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Critical Analysis and Innovation in a Context of Rehabilitation of a Complex Dam in Tunisia

***Lakhoua Mohamed Najeh* [*1]**

[1] *University of Carthage, Tunisia,*
Research Laboratory Smart Electricity & ICT, SEICT, LR18ES44.
National Engineering School of Carthage.

[*] *Coresponding author :* MohamedNajeh.Lakhoua@enicarthage.rnu.tn

ABSTRAK

After a presentation of the general context of water consumption around the world and in Tunisia, we present the water treatment in KASSEB complex (northern Tunisia). A critical analysis of the complex identifying the different innovation points was presented and a system modeling approach has been applied in the context of rehabilitation of KASSEB complex. This approach facilitates the global analysis and the production of electronic cards for the safety of the complex's pumping group.

KEYWORDS

water treatment, analysis, system modeling, safety, innovation.

INTRODUCTION

The efficiency of the productive combination of an enterprise is measured thanks to the fruitfulness. The objective of the enterprise is to improve its fruitfulness to increase its profitability. Indeed, an automated process system is a means to assure the objective primordial of an enterprise and the competitiveness of its products. It permits to add a value to the incoming products [1], [2].

The notion of the automated system can apply to a freestanding machine as well as to a unit of production, or even to a factory or a group of factories. It is therefore indispensable, before all analysis, to define the border permitting to isolate the automated system studied of its outside.

The world's population continues to grow, among the problems associated with this growth, that of freshwater needs. Over the past century, water consumption has been increasing twice as fast as the population. Today, 1.4 million people do not have access to safe drinking water. According to the United Nations forecast, this figure could rise to 2.5 million by 2025.

For the past two centuries, the world has begun to develop projects that can find solutions to this problem. Among these solutions is the construction of dams on water resources [3], [4].

In Tunisia, among the dams built are the SIDI SALEM dam, the JOUMINE dam and the KASSEB dam [5].

The KASSEB complex was built in January 1968. It is located in the KASSEB region of the North West, a distance of 20 km from the governorate of BEJA. The latter was built on a very favorable site: limestone banks marked downstream / upstream. Although geological conditions have favored the importance of the water volume of the reservoir (81 million m3), SONEDE (National Water Exploitation and Distribution Corporation) exploits the water resources of this dam to supply raw water to many treatment plants with high flows. One of these stations is the KASSEB complex which represents the site of our research [5].

PRESENTATION OF KASSEB COMPLEX

KASSEB complex (Figure 1) is fed by water from the dam from a stitching on the pipe from KASSEB to Tunis. This stitching is located at a distance of about 4km from the dam with a flow of 40l/s. The KASSEB complex is located about 300m from the stitching on the KASSEB line and about 3730m downstream from the KASSEB dam. It is broken down into two stations: a treatment station and a pumping station [5].

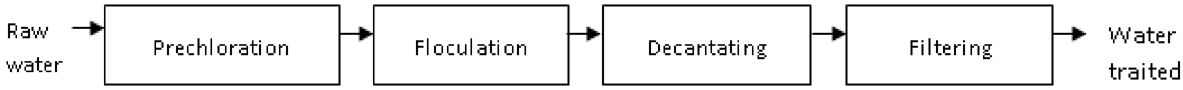
We present in the paragraph the global process of KASSEB complex (Figure 2).

Figure 1- KASSEB complex.

The treatment plant is sized to treat 40l/s (Figure 3). The water treatment process is carried out in four stages: prechloration, floculation, decanting and filtering [5].

Figure 2- Global process of KASSEB complex

Figure 3- Under- process: water treatment



Prechloration is the first stage of water treatment; it is used to inject the javel at 30 degrees into the tarpaulin of raw water, which receives water through a pipe of 300mm diameter. From the tarpaulin of raw water, the water is transported to the floculators where the second stage of treatment is carried out (floculation).

The water from the raw water tank through two weirs is treated with alumina sulfate and polyelectrolyte. The preparation of these two products is carried out in the room of the raw water tank. The flocculation is carried out in two flocculators, each made up of nine small flocculators so that the water flows sometimes at the top, sometimes at the bottom to allow continuous agitation which brings the suspended matter into contact.

At the output of the flocculators, the water is conveyed to the two settling tanks where the settling takes place. This step is used to put the flocculated water in two rectangular basins with horizontal circulation (called settlers), and to facilitate the settling of suspended particles (called flocks).

At the bottom of each settling tank, a slope of 5% facilitates the flow of sludge resulting from the settling.

On leaving the settling tanks, the water is filtered through five sand filters. Each filter is made up of filter pads; a layer of gravel of 400mm and a layer of sand of 1000mm.

After a certain period of time, the filters will become clogged and their performance gradually decreases, hence the need to wash the filters. At the end of the filtration step, the water is collected in a treated water tank through a 300mm diameter pipe where the pumping station process begins. After a certain period of time, the filters will become clogged and their performance gradually decreases, hence the need to wash the filters.

The filtered water is collected in a treated water basin. This water is conveyed to a pumping station. This basin regulates the operation of two pumping groups by creating a buffer volume between the treatment station which operates at a constant flow rate and the pump units. These groups act permanently on the treated water produced by the pumping station with a flow rate of 40l / s (20l / s for each group).

After a certain period of time, the filters will become clogged and their performance gradually decreases, hence the need to wash the filters.

The pumping station is made up on the one hand of three motor-pump units, one of which is a reserve to fill the regulation reservoirs of the cities of Amdoun, Bouaouane and Balta and, on the other hand, of two small groups, one of which is to fill the washing tank of the filters. These groups are made up of three-phase asynchronous motors and centrifugal pumps.

CRITICAL ANALYSIS OF KASSEB COMPLEX

Despite the favorable geological conditions and the good quality of the treated water, the CTEK shows some failures. We cite some:

- In the water line, there is a regulating valve to set the requested raw water flow. The control of this valve is manual. In the absence of a sensor for measuring the water flow, exact knowledge of the flow is difficult for the operator.

- The injection of the javel into the raw water tank is carried out by a douser pump at constant speed (constant flow). While the injection of this product depends on the water flow and therefore if the water flow changes, the injection rate of the javel also changes. Although the javel injection control is manual, the operator cannot perform the exact dose of this product.

- The control of the injection of the two products, aluminum sulphate and polyelectrolyte, is also manual, the operator cannot correctly dose these two products. In addition, their injection depends on the turbidity of the water.

- The washing of the filters depends on their degree of clogging in the treatment station. Indeed, the washing of the filter is carried out manually and in a time chosen by the operator. The clogging of the filter varies depending on the quality of the raw water. This also varies over time; therefore, clogging can be established in less time than the time set by the operator.

- In the two regulation tanks, we can know the water level when the tank is full, but the problem is knowing the water level when it is not full. Thus, the same situation is repeated with the wash tank.

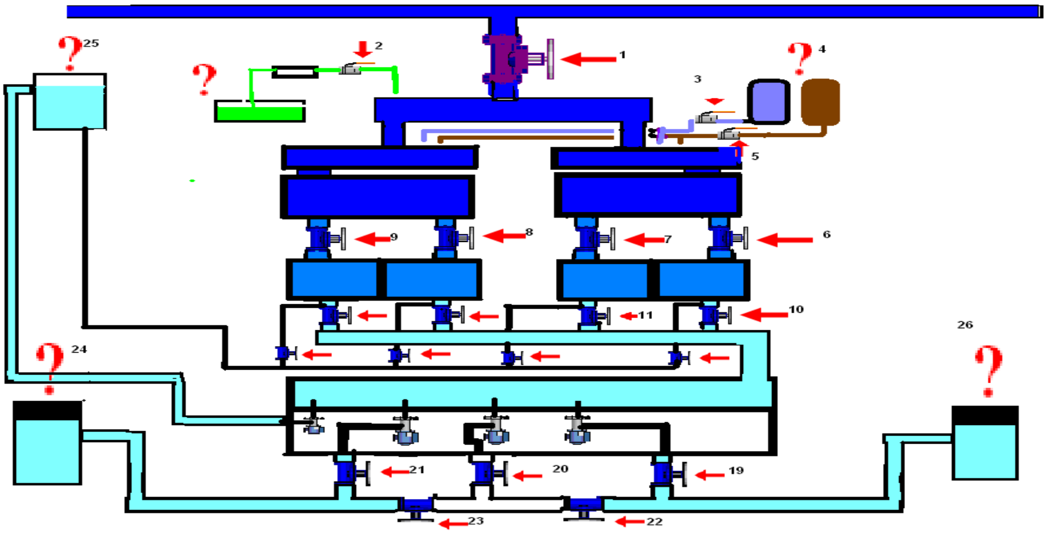
- A phase inversion protection relay is used to protect the pump against reverse operation, but the latter has several drawbacks (very expensive price, volume, detection time, electronic characteristics (motor power dependence, etc.).

In order to improve the performance and operation of KASSEB complex, it is necessary to move towards the rehabilitation of the entire complex and this by adopting a solution of automation [6], [7] and innovation of its various components [8], [9], [10].

INNOVATION OF KASSEB COMPLEX

Despite the importance of the quality of the treated water, KASSEB complex has various problems with its production system. This is why it is necessary to use techniques that can contribute to the innovation of the entire KASSEB complex (Figure 4).

Figure 4- Innovation points of KASSEB complex



Analysis system, or system approach, belongs today to the scientific current that analyzes the elements of complex processes as components of a together where they are in relationship of dependence mutual. His area of study is not limited to the mechanisation of idea [11], [12]: systemic analysis is a methodology that organizes information to optimize action.

The analysis of a process system is a complex operation. It first requires knowledge of the global working of the system and then a more and more detailed knowledge of the various components of the system. It is appropriated therefore to use a systemic approach that adjusts to this global gait and permitting to establish ties brings in means and ends on the basis of a previous analysis of problems, objectives and activities.

Automation is an important step allowing the implementation of actions to improve the efficiency and operation of the complex's equipment [13], [14], [15]. This is an important step in the control of new technical systems. This function has become widely used both by designers and operators of technical systems.

In fact, the development of a consistent information system in a production system is elemental [16], [17], [18]. Our contribution consists in improving the various components of KASSEB complex in particular the realization of electronic cards for the protection of the pumping unit on the one hand, and the modeling of the operation by GRAFCET for automation, on the other hand. This is how we first identified the various actuators and sensors in the complex.

CONCLUSION

Due to the importance of the water treatment process on the one hand and the need for fresh water for the population on the other hand, a reflection was carried out in the context of the rehabilitation of KASSEB complex. In fact, in order to improve the efficiency and operation of the complex, we have adopted a system approach for the analysis of the entire complex using a representation by block diagrams in order to situate the process in its environment. We also contributed to the analysis as well as to the modeling of the operation of the entire complex and to the production of electronic protection boards for the pumping units on the other hand.

Starting from this study of the analysis and the innovation of KASSEB complex presented in this paper, we will extend the analysis and modeling methodology to the different stations.

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