, internal services group energy consumption represented approximately 6.7% of total generation of 330 MW group

Table 5. Real power balance results drawn from gas vents (VG1 and VG2), air vents (VA1 and VA2) and bands Redler (1 ... 6) for one month of operation at partial throttle load (82%)

Item	Consumer	Rated active power losses	Active power absorbed	Reactive power absorbed	Loss of power absorbed	Variable nominal power losses	Constant power losses	Variable loss of power absorbed	Electricity absorbed	Electricity losses
Symbol		ΔP_{nom}	P_{abs}	Q_{abs}	ΔP_{abs}	ΔP_{varnom}	ΔP_{ct}	ΔP_{varabs}	W_{abs}	ΔW
U.M.		kW	kW	kVAr	kW	kW	kW	kW	MW·h	MW·h
1.	VG1	204,26	1891,23	1020,78	170,21	49,24	155,01	15,20	1229,30	110,64
2.	VG2	204,26	1858,31	1003,01	167,25	52,72	151,54	15,71	1207,90	108,71
3.	VA1	306,59	1402,88	757,19	140,29	200,27	106,32	33,96	911,87	91,19
4.	VA2	344,44	1419,34	766,08	184,51	187,59	156,86	27,66	1199,34	119,93
Total fans		**1059,55**	**6571,76**	**3547,06**	**662,26**	**489,82**	**569,73**	**92,53**	**4548,41**	**430,47**
5.	BRpl 1	1,36	8,72	6,09	1,05	0,67	0,69	0,36	5,67	0,68
	BRp 1	1,36	7,67	5,15	0,92	0,74	0,62	0,30	4,99	0,60
	BRr 1	0,31	0,62	0,67	0,19	0,19	0,12	0,07	0,40	0,12
	Total BRedl 1	**3,03**	**17,01**	**11,91**	**2,16**	**1,60**	**1,43**	**0,73**	**11,06**	**1,40**
6.	BRpl 2	1,36	8,12	5,67	0,97	0,72	0,64	0,33	5,28	0,63
	BRp 2	1,36	7,88	5,29	0,95	0,72	0,64	0,31	5,12	0,61
	BRr 2	0,31	0,71	0,75	0,22	0,16	0,15	0,08	0,46	0,14
	Total BRedl 2	**3,03**	**16,71**	**11,71**	**2,14**	**1,60**	**1,43**	**0,72**	**10,86**	**1,38**
7.	BRpl 3	1,36	5,74	4,01	0,69	0,87	0,49	0,20	3,73	0,45
	BRp 3	1,36	5,49	3,69	0,66	0,88	0,48	0,18	3,57	0,43
	BRr 3	0,31	0,52	0,56	0,16	0,20	0,10	0,05	0,34	0,10
	Total BRedl 3	**3,03**	**11,75**	**8,26**	**1,51**	**1,95**	**1,07**	**0,43**	**7,64**	**0,98**
8.	BRpl 4	1,36	8,18	5,71	0,98	0,71	0,65	0,34	5,32	0,64
	BRp 4	1,36	7,42	4,98	0,89	0,75	0,61	0,29	4,82	0,58
	BRr 4	0,31	0,70	0,74	0,22	0,15	0,16	0,07	0,46	0,15
	Total BRedl 4	**3,03**	**16,30**	**11,43**	**2,09**	**1,61**	**1,42**	**0,70**	**10,60**	**1,37**
9.	BRpl 5	1,36	7,23	5,05	0,87	0,78	0,58	0,29	4,70	0,56
	BRp 5	1,36	7,98	5,36	0,96	0,71	0,65	0,31	5,18	0,62
	BRr 5	0,31	0,70	0,75	0,22	0,17	0,14	0,08	0,45	0,14
	Total BRedl 5	**3,03**	**15,91**	**11,16**	**2,05**	**1,66**	**1,37**	**0,68**	**10,33**	**1,32**
10.	BRpl 6	1,36	8,32	5,81	1,00	0,70	0,66	0,34	5,41	0,65
	BRp 6	1,36	7,57	5,09	0,91	0,74	0,62	0,29	4,92	0,59
	BRr 6	0,31	0,71	0,74	0,21	0,17	0,13	0,08	0,46	0,14
	Total BRedl 6	**3,03**	**16,60**	**11,64**	**2,12**	**1,61**	**1,41**	**0,71**	**10,79**	**1,38**
Total conveyor belt type Redler		**18,18**	**6666,04**	**66,11**	**12,07**	**10,03**	**8,13**	**3,97**	**61,28**	**7,83**
Total Consumers		**573,00**	**3721,95**	**3613,17**	**674,33**	**499,85**	**577,86**	**96,50**	**4609,69**	**438,30**

BRp1...6 - Conveyer belt type Redler –plate; BRp 1...6 - Palette knife of the conveyer belt; BRr 1...6 - Conveyer belt type Redler - craper wall

Of the total domestic consumption of electricity services for the month of study, analysis equipment consumption is about 42.80% and the total energy produced by energy group, representing about 2.86%.

The category also includes internal service users mills whose coal consumption is about 1.50% and various pumping plants whose consumption is approximately (1.2 ... 1.3)% of total energy produced by energy group.

Related to the consumption of the proper functioning of equipment and installations for domestic services for the proper conduct of the real energy balance should be added and energy loss associated electrical cables through which these facilities/equipment are supplied from the network and not least energy losses in transformers internal services.

Overall, bands Redler works in all three regimes of charge energy group, with yields around 87.20%.

Electricity consumption of the bands of course vary depending Redler hourly fuel consumption of coal transported group and density, leading to variations in power drive motor and hence the variation of absorbed power and electricity network. Given the technological and constructive characteristics, air vents are characterized by low values of power technology, under the project, ranging from the three operating modes, between 34% and 39.87% for fan air VA1, respectively 35.80% and 40.61% for VA2 air fan.

Also, gas vents are characterized by low values of functional technological powers, under the project, between 26.53% and 32.57% for VG1 gas fan and between 27.24% and 33.07% for VG2 gas fan.

In general, high values are due to losses in fan motors drive them but, characteristics of the working fluid (air or flue gas).

Given the energy balance results presented above, it is necessary to take technical measures - economic and organizational help to the improvement of balance and power consumption savings [1], [5], [8].

The main measures aimed at: ensuring optimal functioning (at full load) technological equipment and avoid possible operation group at low loads, revisions and repairs after the schedule and quality, requiring the tracking and highlighting proper lifetime of the equipment and equipment, reducing load losses especially at low voltage consumers, periodic cleaning of the fans and capacitors, as deposits affect engine load, learning to use the variable speed drives to consumers of 6 kV and 0.4 kV and especially the bands and fans Redler

Following the implementation of these measures, in one year, for example, regime b (presented in detail throughout the paper), with an average of 5,000 unit operating hours, the amount of energy saved from internal services is 271.90 MWh/year, so about 9516.50 Euro/year.

Acknowledgment

“This work was partially supported by the strategic grant POSDRU/CPP107/DMI1.5/S/78421, Project ID 78421 (2010), co-financed by the European Social Fund – Investing in People, within the Sectoral Operational Programme Human Resources Development 2007-2013.”

BIBLIOGRAPHY

[1]. Mereuță, C., Măsuri practice generale pentru economisirea energiei electrice în industrie, Editura Tehnică, Bucureşti, 1985.

[2]. Carabogdan, I. Gh., ş.a., Bilanțuri energetice. Probleme şi aplicații pentru ingineri, Editura Tehnică, Bucureşti, 1986.

[3]. ***, Normativul pentru întocmirea şi analiza bilanțurilor energetice. PE 902/1996, Bucureşti, CIDE.

[4]. ***, Normativ privind metodica de întocmire şi analiza bilanțurilor energetice în întreprinderile industriale, ICEMENERG, Bucureşti, 2000.

[5]. Răducanu, C., ş.a., Audit energetic, Editura Agir, Bucureşti, 2000.

[6]. Ionescu, C. D., ş.a., Monitorizarea şi evaluarea continuă a eficienței energetice, Editura Agir, Bucureşti, 2001.

[7]. Mircea, I., Ruieneanu, L., Dinu, R.C., Producerea energiei electrice şi termice, Îndrumar de laborator, vol.I, Reprografia Universității din Craiova, 2001.

[8]. Vuc, Gh., *Managementul energiei electrice,* Editura Agir, Bucureşti, 2001.