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STRUCTURE OF POWER CONSUMPTION OF DRESSING PLANT AT THE "ELATSITE – MED" Co

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ABSTRACT

Data about power consumption of the "Elatsite - Med" is analyzed for a period of one year, one month and one typical working day. Structure of power cost is determined for different workshops and for different rate zones. Characteristics for qualitative estimation of efficiency of the activities for power saving are suggested. The options for more rational distribution of power among the different rate zones are discussed. Organizational and technical decisions for reducing the specific power consumption are also suggested.

""Elatsite – Med" Co. mines and processes more than 12 million tones of low-grade copper-containing ore. Mining and coarse crushing is carried out at the open pit of the "Elatsite". Crushed ore (class 0-200 mm), loaded on a belt conveyer is fed from the mine to open-air hopper #2 above the department for medium-size and fine crushing (MFC). Medium-size crushing is realized by cone crushers of the type KSD and "Kubria" 210-35, and fine crushing in cone crushers of "Kubria" 210 –15 type. Crushed ore of the class of "-15mm" (86%) from the interim hoppers is fed to the milling department. Grinding of ore is carried out in ball crushers of central unloading of the type of МШЦ – 4500x6000, operating under a single-stage system of grinding with a control classification in a hydrocyclon ГЦ-1000 and "KREBS". The milled product enters a flotation cell, where the main flotation is done by machines of Denver 500 type. The froth product from the main flotation, enters for re-grinding in a mill МШЦ 2000x4500. Mills work in a closed cicle with the hydrocyclon "KREBS". The concentrate, after 3 (4) scavenge operations in the flotation machines is fed into condenssers СП-30, and then into a pressing filter БОУ-40-3 for drying. The ready concentrate has an average copper content of nearly 25% and moisture content of 9-11%.

Pumping plants of three stages of pumping of circulation water are constructed for the needs of circulation water supply.

Electric power is supplied to the dressing plant through the main substation by two three-coiled transformers 50 MVA, 110/20/6 kV. A voltage of 20 kV suplies the pumping plants, and a voltage of 6 kV supplies the dressing departments. Annual power consumption is more than 260 millions kWh.

According to a decision of the State Committee of Energy Regulation of November 1st 2002 the company pays the power consumed in holidays with a certain discount from working days and night rates.

In 2000 a modern micro-processer system for measuring, regulation and control of power consumption (Stoilov, Djustrov et al., 2003). The system prints out records of data about consumed active, reactive electric power and factor of power. Those data, referred to specific rate zones, comprise each department and the company as a whole. A record of expenses in leva is also printed for specific departments and the whole company as well, according to stipulations of the Regulation for applying the prices and rates for power consumption. All the data about power consumption, the average for a period of 30 min are stored in the system for a period of 5 years.

An analysis of the structure of power consumption is prepared for a period of one year (May 2000 – April 2001), for one month (June 2000) and a typical working day (June 16th 2000).

Fig. 1 represents the annual districbution ofconsumed active electric power from the company for different rate zones.

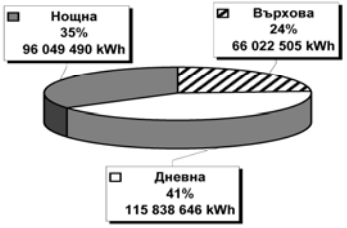

Figure 1

Compared to the case when the average consumed power in all the zones is equal (peek – 25%, daytime – 41,66% and nighttime – 33,33%) it is evident that efforts are paid for limiting consumption in the peek and daytime consumption on the account of the night-time. In June 2000 a monthly distribution of consumed active power is achieved, which is 1% less in the peek zone on the account of

the day-time zone. This represents reserves, which in fact are available for better distribution of power in different rate zones.

Fig. 2 shows distribution of annual currency expenses for power in different rate zones.

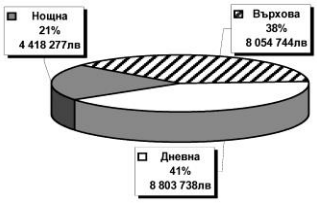

Figure 2

Significant portion of funds are paid for power consumed in the peek zones – 38%. The equality in the percent distribution of power and expenses for it (41 %) for the day-time zone is interesting.

Distribution of consumed active power for specific departments is shown in fig.3.

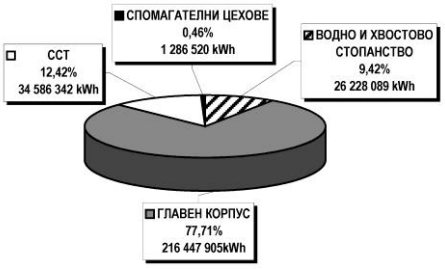

Figure 3

The consumer of the highest consumption is the MAIN BUILDING, where the main portion of production is concentrated – grinding, fine grinding, flotation, compression and filtering. The MAIN BUILDING uses 77,7% of the power, Department for medium and fine crushing – 12,42%, water circulation and tailings – 9,42%.

The other auxiliary departments – mechanical repairing department, heating department, electrical repairing department and administration – 0,46%.

Production process in the depatments of MAIN BUILDING is continuous. The process grinding is the most power-consumable. There are 10 mills, driven by synchronous motors of 2,MW power. Annual and month distribution of electric power, consumed by the MAIN BUILDING is: peek zone - 25%, day-time zone – 41%, night-time zone – 34%. Therefore, the average hour power is almost constant for all the rate zones.

The schedule of work of the department for medium and fine crushing is subjected to the objective of reducing consumption of power in the peek zone. As a rule the department interrupts operation for technical servicing during the morning peek zone. The availability of a hopper with a large enough volume between the Department for medium-size and fine crushing and the MAIN BUILDING provides the option of interrupting the Department for crushing during the evening peek zone, in case of future enhancement of its productivity. Below is presented the annual distribution for different zones: peek zone – 20%, day-time zone – 42%, night-time zone – 38%. There is a real opportunity for achieving a better distribution, which is evident from the data obtained for June: peek zone – 18%, day-time zone – 43%, night-time zone 39%.

Circulation water supply and delivery of fresh water to the plant occupies a share of 9,42 % of the power consumption of the company. In case of the existing scheme of circulation water supply (pumping stations, water-collecting basins and schemes of work) the distribution of consumed power is as follows: peek zone – 20%, day-time zone – 42%, night-time zone – 38%. In June 2000 the distribution was better: peek zone – 16 %, day-time zone - 41%, night-time – 43%, and on June 16: peek zone – 12%, day-time zone – 37%, night-time zone – 51%. It is evident that much better distribution of electric power consumption for different rate zones may be realized for the cycles of water supply.

Annual expenses of the company distributed for specific departments and rate zones is shown in fig.4.

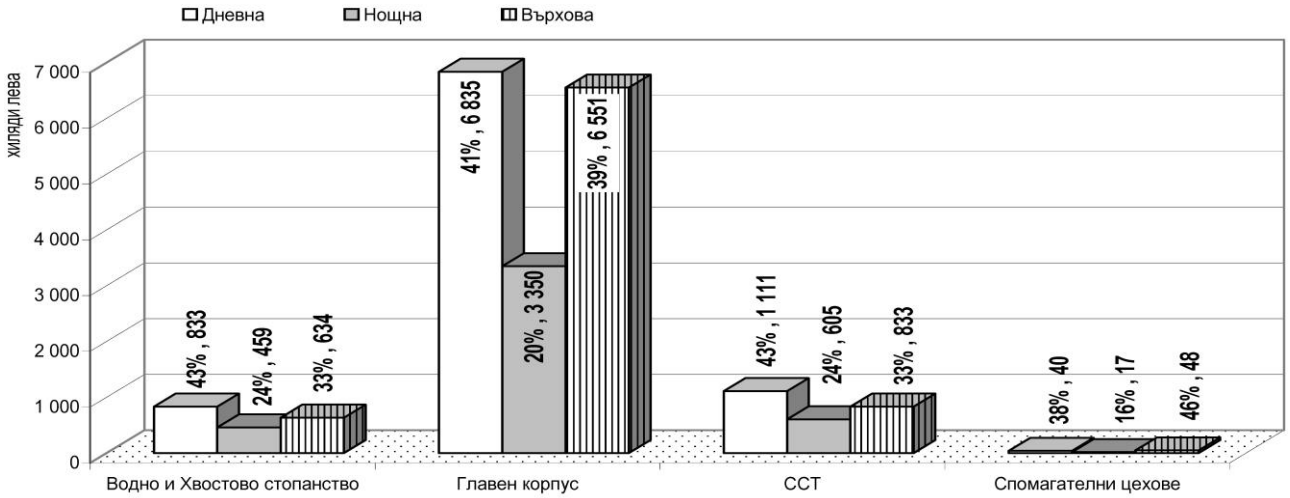

Figure 4

Percentage distribution of annual expenses for electric power for specific departments is as follows: MAIN BUILDING – 77,27%, MEDIUM-SIZE AND FINE CRUSHING – 13,27%, WATER SUPPLY AND TAILINGS – 8,95% and supplementary departments – 0,51%.

Expenses are minimum in the month of June due to the better distribution of electric power within the different zones. Therefore, characteristics achieved for that month may be considered as a norm.

Operative control of power consumption of the whole company is done by the person-in-charge in the main sub-station on the basis of visual data from the micro-processing system. Planning and reading of power consumption is done on the basis of records from daily power consumption. Each day professionals from the power department determine the following characteritics, generally for the company and for the departments of MAIN BUILDING, Medium-size and fine crushing and water supply and tailings:

- specific power consumption;
- average specific consumption for the current day of the month;
- percentage distribution of consumed power supply for each day for spcific zones;
- implementation of the schedule for power consumption, in kWh and in leva for specific rate zones.
- percentage implementation of schedule for each day and for the current day of the month.
- avergae factor of power for the day-time and the peek zones - - for each day and from the beginning of the current month.

Each month data are summarized and a record is prepared for consumed electric power and expenses in (eva) for rate zones for each department of the company, including the supplementary departments.

The criterion for analysis of power consumption, namely – the specific power consumption does not provide an objective assessment of the effect of redistribution of loading in the different rate zones and expenses. The other criterion – daily determination of percentage power distribution in the rate zones provides a certain opportunity for comparative assessment, however the logical analysis is difficult due to the large scope of data. For that reason we suggest the involvement of a differential reading of power specific consumption for rate zones. A better view of the distribution of funds may be presented by the parameter "C" – levas for the electric power spent for 1 ton of processed ore (leva/ton). That parameter shows completely the main factors, effecting on expenses for electric power – quantity of used electric power, ratio of cost of power in the different rate zones and possible financial penalties from the power supplying company. Below are presented the bases for that suggestion:

- technological process in the MAIN BUILDING, where more than 77% of the total power is consumed, is continuous;
- daily productivity of the plant is rather constant and for the year 2002 it is within the range of: minimum: 32299 tones, maximum 34420 tones and average 33247 tones. The above presented is a reason for accepting, with a certain approximation, that the daily, respectively monthly productivity is proportionally distributed in a ratio corresponding to the percentage distribution of rate zones – peek rate 25 %, day-time rate 41,66% and night-time rate 33,33%. The Department for medium-size and fine crushing works with interruption during the morning peek zone, and the Water supply and tailings department reduces loading during the two peak zones. A reduced specific electricity consumption is determined for those departments as a consumed power for the respective rate zone referred to the quantity of dressed ore of the MAIN BUILDING. Having in mind that the month coefficient of motion of the mills is within the range 95% - 99% and for the year the average-weighed value is 97,22%, we consider that its reading is not necessary for comapring the month characteristics for specific consumption of electric power.

The establishing of a scheme for determining the structure of power consumption for each month is advisable. Table 1 shows the comparison of suggested parameters for months January and month December of 2002. The selected months belong to the winter period, which allows not to read the coefficient of season. The specific power consumption for January is – 23,376 κWh/ton, and for December 23,01 κWh/ton. The table covers the whole structure of power consumption, reading all the factors – changes in the regulation for cost of electric power, effects of the activities for saving of energy, and what are the departments of the company and what is the approach for achieving that effect. For example, for dressing of one ton of ore in January the enterprise paid 1,788 BGL for power, and for December - 1,695 BGL. For a conditional average month productivity of one million ton, in case of the above ratio, expenses for electric power will be reduced with 93 000 BGL. A portion of the reduction is due to preferential costs for December for the day-time and night-time power during the weekends and holidays. However, there are other factors that are evident from the suggested structure in table 1.

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Table 1

zones	peek zone				day-tine zone				night-time zone				total			
months	I		XII		I		XII		I		XII		I		XII	
	ω kWh/t	c BGL/t	ω kWh/t	c BGL/t	ω kWh/t	c BGL/t	ω kWh/t	c BGL/t	ω kWh/t	c BGL/t	ω kWh/t	c BGL/t	ω kWh/t	c BGL/t	ω kWh/t	c BGL/t
PP	22,41	**2,734**	21,21	**2,59**	22,996	1,748	23,10	1,68	24,578	1,131	24,25	1,04	23,376	**1,788**	23,01	**1,695**
FP	17,88	2,181	17,93	2,188	17,971	1,366	18,28	1,332	18,007	0,828	18,596	0,798	17,96	1,39	18,299	1.368
AFC	**2,448**	0,299	**1,689**	0,206	2,878	0,219	2,683	0,195	3,385	0,156	2,997	0,129	**2,939**	0,218	**2,539**	0,176
WST	1,896	**0,231**	1,387	**0,169**	1,982	0,151	3,059	0,144	3,038	0,140	2,517	0,108	2,312	0,167	2,008	0,138

For example, for the peek zone, when the cost of power was not changed, 2,734 BGL were paid for January, while 2,59 BGL were paid for December for the dressing of 1 ton of ore. In that case, the reduction of expenses is due to the more-rational management of power consumption. The specific consumption of power in the peek zone for the Department of Medium-size and fine crushing is reduced from 2,448 kWh/ton to 1,689 kWh/ton. Therefore, a significant reduction of loading during the peek zone is achieved on the account of the night-time zone. That is a result of strict observation of the regime of work at the department – excluding the whole period of the morning peek, implementation of planned repairs in the peek zones of the working days, maximum loading in the weekends and holidays. There is a positive tendency in the general specific consumption for the Department for Medium-size and fine crushing from 2,939 kWh/ton is reduced to 2,539 kWh/ton for December. The automated system for control of the technological process, which optimizes the work of crushers and limits the idle work contributes to the power consumption reduction (Voloshtenko, N.E., Ostrovski et al, 1990r.)

At the Water supply and tailings Department a more rational distribution of the specific power consumption in the respective rate zones is realized in December. That brings to reduction of expenses for circulation water supply in the peek zone from 0, 231 BGL to 0,169 BGL for ton of dressed ore.

The month elaboration of the suggested table gives an opportunity for discovering the structure of main parameters, characterizing the power consumption. Comparison of suggested parameters for individual months provides the option for qualitative assessment of applied measures for saving of power.

Professionals from the enetrprise achieved the following positive long-term effects on the basis of data about distribution of power consumption:

I. In respect of acting rates for paying the power:

1. Precise planning of consumed electrical power for a quarter of year without any corrections.
2. Lack of penalties for the low average month values of the factor of power.
3. Lack of penalties for returned in the system reactive power.
4. Satisfactorily distribution of consumed power among the rate zones for the technological processes.
5. Tendencies for increase of consumed power in day-time and night-time zones in the weekends and the holidays..

II. In respect of saving the power:

1. Voltage of major consumers is maintained close to the maximum to the nominal one. For that purpose, digital volt-meters and a device for sound signaling of the deviation of voltage from given values are mounted in the sub-station.
2. Excitation of synchronous motors is optimized to a level that their common work with condenser batteries is realized with an average-month factor of power of 0.9 - 0.91. A regulation of the factor of power by changing the voltage by Jansen regulators of transformers is allowed, however within narrow boundaries, determined by experimental investigation (Menteshev, Stoilov et al., "Report", 1994)
3. Regime of work of air electrical ducts and transformers in the pumping stations of the circulation water supply is optimized. Losses of power are calculated for three versions and the most economic one is selected. The pumping plant for fresh water works only three nights in the week, two of them in the weekends or in the holidays, if possible. In all the other time the transformer – 1600 kVA/20/6kV is also switched out.

Expenses for electric power occupy the highest share of the expenses of the company. The issue of reduction becomes more and more up-to-date, due to the tendency of rise of power cost. The schedule of loading, constructed for a typical working day (fig. 5) illustrates the character of electrical loading.

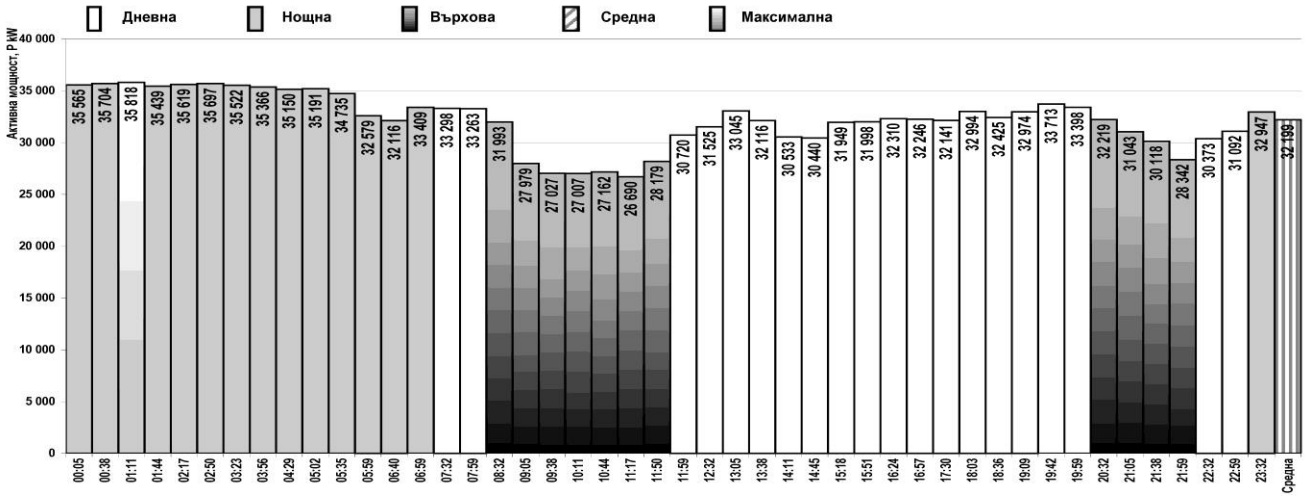

Figure 5

Evidently, opportunities for reduction of expenses through more optimal distribution of power among the rate zones have already been exhausted. For that reason, measures of larger scale are undertaken to use more rationally the opportunities of payment rate of electric power:

1. Water-colecting basins for circulation water on the territory of the plant are reconstructed. Their volume is increased with 3000 m^3 , which will allow an unloading of peek zones with nearly 2100kW.

2. A project is developed for increase of the productivity of Departemnt for Medium-size and fine crushing to 2000 t/hour. Its implementation will make possible the interrupting of operation of the evening-time peek zone. This will bring to:

reducing the loading of the company during the evening peek with nearly 4000kW.

The main criterion for effective use of power supply in the technological processes is the specific consumption. In the MAIN BUILDING the type of loading is determined by the ball mils. They consume more than 70% of the power. The following energy characteristics of power P=4,41.A + 18762 and specific power consumption ω = 4,41 + 187622/A (Danailov D., 1985) are derived with the aim of determining the regularities of power consumption at the department, (data of power and productivity refer to June 2000). Fig. 6 illustrates the above dependencies.

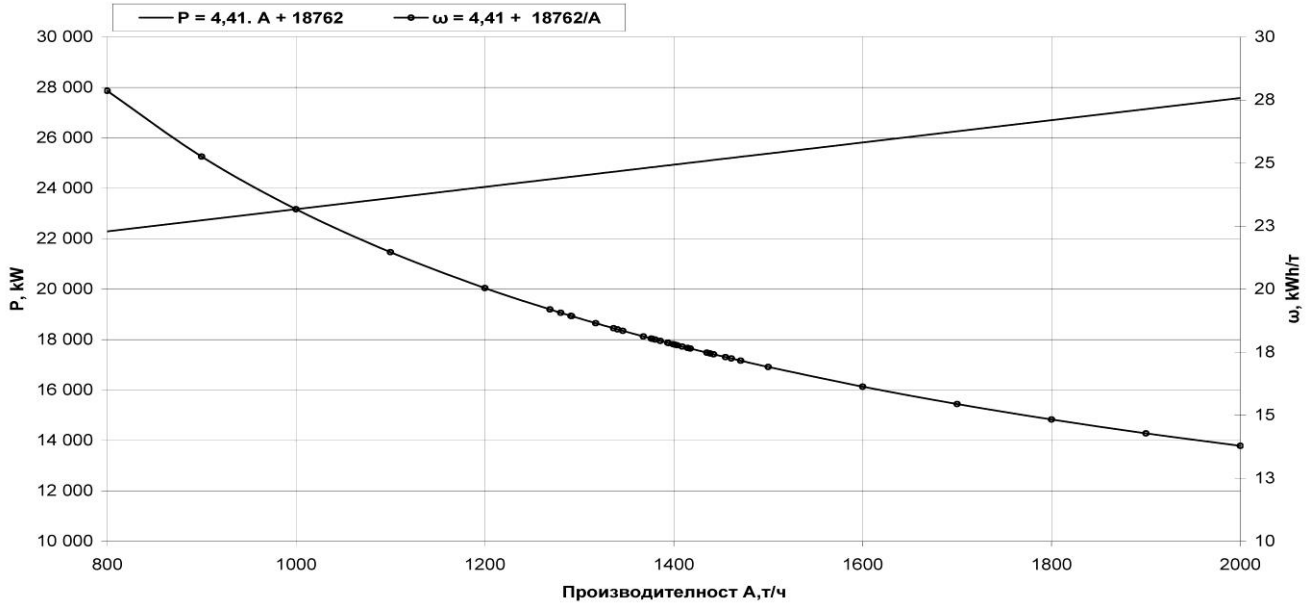

Figure 6

As it is known, specific power consumption for grinding in ball mills is closely related to the technological process and depends on a number of factors: weight of ball loading, density of slurry, size of feeding material, mechanical properties of ore, productivity of the mill, granular composition of milled product etc. Experimental investigations showed that the main power in the ball mill is used for rise of the ball loading – nearly 80% (StepanovV.S.,1984). Increase of mill productivity brings to insignificant increase of used power. Considering that ball mills are a decisive factor in the structure of power consumption, the intention for increase of mill productivity and respective reduction of specific power consumption is logical. For that purpose, the flowsheet of the Department for medium-size and fine crushing comprises a set – cone crusher, sieving machine and a shaft crusher. Milling aggregates are to be fed with ore, in which the class "-15мм" is 95%, i.e. through reducing the size of ore fed for milling to improve the productivity of mills. This, on its own behalf will bring to reduction of the specific power consumption for the process of grinding. The mounting of two new sets is forthcoming. On the other flows for fine crushing the class "-15мм" will be controlled with sieving machines only.

Productivity of the depends on the correct selection of the ball loading. Both the enhancement and the reduction of ball loading bring to reduction of mill productivity, and therefore rise of specific power consumption. Size of grinding bodies (balls) also effects productivity of milling process. An investigation for optimizing the diameter of grinding bodies (balls) is needed, when the provided granular composition of incoming ore (95% class "-15mm") is achieved. That is why an automatic system for dosing the balls in the mill is in a process of testing. It is typical that feeding of balls is a continuous process, which improves the structure of ball loading. It is expected that with the optimization of ball loading, in both quantity and structure, the productivity of the mill will be enhanced and parameters of outgoing product will be improved.

The determination of structure of power consumption at the dressing plant through differentialtion into the rate zones for specific consumption of power ω_i and expenses for power for a ton of the processed ore are a pre-condition for:

- more rational control of power consumption;
- effective control over the departments for the observation of determined regimes of operation;
- precise quantitative assessment of the efficiency of activities for saving of power;
- reasoned determination of the differential norms for power consumption for individual departments.

For the "Elatsite-med" Co. the conclusion of a contract, as a privileged consumer, with the power supplying company is forthcoming. Based on the data of structure of power consumption, professionals from the company will be able too negotiate attractive costs and parameters, if they are supplied with the respective option.

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