PRODUCTION DISPACHING IN OPEN PITS; EQUIPMENT TO ESTIMATE THE QUANTITY OF EXCAVATED MATERIAL WITH ENERGETIC METHODS

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ABSTRACT: The quantity of excavated material should be known to supervise the coal production and economic efficiency on each excavator.
The debit calculating algorithm consist in mathematic formulas having as calculating parameters, the values measured in the technological process and specific technological constants.
The instantaneous quantity displaying in the digging-man's cab allows the supervising of the conveyer loading, elimination of unproductive time, determination of economic efficiency. The system bases on intelligent transducers, control and acquisition equipments.

1. INTRODUCTION

The Lignite Coal National Company of Oltenia realized many projects to up-to-date the excavating equipments and the technological flow, to reduce the specific consumes- electric energy, especially. We have chosen the Husnicioara working which belong to Mehedinti Mining to implement the system.

2. SYSTEM DESCRIPTION

Generally, the system consist in three units running as an ensemble:

- real time data acquisition equipment- UC-placed into the electric house on the conveyer number two of excavator; into the same electric house there are the current and voltage transducers. The equipment including a local module displaying the quantity of coal excavated and conveyed on the conveyer number two.
- remote data displaying equipment-LCD- which display the data referring to the conveyed quantity of coal (to/h). The equipment is placed into the excavator's cab.
- superior level communicating unit .

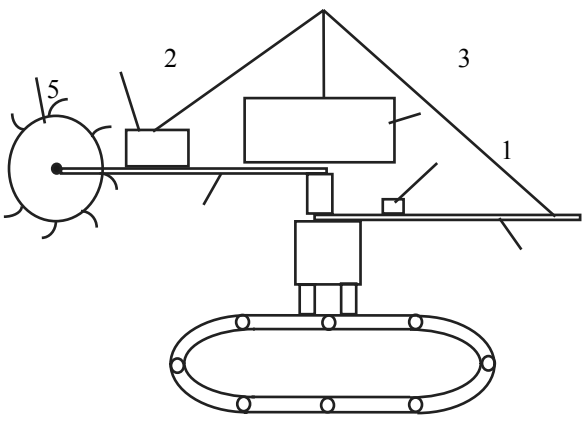


Fig 1. The scheme placing on the excavator

1. Electric house – equipment UC
2. Excavator's cab – equipment LCD
3. Conveyer number 1
4. Conveyer number 2
5. Buckets wheel

The equipment consist in :
data acquisition, processing and transmitting unit:

- supply $\pm$12V+5V
- processing board
- analogue data acquisition and converting board
- serial data switching board and watchdog
- board converting RS 232 / RS 232-current loop
- alphanumeric display
- keyboard

debit displaying unit

- processing board
- board converting RS 232 / RS 232-current loop
- alphanumeric display
- switch

communication processor

All the equipment's modules are dedicated.

Fig 2. Local equipment in electric house;

Fig3 Displaying equipment into the excavator's cab

The module including the voltage and current transducers makes an conversion from high to low that is the ratio of transformation is 100/1,because the acquisition equipment do not tolerate current values higher then 5 A at the current scanning inputs.
The digital equipment calculate the multiplication of voltage effective value, current effective value and the cosine of the phase difference angle between current and voltage.
The current or voltage effective value is calculated by central processor (80C552, 8 bits micro controller of 8051 family).
In this way calculate the instantaneous power; for data acquisition use a 12 bits fast analogue-numeric converter with a acquisition time satisfactory to solve the problem(for example, the response time is maximum 5 μs/acquisition).
The central processor on the main board is a 8bits micro controller repeating the multiplications with a certain acquisition and calculating rate.
Also, the central processor makes a numerically filtration of the acquired data obtaining the instantaneous power for one motor (the supervised conveyer may have one or two motors).
In this way, the equipment knows the powers, voltages, currents, phase difference of both motors.
The calibration of the results provided by equipment is made on the testing stand connecting an inductive load and varying the supplying voltage at its terminal. Also, it is possible to calibrate the voltage, current and phase difference scale coefficient(suppose that the phase difference is known).

The equipment was tested using a homologated kilowatt meter integrating in time the results provided by the digital equipment.
It is experimentally proved that the motor's torque is function of active power consumed between two close time quantum (few second) or is equal with instantaneous power.
The processor placed on the main board makes both the calculation of power and the storage of this in a mini archive to communicate with superior levels.
Because the data acquired by the processing unit are supervised by many users as: digger men, normators, etc , there are more methods to display the debits.
For the excavator's cab (cab number 1) there is an alphanumeric display which show the instantaneous debit of coal or barren gangue, function of options.
The displaying unit consist in a WatchDog module, an alphanumeric display and a switch with which the digger man selects - coal or barren gangue – function of working frame.
The local equipment communicates with the central dispatcher (production dispatcher) by a signal processor and a radio infrastructure.
The communication modules are connected to a high frequency radio-modem system (2.4 GHz).
The data arriving in the PC are: current debit type (providing information about each excavator), cumulated debit type (coal and barren gangue) and date and hour of recording.

3. SYSTEM'S FUNCTIONS; CENTRAL DISPATCHER PROGRAMS

In the mines is needed a quantitative estimation of coal to supervise the production on the each excavator, estimate the costs per product unit and supervise the economic efficiency.
The instantaneous quantity of coal displaying in the excavator's cab allows the supervising of the conveyer loading and elimination of unproductively time to determine the economic efficiency.

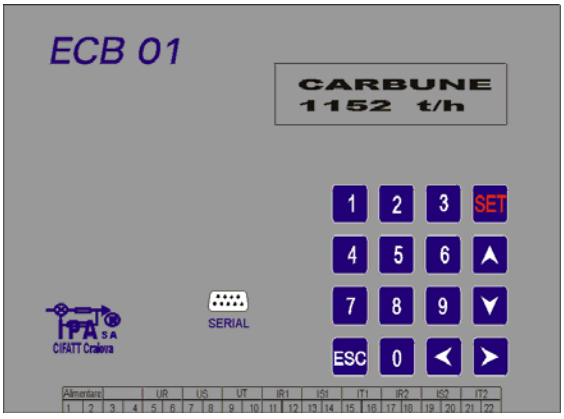


Figure 4. Local equipment

For dispatching, it is allowed the monitoring and administration of the following parameters:

- instantaneous quantity (to/h); recording of material quantity (to)
- intensive using indicators
- extensive using indicators
- using indicators of installed power

The equipment has the following functions:

- acquiring the current and voltage data from both motors driving the second conveyer of excavator and conveyer start/stop data ; computing of consumed energy;
- equipment calibration eliminating (basis on an mathematic algorithm) the friction and wear loss;
- estimating the quantity of excavated material (coal or barren gangue); recording in the data bases;
- determination of running and waiting time per periods of time and shifts of workers;
- local displaying of the data and conveyer's state (functional or non-functional);
- data transmitting to the remote data displaying equipment –LCD and to the hierarchical superior level – production dispatcher;
- displaying of the synopsis scheme and general state of excavators and mine;
- data transmitting to the dispatcher (display and printer).

4. PARAMETERS MONITORING

The equipment estimating the excavated quantity of the coal bases on the following reasons:

- the excavated quantity of the coal is proportional with the energy consumed by the motors which drive the conveyer;
- the estimating accuracy is affected by the friction and wear loss of the conveyer, rolls and other elements;
- the loss measuring must be made periodically;

The energetic consumes may be written in this way:

E process = E digging + E moving +E transporting +E other mechanisms

The energetic consumes due to other excavator's mechanisms are constant, indifferently of excavated quantity.

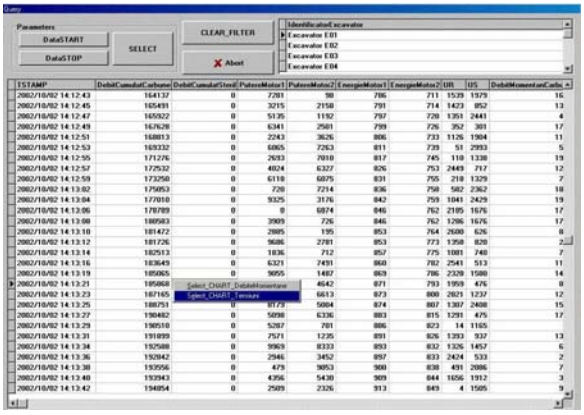


Fig 5. Reports

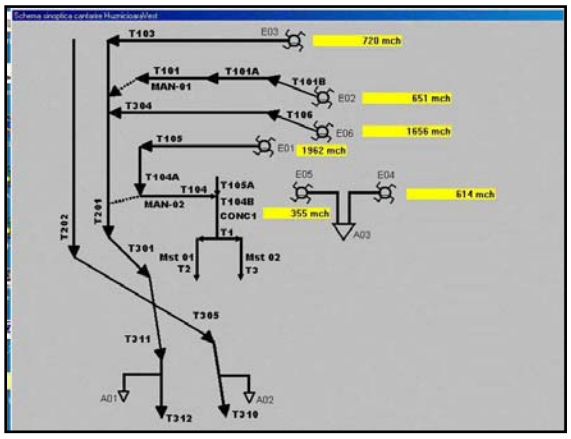


Fig 6. Mine's synopsis scheme

5. THE DEBIT COMPUTING ALGORITHM

The algorithm consist in formulas (integral, sums, calculation of minimum and maximum values) having as calculation parameters both the measured values during the technologic process and ECB's specific constants.

The equipment is included in the informatic system and allows a decreasing of energetic consume.

6. REPORTS

The user chooses two periods of time – the first is considered as start and the second as stop. After the communication protocol, the soft recasts and prints the excavated quantity of material, the effective running time (conveyer loaded), the using indicator of the excavator's second conveyer. This indicator is calculated as the report between the excavated quantity of material and the effective running time.

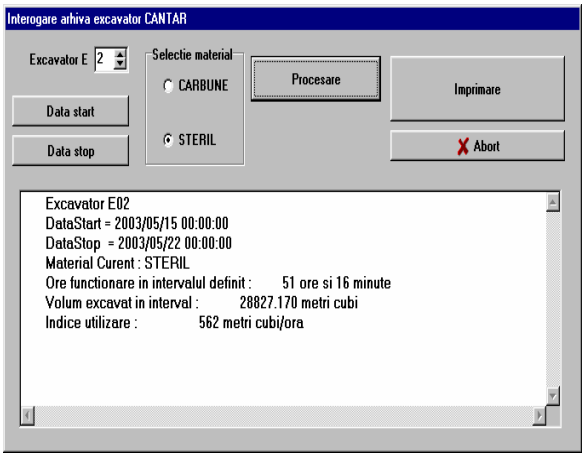
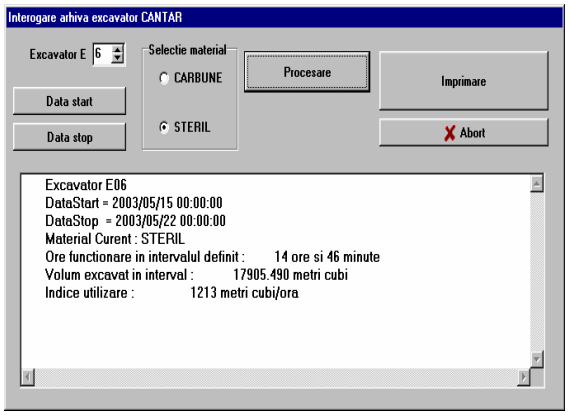


Fig 7. Reports



6.1. Optional reports

-The user has the possibility to see the data (as table) about a certain excavator: monthly, weekly, daily, shift of workers (it is established by the user the hour when begin a shift and the period of shift).

-The user may see the stopping of a excavator between two predefined period of time. The stopping will be shown in a list.

After the communication protocol, the soft provides the following data:

- the quantity / cumulated volume (to/h, or mc/h) between two dates selected by user;
- the total running time within the established period of time (in hours and minutes);
- the unload running time(with unloaded conveyer) within the established period of time (in hours and minutes);
- the total running indicator of excavator(equal with the report between excavated quantity or volume and load running time, within the established period of time).
- The real running indicator (equal with the report between excavated quantity or volume and total running time, within the established period of time; the total running time is a sum between the unload running time and the load running time).

For a on-line analyze the computer displays (with a refresh rate depending on the choused radio system) information about each ECB, as:

- the debit of barren gangue (mc/h);
- the debit of coal (to/h);
- the load running level of excavator (percentage).

For a off-line analyze may be to show the energetic loss on the base of the daily, weekly, monthly, shift of workers, yearly reports.

Analyzing the reports, it is possible to command an efficient and moderate rate of excavation and to prevent an overloading of conveyers leading to an overheating of rubber band and to a negative modification of the price/to report.

7. DATA BASE - CONVEYED MATERIAL

There is a single table of DBASE type for Windows in which record information as:

- equipment's identifying;
- cumulated quantity of coal;
- cumulated quantity of barren gangue;
- type of material selected by user;
- unload running time for barren gangue;
- load running time for barren gangue;
- unload running time for coal;
- load running time for coal;

8. CONCLUSIONS

The communication network between the excavator and communication server is a distributed network so, the server questions each equipment included in the system, by radio-link; the excavator answers if it is running and the communication server transmits the equipment's answer (ECB's answer) to a database server providing the data shown above. In Husnicioara mine, each computer endowed with this soft, creates own table copied from server's data base.

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