

THE RETOOLING OF THE HYDRAULIC AND PNEUMATIC EQUIPMENTS BELONGING TO THE HYDRO POWER PLANTS FROM ROMANIA

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Abstract: The new position of the Romanian Power System in the European Power System generates numerous technical problems concerning the retooling of an important part of the power units, in order to meet stringent quality requirements for delivered energy. Also, in today's supply of electricity by hydroelectric power through the market of hydroelectric power, the indicators of reliability and availability of hidropower plants are very important to be directly connect by the technical capacity to meet the demands of commercial terms and contract values.

Keywords: the retooling, hydraulic and pneumatic equipment, the reliability, availability, compressor, pump, servo valve.

1. THE SITUATION OF THE INITIAL EXISTING EQUIPMENTS FROM THE OPERATION OF THE HYDRO POWER PLANTS

In the case of hydraulic and pneumatic initial existing plants from the operation these are characterized by the following operational characteristics: the failures and the frequency of their occurrence in the most of the cases are typical of hydraulic, pneumatic, lubrication and industrial transmissions; in terms of the characteristics of the rate of falls (the bathtub) the most plants are situated in the stage of wear; the supply of spare parts is difficult due to the fact that the manufacturing enterprises have stopped or greatly diminished the activity in the economic context after 1989; they have low power performances; they have dynamic performance and reliability under the demands imposed by the current rules and regulations; they have relatively large dimensions; they show potential risks of labor security (loud noise, explosions of pressured insides, sudden shifts of the mechanisms caused by

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deficiencies in the control systems); they shows the potential environmental risks (oil leaks, noise).

We will enumerate below some of the typical deficiencies registered in operating :

In the case of **the electrohydraulic converter** which equips speed regulator: the absence of the reaction of the local position from the converter drawer affects essential the accuracy of the adjustment system if the oil purity is not assured; the permanent vibration of the reaction vibration induces a permanent noise in the whole control system;hydro-mechanical equipment wear due to the constant vibration in the control system.

In the case of **the valve taps** which equips the installation of Oil Pressure Group: large hydraulic losses in the open position of the tap because of the complicated geometric shape of the tap; rapid wear of the seal between the valve and the seat and consequently loss of functional capacity of hydraulic isolation; require high mechanical work to perform a complete course "open- close" of the tap;they have a low work rate compared with other types of taps to perform a complete course "open-close".

In the case of **the centrifugal electric pumps** which equips the installations of epuishment and drainage: the unfulfillment of the primers, the unfulfillment of the flow and the unfulfillment of the discharge height in the case of the pump ,respective the electric motor drive will not start, not develop the required power or overheating during operation.

In the case of **the compressor with piston** which equips the compressed air installations: loud noise from the cylinder; the crank mechanism noise; strokes in bearing;the increase/decrease of the delivery pressure from the normal; the heating of the bearing; the heating of the cylinder,of the drawbar and of the gland;the decreased flow of the displaced air; the increase of the oil temperature; generation of burns in the cylinder;leakage of the gland; the safety valve is opened before or after reaching the limit pressure.

2. SUGGESTIONS FOR IMPROVEMENT

The retooling is the action to change the existing technologies which are built in obsolescence and/or depreciations with modern technology,based on high tech, which has the effect of reducing the manufacturing cycle time,the improve of the quality,the reducing of the material consumption and power, the increase of the production volume, the improvement of the performance of the products.

The necessity of retooling of the hydro power plants in operation derived mainly from these considerations: advanced age of some hydro aggregates and the exhaustion of the life time; the existence of some weaknesses of conception and execution;the use of the equipments with low reliability and technical performance exceeded; initial energo – economic performance reduced or diminished through wear

in operation; low standard of automation through the initial conception; reduced capacity to supply of the system of technology services.

2.1. The speed regulator

The fast evolution of the digital industrial computers and the major progresses made in the field of electrohydraulic servo valves with proportional electromagnets by course have created in the last decade the practical conditions necessary for a new generation of speed and power controllers that solve the problems mentioned. The classical electrohydraulic servo valves with preamplifier by type fit range or mobile injector contain an internal reaction of position that ensure the linearity of the static characteristic but require a very clean fluid environment (the 6 class of purity after NAS 1638). For this reason they are not suitable for speed control and power of the hydraulics turbines without a permanent effort of oil purification, which is extremely expensive. The first generation of proportional servo valves made by electromagnets with proportional force, allowed switching to a lower class of purity, specific to industrial applications, but the dynamic performances were not sufficient for the speed control systems. The second generation of proportional servo valves, based on electromagnets by course, offers all the static and dynamic qualities required for the fast industrial automated systems under a level of purity acceptable economically (the class of the purity liquid is between 7 and 9 after NAS 1638).

The speed regulator of type RDC – K for the control of the hydraulic turbines with two regulating organs (type Kaplan or bulb) regardless of their power. The regulator is numerically, with continuous drive controllers and it replaces the old models of electrohydraulic regulators. The version “K06” presented in the following is made like a hard with the central unit by type CPU 313C and the command of the servo motors of driving the control device and the rotor blades is made by the regulator through the proportional distributors and by the drawers of distribution existing from the old system of control. The regulator is composed of a main enclosure with protection degree IP66 or IP55 in which are assembled its electronic components, the operator Panel of type OP77A mounted in the control room, an element which is the communication interface between the operating staff and the regulator and an auxiliary enclosure along with hydromechanical components are mounted at the level of the control device of the hydroaggregate. Main elements of the regulator are : modules from the automatic programmable by type S7-300, measuring frequency interface (generator and system), outputs relay for the signals in 220Vcc, series of clamps, hydraulic control block for AD/PR, which contains proportional dispensers through which are commanded drawers AD/PR and the selectors by the operating system of RAV (manual/automatic) of the hydraulic circuit, electronic distributor of the oil control and an oil pressure transducer.

The new solution realized with electrohydraulic servo valves with proportional electromagnets by course has the following advantages: increasing precision control system: the reduction of the wearing of the hydro-mechanic equipment through

eliminating of the permanent vibration in the control system; maintainability and high availability.

2.2. The group of oil under pressure

The valve taps are replaced with ball taps that have many advantages towards them: the geometric shape causes the reduction of the hydraulic losses in the tap open position; high durability of the sealing element; require low mechanical work to make a full course “open – close” of the tap; they have high speed compared with other types of taps to perform a full course “open – close”.

2.3. The installations of equipments and drainage

The new generations with pumps built with electric motor are designed to ensure an efficient pumping, reliable, without problems for a long time. These pumps by improving the economic parameters, have significant effects on reducing the total operating and maintenance costs of the pumping installations. The construction of the rotor by semi open type, combined with discharge channel from the pump housing, reduces the risk of clogging and maintain the pumping efficiency also in conditions with difficulty in functioning. The safe in functioning was increased using the isolated motors by class H with improved cooling, lower operating temperature leads to the reduction of the wearing. The existence of an inspection camera allows the verification and the fast maintenance. The electric motor has by constructive point of view: thermal sensors on each statoric phase for thermal protection, humidity sensors for tracking, the starting equipment is incorporated, no need for external starting equipment. Similar the pump is built with: double sealing at the shaft, with oil chamber, conductivity sound for detecting the presence of water in oil chamber, new hydraulic design that minimizes wear and makes the pump at least three times more wearing resistant, fewer components resulting checks and repairs faster, easier and less expensive that simplifies the handling of the pump. In the following figure (1) is presented a longitudinal section through a submersible pump of type PKD 150 – producer DESMI A/S.

2.4. The compressed air installations

The piston compressors were replaced with helicoid compressors. The helicoid compressors function on the basis of penetration of a gas bubbles in the space between the two teeth of the compressor and its transport to the discharge area.

The main characteristics of the helicoid compressors of type KAESER are: requires a minimal space requirement; have a quiet operation; it is a reliable and efficient source of compressed air adapted to the requirements; the installation costs are significantly lower than in the case of the traditional systems; involve minimum maintenance costs by using high quality components and an ergonomic construction

which allowing an easy access to the maintenance points; they allow the connection to a centralized management system of the compressed air; in accordance with the requirements of the key systems they are ready for immediate operation once that they were connected to the supply network and to the compressed air network.

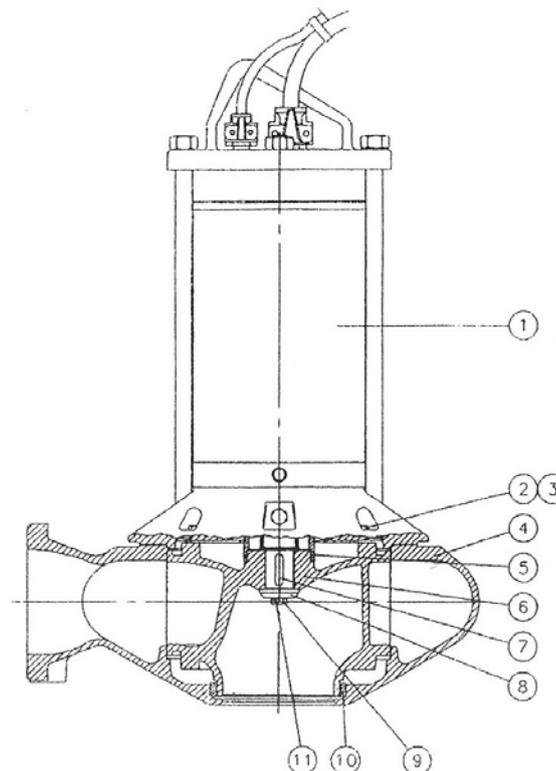


Fig. 1 Logitudinal section through the electropump of type PKD1150-
produced by ESMI A/S

1- engine; 2, 9 – screw; 3,11 – washer;4- pump housing; 5- the pump rotor; 7- the key;
8 – the plate;10- the sealing ;

The helicoid compressor SM compact with screw was redesigned and optimized: with airflow by 0,8, 1,2 respectively 1.5 m³/min at 8 bar , the three models available - SM 9, 12 and 15- each of them delivers more flow than the previous models SM15 ; it is a model of 9 KW, which is adds at the existent versions by 5,5 and 7,5 KW.In addition , SM 12 may be equipped with a frequency converter KAESER “SFC”, allowing the precise adjustment of the flow of the compressor at the variable consumption of compressed air.An integrated refrigeration dryer ensures the safe drying of the compressed air , the dryer is thermally shielded to prevent the expoure to the heat produced by the compressor.Also,the air quality can be obtained precisely, at the level required by using an optional air filter (available on request).The compressed

air is stored in the air receiver by 270 liters mounted below the compressor. All three modules – compressor, dryer and air receiver- of the new equipments KAESER from the serie "Aircenter" are included in a single casing, so that the entire system looks like a single unit. (fig.2 and fig.3). Each model represents the latest advances in design and construction of compressed air systems. Each unit uses an optimized compression block "SIGMA PROFILE" with injected engine coolants and an engine EU EFF1 with a high efficiency to guarantee an excellent specific power, with a high energy efficiency. The engine and the compression block are connected by a drive system with belts equipped with an automatic tensioning system. Using SIGMA PROFILE are realized the following : the save up till 15% percent of energy through optimum performance of the profile and through the excellent flow characteristics of the induction channels; the high quality roller bearings, aligned precisely, ensure a long period of life ; the high reliability result from the processing in close classes of tolerance on the high precision grinding machines.

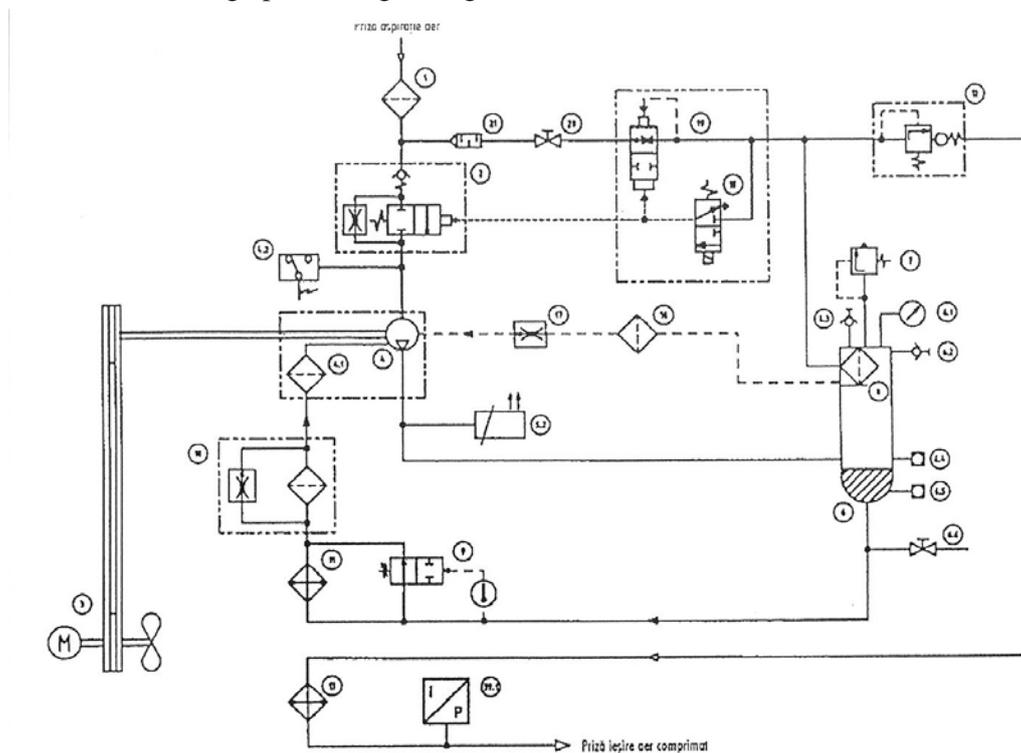


Fig.2. The pneumatic diagram of the Kaeser compressor AT 19/7,5

1- air filter; 2- intake electro valve ;3- engine; 4- compression chamber; 5- sensor; 6- separator tank cooling fluid; 7- protection valve at suppression; 8- filter cartridge; 9- temperature regulator; 10- cooling fluid filter; 11- cooling fluid radiator; 12- minimum pressure detector electro valve; 13- cooling air radiator; 14,15 – filters; 16- waste collector; 17- connecting; 18,19 - difunctional electro slide valve control / ventilation; 20- ventilation tap; 21- sound attenuator



Fig.3 The helioid compressor Kaeser – general view

3.CONCLUSIONS

In the case of the main solutions of modernisation the following conclusions can be drawn:

- replace the initial equipments making the same function at the level of the hydro-electric power plant ;
- there are equipments according with the EU legislation in force concerning industrial machines ;
- in terms of the characteristics of the rate of the falls (bathtub) the most installations are situated in infant stage or ,after case, in the maturity stage ;
- the supply with exchange parts is facilitated by the possibility of relationship with the supplier of the equipment for the wear parts and consumables ;
- they have high energy efficiency ;

- they have dynamic performance and reliability at the level of requirements imposed by current rules and regulations ;
- they have reduced dimensions than the initial and has a better accessibility to the service points ;
- due to the technological concept they present security and environmental risks much lower than the initial ;
- they are made with an attractive design and an ergonomic thinking ;
- they have the possibility of integration into the automation system of the power plant ;
- on the medium and long time the modernisation version is preferable because the effect of decrease of the maintenance costs become dominant in a longer period of time.

REFERENCES

- [1] **Exarhu , M.**, *Masini si instalatii hidraulice si pneumatice*, Editura AGIR Bucuresti 2006
- [2] **Seteanu ,I ; Vasiliu, D.**, *Mecanica fluidelor si sisteme hidraulice. Vol I si II* , Editura Tehnică Bucuresti 1998
- [3] **Sas A.** , *Raport de cercetare nr. 1 – Posibilitati de retehnologizare a instalatiilor din centralele hidroelectrice* , Petrosani 2009