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WITH INTERNATIONAL PARTICIPATION
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MINING OF MINERALS

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THEMATIC TOPICS


2. Drilling and blasting technique, transport safety, and work safety. Ventilation of the deep open mines.

3. Information technologies, computer systems, software products in geological prospecting, surveying and mining activity.


5. Draining, stability and consolidation of slopes in open cast mines and quarries. Quarries and dumps and tailings pools.


7. Economy, organization and management of the technological processes and production in the open and underwater mining of minerals. Markets and realization of the products.

8. The mining legislation and its harmonization with European normative base. Educatonal qualification and specialization of mining experts of open cast and underwater mining minerals.
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ABSTRACT

Company EFT Mine and Thermal power plant Stanari d.o.o. planes to the end 2013. years to con: Thermal power plant with power of 420 MW in Stanari (Bosnia and Herzegovina). This paper presents analysis of choices of number and location dewatering wells from the aspect of water supply reliability of the thermal power plant in town Stanari.

Key words: Thermal power plant, Stanari, dewatering wells.

1. Introduction

For the need of reliable water supply of the future thermal power plant “Stanari”, with 420 MW output it is necessary, in order to check system’s working reliability, to perform preliminary analysis number of wells even at an early phase, so that they can provide quantity of water of about 1600 m³/h certainty.

Location of the power plant is in the central part of Republika Srpska, respectively in the northern Bosnia and Herzegovina and it is in Doboj municipality (Fig 1.).

Fig. 1. Geographical position of the mine and future power plant “Stanari”

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place where the plant should be built is a plateau on a hilly and montaneous terrain, of mostly age and steep slopes. On the south side of the exploration area which is planned for power plant there are river basins of rivers Radnja and its tributary river Ostruznja. Northern side of the network of creeks Klasnjak, Kosnjak, Radava and Lipanja. On the northern and of the envisaged location, there is a developed road network as well as the Sunja – Doboj railway:

g data obtained by the hydrogeological survey of the location of the planned thermal power plant groundwater level was constructed in the area of the future thermal power plant "Stanari" (Fig. 2.)

2. Selection of the Number of Wells

An increase of the reliability of the system of wells can be made in advance through the predicted reliability of units or by the introduction of parallel lines. When the selection and evaluation of certain reserves is done, it is necessary to determine the conditions for the normal function of the system, namely: the interval of its decrease and to determine the state of failure. For a normal system function, a value of the planned capacity (Q) is required. In the period of the state of permissible partial failure the system would provide the capacity which is not less than \( Q_d = K_d \cdot Q \). The limit value of the coefficient of reliability, which can be anything from 0 to 1, is defined based on parameters of reliability of the system \( \Phi \), the influence of working environment, factors of organization (Q) and permissible level of capacity of the system of wells within a specified time. For the value \( K_d = 0 \) total failure of the system within a time is allowed, while for \( K_d = 1 \) the decrease of the planned capacity is not allowed.
The basic type of structure of the reserve of the system reliability is using the parallel number.

Optimization is reduced to the finding of such number and arrangement of wells that at minimum level provides the necessary reliability by simultaneous operation.

The reliability of the system is increased with increasing the number of reserve lines or elements or reserve coefficient which represents the relation between conditionally set number of reserve \( N_\text{r} \) (\( N_\text{r} = N_0/N_\text{r} \)) wells \( (K = N_\text{r}/N_0) \), when the system technologically consists of \( N = N_0 + N_\text{r} \) number of wells. If the minimal number of wells whose failure causes the system failure the following relations are valid:

\[
N_\text{r} = N - M + 1, \quad i = N - N_0 + 1 = N_\text{r} + 1, \text{ so:}
\]

\[
N_\text{r} = M - 1.
\]

When the reserve is used by the principle of simultaneous function of all wells, each and even the system in function in the normal conditions has the capacity \( 0 \). The limit state before the system is the state when only conditionally essential wells \( (N_\text{r}) \) remain in function. Capacity of each well in increases to the level \( K = Q/N \). The failure of \( M \) wells leads to the system failure. In this way, the number of basic elements of system is determined based upon the value of \( Q \). Although the total is realized within the allowed limits, it is lower than planned capacity \( (Q_\text{pl} > Q) \), so that decreasing of the number of wells in function usually leads to the increase of capacity of remaining wells in function.

The remaining number of wells in the water supply system depends from the given value \( K_\text{r} \) number of possible wells with reserve is \( N = 2 \). While using the reserve of the capacity with simultaneous function of three lines or groups of wells, the capacity along each line is \( Q/N \). For \( N = 2 \) capacity of or approximately \( 0.5^*Q \). When placement is being done of any larger number of wells the initial capacity well is less than \( 0.5^*Q \). If given value \( K_\text{r} < 0.5 \), two wells allow realization of the system reserve. Work provides the function of only one well. With \( N = 3 \) the capacity of one well is \( Q/3 = 0.33^*Q \). Working such system is provided with function of any two wells \( (0.5^*Q < 0.66^*Q) \) so conditionally there are \( t \) and one backup well.

Water demand for water supply of the future thermal plant “Stanari” will be provided with functioning wells with determined optimal capacity of 8 l/s each. As determined limit value of the coefficient of utilization the reliability of function of each well from \( K_\text{r} = 0.65 \) than it is clear that two wells do not provide reliability of the reserve of the system water supply \( (0.50 < 0.65) \)

For three wells \( (N = 3) \), working state of the system is provided with function of any two \((0.65^*Q < 0.66^*Q)\) so conditionally there are two basic and one reserve well. The conditional coefficient of reserve is \( K_\text{r} = N_\text{r}/N_0 = 0.5 \).

General task of calculation of system reliability of the system of wells is to determine indicator that characterize the function. The calculation contains defining criteria and types of system failures, also indicators and determining structural schemes based on the analysis of the system, including repairing and control.

Mostly used indicators of reliability are mean time of the function until the failure of the probability of the set time, the intensity of the cancellation and renewal as well as stationary probe work. Flows crossing the state of recovery to function state, and vice versa define the transition intensity and \( (\beta) \).

The function of the system to the failure, as a continuous random value, can be described with distribution depending of the system's features and its elements, working conditions, character of failure. Simpliest and the mostly used is the exponential distribution function with the following function of distribution:

\[
F(t) = P(T < t) = 1 - \exp(-\lambda t),
\]

where: \( T \) — work duration, \( t \) — given time of work, \( \lambda \) — distribution parameter

Distribution parameter is:

\[
f(t) = dF(t)/dt = \lambda \exp(-\lambda t).
\]

Reliability function is:
\[ P(t) = 1 - F(t) = \exp(-\lambda t). \]  
(2.5)

Mean time of function until failure:
\[ t_r = \frac{1}{\lambda}. \]  
(2.6)

Failure intensity:
\[ \lambda(t) = \lambda \cdot \exp(-\lambda \cdot t). \]  
(2.7)

Structural schemes which represent graphical display of wells in the system unambiguously can define
function or failure of the system of wells. Elements of the system can be connected in a serial, parallel or
combined way. If the failure of elements simultaneously represents failure of the system the connection is
serial but if the system fails only after the failure of a part or all the elements it is the parallel type of
connection.

The system of the wells is a system that consists of \((n)\) parallely connected elements, so the probability
of the system function \(P_S(t)\) for the probabilities of function of each element \(P_i(t)\), is:
\[ P_S(t) = P_1(t) \cdot P_2(t) \cdot \ldots \cdot P_n(t) = \prod_{i=1}^{n} P_i(t). \]  
(2.8)

The group of wells is a system which consists of \((m)\) parallely connected elements, where the probability
of failure of each \(Q_j(t) = 1 - P_j(t)\), so the probability of the system failure is:
\[ Q_S(t) = Q_1(t) \cdot Q_2(t) \cdot \ldots \cdot Q_m(t) = \prod_{j=1}^{m} Q_j(t). \]  
(2.9)

Probability of the system function is:
\[ P_S(t) = 1 - \prod_{i=1}^{n} (1 - P_i(t)) = 1 - \prod_{j=1}^{m} (1 - \exp(-\lambda j t)). \]  
(2.10)

Having in mind the existence of the water reservoirs as a part of the future thermal power plant
"Stanari", for the smooth operation of 24 hours, required reliability of the system of three wells is 95%.

Reliability of function of each and every well, as a serially connected sequence of elements is:
\[ P_S = P_1 \cdot P_2 \cdot P_3 \cdot P_4 \cdot P_5 = 0.95 \cdot 0.95 \cdot 0.95 \cdot 0.95 = 0.65. \]

Where: \(P_1\) - reliability of the function of pump,  
\(P_2\) - reliability of the function of other elements of pump,  
\(P_3\) - reliability of the function of the well and complete pipeline,  
\(P_4\) - reliability of the impact of working environment,  
\(P_5\) - fail of reliability due to organizational factors.

Stationary probability of thermal power plant water supply system from three wells is:
\[ P_S = 1 - (1 - P_5)^3 = 1 - (1 - 0.65)^3 = 0.96. \]

With a group of three wells, with the reserve water tank, the possibility of the increase of capacity and
reliability of function of individual wells as needed, required safety of water supply of the future thermal power
plant "Stanari" is completely achieved.

3. Conclusion

In this work, the possibility of choice of number of wells for the reliable water supply of the future thermal
power plant "Stanari" in Stanari with capacity of around 16 l/s is explored. Optimization came down to finding such
number of wells that at the minimal level of function, by their simultaneous function provide required reliability.

Based on hydrogeological investigation data it has been concluded that the location on which the
siting of the future thermal power plant "Stanari" is planned is potentially rich with underground waters
essential for safe water supply.
With a group of three wells with capacity of 8 l/s each (one in reserve), with a reserve water possibility of the capacity increase and reliability of function of individual wells as needed, the required water supply of future thermal power plant "Stanari" is achieved completely.

Literature
