

***OPTIMISATION OF ELECTRIC POWER CONSUMPTION
BY REHABILITATING THE COMPRESSOR STATIONS***

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1. OVERVIEW OF EXISTING STATUS

The mining units of National Hardcoal Company S.A. Petrosani are endowed with a total number of 68 piston compressors, type L 100/428, manufactured by U.C.M. Resita, of which a number of 28 compressors are in operation, and the difference up to 64 compressors are active and can be putted into operation any time.

The piston compressors, type L 100/428, produced by U.C.M. Resita, have been manufactured following the design of ATLAS COPCO in accordance with the technologies used in the year 1970, no modernisation being performed until present to these compressors. Beginning with the year 1980, in the world, the companies manufacturing piston compressors, for which low efficiency was noticed, have started to design and manufacture new types of compressors that are simpler than the old ones. These compressors consist in a lower number of premature wearing parts, which includes the integral replacement of pistons and compression cylinders with other solutions that decreases the maintenance costs. These solutions lend for complex mechanisation and automation, involving integral reduction of personnel that is responsible for monitoring, maintenance and repairs. In the same time, following the adopted solutions, the new installations producing compressed air have been simplified by cancelling/removing both the entire cooling system and the greasing/oiling installations.

Although the piston compressors types L 100/428 have a high wearing level and are out of date, in present they represent the main source for compressed air of the mining units, and without them no production/mining process can be performed. In the same time they provide the safety climate/environment in underground.

2. ASSESSMENT OF OPERATION AND MAINTENANCE COSTS

In order to keep in operation the piston compressors existing in present at the mining units, certain monthly and yearly costs are required, consisting of the followings:

- labour force costs;
- operation and maintenance costs;
- depreciation costs;
- spare parts costs;
- electric power consumption costs.

It should be mentioned that within the chapter “Operation and maintenance costs” the following articles are included:

- cost of oils for lubrication;
- cost of cooling water;
- cost of small materials, for cleaning and maintenance.

The costs afferent for keeping into operation the piston compressors from our mining units and coal processing plants for one year period (2001) are presented in the annexe 2. It should be specified that the total annual costs amount to 140,954,172,000.00 ROL, in this value being also included the costs for keeping into operation the turbo-compressors from Petrila Mine, Vulcan Mine and Lupeni Mine. The costs afferent for keeping into operation the piston compressors have the value of 116,021,772,000.00 ROL.

From the analysis of costs presented in the annexe 2 it results that over 77% of them represent electric power costs, 11% of them are the costs afferent for purchasing spare parts, and the rest of 12% represent labour force costs, maintenance and depreciation costs. In order to perform the required works of maintaining and repairing the piston compressors types L 100/428, at the level of underground mining units from C.N.H.-S.A. Petrosani there are appointed 153 workers, of which:

- underground blacksmiths and electricians = 71
- above ground blacksmiths, electricians and operators = 81/72 qualified personnel – women).

In accordance with PTC-16 (Additional instruction of NSPM-ed. 1997) it is imposed that the personnel responsible for operating and maintaining the compressor stations to be properly trained and authorised every year. In this context, it is mentioned the fact that after the large personnel reductions performed in the past years, it was required to perform the maintenance activities with underground skilled personnel (electricians and blacksmiths).

The list with personnel responsible for compressor stations is presented in annexe 3.

Due to the complexity of compressed air installations it was required to reconsider the training level of personnel in charged with operation and maintenance of compressor stations, so that after the above mentioned personnel reductions it was imposed that certain maintenance and repair works to be performed with underground personnel (blacksmiths and electricians).

The financial effort made by the mining units for providing the salaries of personnel responsible for carrying out the activities of maintenance, repair and operation of piston compressors amount every year to 7,484,844,000.00 ROL. In the annexe 4 there are presented the values afferent for every speciality and mining unit. In addition to the high costs afferent for the labour force responsible for operation of piston compressors, an important index is represented by the annual oil consumption, which, in the year 2001, was of 150 tones, amounting to 2,300,000,000 ROL.

The value of spare parts contracted with UCM Resita and purchased for keeping into operation the piston compressors was of 6,772,176,955.00 ROL (in 2001).

3. NECESSITY AND OPPORTUNITY FOR REHABILITATING THE COMPRESSOR STATIONS

Since the date when the piston compressors have been manufactured until present no modernisation was implemented to them, and the repairs performed with the actual technique and technology didn't allow to keep the operation parameters at the nominal values; their efficiency has decreased continuously with all repercussions resulted from this aspect.

Having in view the fact that in the same time with the increase of piston compressors' number of operating hours increases also the costs afferent for:

- purchase of spare parts;
- performance of current and capital repairs;
- involvement of a larger number of personnel for unset the nominal operational and technical parameters of compressors;
- for the restart of compressors after a non-operation period, a high electric power consumption is required, it was required to investigate new solutions for rehabilitating the compressor stations.

The actual efficiency values of piston compressors have been established both theoretically and on the base of measurements. For the accurate establishment of technical parameters of every existing compressor special measurements should be performed with adequate devices and by the personnel that is specially trained in this activity field. Based on the data we have in present, the global efficiency of piston compressors types L 100/428 is not higher than 53%.

In addition to the above mentioned costs, a significant contribution is due to the electric power consumption. Referring at the energetic impact produced by the operation of compressors, from the data we have for the year of 2001, the following aspects result:

- electric power used for producing the compressed air represents a percentage of 38% from the total consumption of electric power (annexe 5);
- despite the fact that at the level of CNH large programs regarding the decrease of the consumption and the costs afferent for electric power have been adopted, the value of electric power consumed by the compressors is of 114,720,000,000

ROL/year, respectively 43.6% from the value of total electric power consumed, the further on reduction of this consumption being limited by the existing endowment consisting in very low performance/efficiency equipments.

From the analysis of binomial components of the tariff system (differentiated binomial type A) it was noticed that at the maximum power simultaneously adsorbed within the peak hours, a significant influence (of aprox. 38%) is due to the operation of compressors, and, in certain cases, due to the shock involved by the start of asynchronous motors equipping these compressors (PN=480 kW, 6 kV). These shocks are transmitted up to the electric distribution stations owned by SC ELECTRICA SA and they are implicitly registered and invoiced in accordance with tariff A.

Analysing the above mentioned costs, regarding the further on keeping into operation of piston compressors, it was decided that is strictly required to purchase modern equipments (compressors) manufactured at the level of actual technologies. In the world, beginning with the year 1980, the piston compressors have been replaced with other types, with new and simpler solutions, presenting a significant reduction of premature wearing, integral reduction of maintenance personnel; these equipments can be totally automated, and the afferent installations, equipments and constructions for water cooling and lubricating systems can be fully eliminated.

In order to realise the operation way of a new and modern compressor station, it was performed a visit at the "Compressor station" from Baia Sprie Mine within SC REMIN Baia Mare. The specialised personnel from this mining unit has provided all technical and economical data that represented the base for purchasing and installing 6 compressors type GA 250 – ATLAS COPCO, inclusively the studies and execution projects elaborated by the specialised institutes, which represented the base of decision for the replacement of piston compressors.

In the annexe 5 it is presented, for exemplification, the comparative table regarding the technical parameters of a compressor type GA 250 ATLAS COPCO, and respectively, of a piston compressor type L 100/428. At the first assessment there are noticed the incontestable advantages for the case of using the compressor type GA 250.

As regard the necessary investment for implementing a helical compressor within the Jiu Valley mining units, in comparison to the piston compressor type L 100/428, the following aspect is mentioned:

- manufacture and delivery price of compressor L 100/428 = 2,380,995,000.00 ROL
according the offer (188,716.00 DM)
- manufacture and delivery price of compressor
type GA 250 ATLAS COPCO (offer price in February 2001) = 1,638,816,000.00 ROL

according to the offer presented in annex 7

(129,000.00

DM)

From the comparative analysis of all costs involved by keeping into operation the existing piston compressors, in comparison to the total costs afferent for keeping into operation the compressors types GA 250 – costs presented in the annex 8, it results that the variant regarding the utilisation of compressors type ATLAS COPCO is very advantageous from economical point of view, and this should be implemented to all mining units in Jiu Valley.

4. FINAL CONCLUSIONS

Based on the detailed analysis of helical compressors in comparison to the piston compressors types L 100/428, from technical and economical point of view, it results the following significant advantages for the case of installing and operating the helical compressor ATLAS COPCO, type GA 250:

- at the same air pressure and flow rate produced, these compressors provide a reduction of 20% electric power consumed;
- the installation costs are minimum, the compressor's house doesn't need a special construction, and the compressor (being monoblock) doesn't need foundation;
- there are totally eliminated both the costs afferent for installing the water cooling system (the compressor GA 250 is cooled with air), and the costs afferent for maintaining the water cooling system;
- there are also eliminated the electric power consumptions needed by the water cooling system (cooling and recirculating pumps);
- oil quantity afferent for one oil change is lower with approx. 25%;
- oil consumption is ignorable, it is not required to add oil between two changes;
- low noise level (75 dB), in comparison to 85-90 dB for piston compressor, where the operator should wear protective headphones;
- there are eliminated the costs involved by the usage of end coolers and of condense pots in the underground pipe networks and implicitly it is improved the global efficiency of the compressed air pipe networks;
- it can be totally renounced to the operational and maintenance personnel, resulting in a labour force saving at the level of CNH (according to annex 9);
- maintenance program with minimum of consumable elements that can be performed at large periods of time (approx. 8000 operating hours);
- totally automated operation system (free or loaded, depending on the air consumption in the pipe network);
- high reliableness level;
- possibility for recovering 75-80% of the energy consumed by the compressor, by installing heat recovery equipments;

- these compressors have no wearing parts and doesn't need spare parts;
- recovery of investment is reached in 2-3 years from the purchase and putting into operation date;
- significant simplification of electric power feeding diagram;
- increase of safety for underground environment and working personnel;
- providing dried air for the compressed air end users, which lead to increase of their efficiency;
- operation in flexible system of the compressor units afferent for producing the compressed air, depending on the needs of underground users;
- providing the required compressed air in the pipe network, having the temperature with maximum 10⁰C higher than the temperature of adsorbed air; in this way all problems that may occur in the case of usage the piston compressors are eliminated (for comparison, the maximum temperature of the air delivered by the piston compressors types L100/428 may exceed 150⁰C);
- total elimination of lubricating oil existing in the compressed air pipe network, cancelling in this way the possibility of its oxidation;

Assessment of the number of equipments required for endowing the compressor stations, inclusively the value of costs for putting into operation these equipments, is presented in annexe A. It is also mentioned that there were taken into consideration equipments similar to those installed at Lupeni Mine.

The total value of monthly savings resulted after rehabilitating the compressor stations is of 10,586.00 mil. ROL/month.