

## TRANSPORT PHENOMENA OF SULPHATE THROUGHOUT DAM LAKE SYSTEM

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### ABSTRACT

*In this study, the river Munzur, the river Pulumur, and Uzunçayır Dam Lake, ten sampling stations have been identified. For each station, in January, March and May, sulphate concentration was measured. For 120 days, every station, changing the concentration of sulphate, has been considered as the first-order reaction kinetics. Accordingly, the reaction constant  $k: 4,10 * 10^{-3} \text{ day}^{-1}$  was calculated. According to the calculated reaction constant the final sulphate concentration of each station was calculated. Experimental and calculated final sulphate concentrations were compared. For ten stations, at the end of four months, changes in sulphate concentrations shown to be identified with first-order reaction kinetics.*

**KEYWORDS:** Dam Lake, Kinetic, Modeling, Sulfate, Sulphate

### 1.INTRODUCTION

Currently, a rapidly increasing human population is causing environmental and water pollution which are the most seriously problems of our age. These problems have become more severe in Turkey.

The need for water rises due to increase, physico-chemical characteristics knew of fresh water are very important so that they could be used efficiently (Dirican, 2008).

Today, dams are being built on our important rivers particularly to gain energy. After gathering water in the dams, terrestrial and running water environments change into lacustrine environment step by step. During this period a rapid interaction between biological systems and ecological systems can be seen. It is known that Dam Lakes especially cause some changes on the chemical structure of water (World Health Organization, 2004).

Sulphate is the most important ion in water, and is deposited in it through natural means. All natural water includes sulphates. Some of the industrial waste water include higher sulphate than natural water. The reasons of sulphate existence in water are mainly because of oxidation of pyrite, dolomite

layers and also anthropogenic sources like industrial activities (Schippers at al., 1996) (Koltuniewicz and Drioli, 2008).

Sulphate compounds are important pollutants for water such as taste, toxin, smell and corrosion problems.

Sulphate, in water resources, if present in excess amounts, is one of the important issues to consider due to adverse effects on health as well aesthetic reasons such as odour and taste and economic effects resulting from corrosion of the structures (Environmental Protection Agency, 1998) (Yalcin and Guru, 2002).

The aim of this study is to identify sulphate concentration changing of surface water in the river Munzur, the river Pulumur, and Uzunçayır Dam Lake as depending time. So that the adverse health effects posed, and economic effects are be able to controlled though the developments around the river and dam.

## 2.MATERIAL METHOD

### 2.1.Experimental

Munzur and Pulumur Rivers and Dam Lake Uzunçayır determined; pre-dam, dam lake and dam areas later taking into account the ten research stations (Figure 1) have been identified.

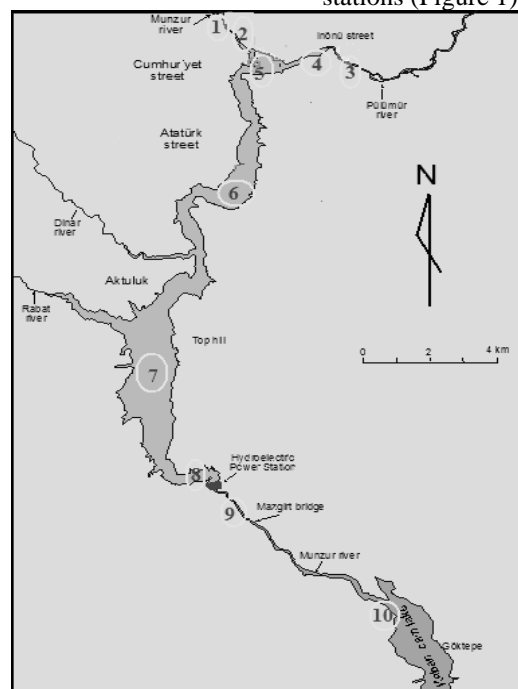


FIGURE 1- Research stations: 1.Before the residential on the Munzur River; 2. Munzur River, just before the pouring lake of dam; 3. Pulumur River, just before the garbage leachate discharge point; 4. Pulumur River, the dam just before the pouring; 5. The dam forehead, Pulumur River flows into the Munzur River just after where; 6. In the middle of dam lake, (I); 7. In the middle of dam lake, (II), 8.The dam lake, close to the part of HES; 9.Right after HES; 10. Munzur River, flows into Lake Dam in the Keban.

For the analysis of sulphate, in January-March-May seasons, the TS-5095 standard is based on each station by one litre of water. Spectrophotometric measurements were carried out in the laboratory.

### 2.2.Theoretical

According to the law of mass action, the velocity of a chemical reaction is proportional to the product of the active masses (concentrations) of the reactants. In a monomolecular reaction, i.e. one in which only a single molecular species reacts, the velocity of the reaction is proportional to the concentration of the unreacted substance (C). The change in concentration (dC) over a time interval (dT) is the velocity of the reaction (dC/dT) and is proportional to C. For infinitely small changes of concentration over infinitely small periods of time, the reaction velocity can be written in the form of a differential equation:  $-dC/dt=kC$ . Here, dC/dt is the reaction velocity, C is concentration, and k is the constant of proportionality, or monomolecular velocity constant, which uniquely characterises the reaction. The minus sign indicates that velocity

decreases with the passage of time, as the concentration of unreacted substance decreases. Plotting C against time would yield a curve of progressively decreasing slope. The mechanisms, the kinetics, described by the differential equation are termed first order kinetics because – although the exponent is not written – concentration (C) is raised to only the first power ( $C_1$ ). The differential equation above may be integrated and rearranged to yield:  $\ln(C/C_0)=kt$ , where ln indicates use of the natural logarithm, to the base e;  $C_0$  is the concentration of unreacted substance at the beginning of an observation period; t is the duration of the observation period; and k is the familiar proportionality or velocity constant. The units of k are independent of the units in which C is expressed. Since a logarithm is dimensionless and t has the dimension of time, the integrated equation balances, dimensionally, because k has the dimension of reciprocal time,  $t^{-1}$ . Notice that for observation periods of equal length, the ratio  $C/C_0$  is always the same; after equal intervals, the final concentration is a constant fraction of the starting concentration, or, in equal time intervals, constant fractions of the starting

concentration are lost, even though absolute decreases in concentration become progressively less as time passes and C becomes smaller and smaller (Anonymous, 2011).

### 3. RESULTS AND DISCUSSION

In research stations, measured sulphate concentrations depending on January-March-May seasons are set out in Figure 2.

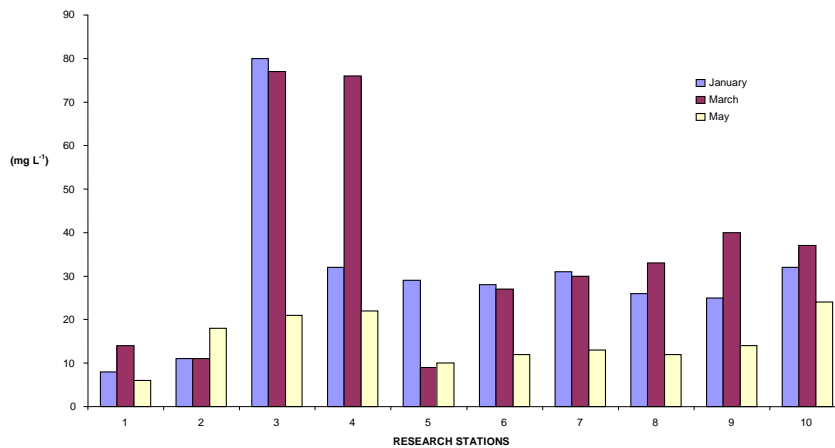


FIGURE 2 - Measured sulphate concentrations depending on January-March-May Seasons in research stations.

In research stations, measured sulphate concentrations depending on time is given in Table 1.

TABLE 1 - Sulphate concentrations of research stations depending on time.

	Research Stations									
	1	2	3	4	5	6	7	8	9	10
1. day	8	11	80	32	29	28	31	26	25	32
60. day	14	11	77	76	9	27	30	33	40	37
120. day	6	18	21	22	10	12	13	12	14	24

In January, station-3: “Pulumur River, just before the garbage leachate discharge point” has got highest  $SO_4^{-2}$  concentration (80 mg/L); station-1:” Before the residential on the Munzur River” has got lowest  $SO_4^{-2}$  concentration (8 mg/L).

In March, station-3: “Pulumur River, just before the garbage leachate discharge point” has got highest  $SO_4^{-2}$  concentration (77 mg/L); station-5:” The dam forehead, Pulumur River flows into the Munzur River just after where” has the lowest  $SO_4^{-2}$  concentration (9 mg/L).

In May, station-10:” Munzur River, flows into Lake Dam in the Keban” has got highest  $SO_4^{-2}$  concentration (24 mg/L); station-1:” Before the residential on the Munzur River” has the lowest  $SO_4^{-2}$  concentration (6 mg/L).

The highest sulphate concentration is 80 mg/L in station-3 : Pulumur River, just before the garbage leachate discharge point” in January.

The lowest sulphate concentration is 6 mg/L in station-1:” Before the residential on the Munzur River” in May.

For kinetic analysis of reaction time of 120 days (60 +60) was time. During this period, the change in sulphate concentration, assuming first-order reaction with the changes (decomposition), the kinetic constants were calculated at each point (Table 2).

For each kinetic constant, the final sulphate concentrations that may occur in May season were calculated. For  $k_2 = 4.10 \times 10^{-3} \text{ day}^{-1}$  (station-2:

“Munzur River, just before the pouring lake of dam”) the calculated concentrations (assuming decomposition) in May, which measured values

are close to the actual sulphate concentrations were determined (Table 3., Figure 3).

TABLE 2 - Calculated reaction kinetic constants depending research stations

Kinetic Constants	day <sup>-1</sup>	Means	day <sup>-1</sup>
k <sub>1-1</sub>	9.33·10 <sup>-3</sup>	k <sub>1</sub>	-2.40·10 <sup>-3</sup>
k <sub>1-2</sub>	-1.41·10 <sup>-2</sup>		
k <sub>2-1</sub>	0	k <sub>2</sub>	4.10·10 <sup>-3</sup>
k <sub>2-2</sub>	8.21·10 <sup>-3</sup>		
k <sub>3-1</sub>	-6.37·10 <sup>-4</sup>	k <sub>3</sub>	-1.11·10 <sup>-2</sup>
k <sub>3-2</sub>	-2.17·10 <sup>-2</sup>		
k <sub>4-1</sub>	1.44·10 <sup>-2</sup>	k <sub>4</sub>	-3.12·10 <sup>-2</sup>
k <sub>4-2</sub>	-2.07·10 <sup>-2</sup>		
k <sub>5-1</sub>	-1.95·10 <sup>-2</sup>	k <sub>5</sub>	-8.87·10 <sup>-3</sup>
k <sub>5-2</sub>	1.76·10 <sup>-3</sup>		
k <sub>6-1</sub>	-6.06·10 <sup>-4</sup>	k <sub>6</sub>	-7.06·10 <sup>-3</sup>
k <sub>6-2</sub>	-1.35·10 <sup>-2</sup>		
k <sub>7-1</sub>	-5.46·10 <sup>-4</sup>	k <sub>7</sub>	-7.24·10 <sup>-3</sup>
k <sub>7-2</sub>	-1.39·10 <sup>-2</sup>		
k <sub>8-1</sub>	3.97·10 <sup>-3</sup>	k <sub>8</sub>	-6.44·10 <sup>-3</sup>
k <sub>8-2</sub>	-1.69·10 <sup>-2</sup>		
k <sub>9-1</sub>	7.83·10 <sup>-3</sup>	k <sub>9</sub>	-4.83·10 <sup>-3</sup>
k <sub>9-2</sub>	-1.75·10 <sup>-2</sup>		
k <sub>10-1</sub>	2.42·10 <sup>-3</sup>	k <sub>10</sub>	-2.40·10 <sup>-3</sup>
k <sub>10-2</sub>	-7.21·10 <sup>-3</sup>		

TABLE 3 - Calculated sulphate concentrations (k<sub>2</sub>=4.10 \* 10<sup>-3</sup> day<sup>-1</sup>) and measured sulphate concentrations in final season .

	Research Stations									
	1	2	3	4	5	6	7	8	9	10
Teoritical (composition) concentration (mg L <sup>-1</sup> )	13.09	18.00	130.91	52.36	47.45	45.82	50.73	42.55	40.91	52.36
Teoritical (decomposition) concentration (mg L <sup>-1</sup> )	4.89	6.72	48.89	19.56	17.72	17.11	18.94	15.89	15.28	19.56
Experimental measured concentration (mg L <sup>-1</sup> )	6	18	21	22	10	12	13	12	14	24

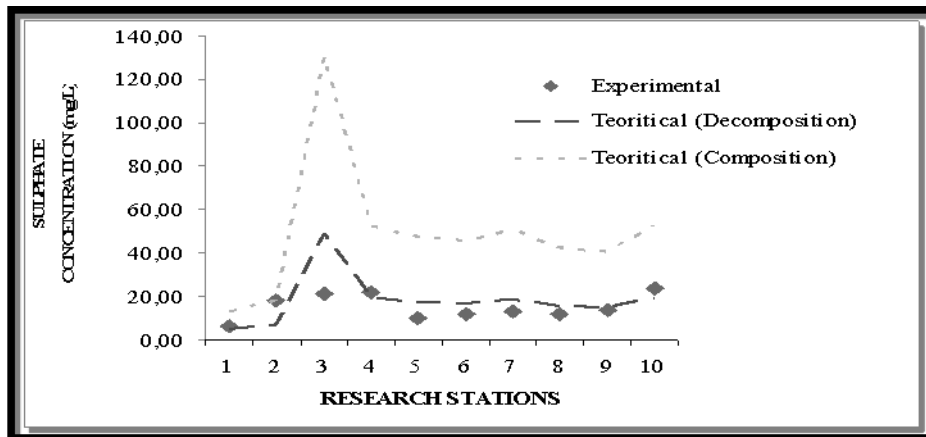


FIGURE 3 - Comparison measured sulphate concentrations with calculated sulphate concentrations ( $k_2=4.10 \cdot 10^{-3} \text{ day}^{-1}$ )

#### 4. CONCLUSION

Station-2: "Munzur River, just before the pouring lake of dam" kinetic is very important during all stations. Because the sulphate decomposition kinetic of this station is be able to identify sulphate decomposition kinetics of other stations (Figure3).

If Station-2 is characterised well as physical, chemical and biological, sulphate concentration decomposition can be identified well during Munzur River, Pulumur River and Uzuncayir Dam Lake.

So that it is be able to discussed about the sulphate content of rivers and dam lake water, and using area.

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