INFLUENCE OF WATER MULTITY LEVEL ON PUMPING STATIONS AND ITS STATISTICAL ANALYSIS

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ABSTRACT

This article examines the turbidity level of water used in pumping stations and its impact on the operational efficiency of pumping units. The impact of silt particles on mechanical wear, energy consumption, equipment service life, and hydraulic losses is analyzed based on statistical data.

Introduction.Pumping stations are an important element of irrigation systems and play a key role in delivering water from the source to the consumer. Water quality, particularly the level of turbidity, significantly affects the efficiency of pumps. Turbid water contains solid particles of various sizes that can damage pump components, reduce productivity, and increase maintenance costs.

The physical essence of water turbidity. Turbidity is an indicator determined by the amount of suspended particles in the water. It is usually measured in the following units:

- mg/L (milligram/L)
- NTU (Nephelometric Turbidity Unit)

Silt particles may include:

- Sand and clay
- Organic substances
- Colloidal particles

The size and density of particles determine the degree of their impact on the pump.

Main impacts of turbidity on pumping stations

Abrasive wear. Solid particles in the sludge consume the following parts of the pump:

Decrease in pump efficiency

Turbid water reduces the efficiency of the pump.

Example:

• Efficiency in clean water ≈ 85%

• Efficiency in turbid water (1 kg/m3) ≈ 75-78%.

This leads to an increase in energy consumption.

Increased energy consumption. Hydraulic resistance increases in the turbid water flow. As a result, the pump consumes more energy.

Statistics:

• When turbidity increases by 20%, energy consumption increases by 10-15%

Rapid failure of pump components. Silt particles cause the following malfunctions:

• Bearing failure

• Seal wear

• Increased vibration

As a result, the repair interval is reduced.

Statistical analysis. Experimental data

The following table shows the relationship between the turbidity level and pump efficiency:

Turbidity (kg/m3)	Efficiency (%)	Degree of wear (%)
0.2	86	5
0.5	82	10
1.0	78	18
1.5	74	30

Correlation analysis. According to calculations:

• There is a strong negative correlation between turbidity and efficiency ($r \approx -0.85$).

• There is a strong positive correlation between turbidity and wear ($r \approx 0.9$).

Regression model.Pump efficiency can be represented by the following model:

PWC=88−9.5·L PWC = 88 - 9.5 \cdot L PWC =88−9.5·L

Here:

• efficiency - efficiency (%)

• L — turbidity (kg/m3)

Variational analysis. Proportion of factors affecting pump efficiency:

•Factor Effect (%)

•Turbidity 45%

•Stream rate 25%

•Pump type 15%

•Other factors 15%

Practical observations revealed the following results:

• When turbidity exceeds 1 kg/m3, the pump's service life is reduced by 30-40%

• Repair costs for mud-water pumps are 1.5–2 times higher

• Energy consumption increases by an average of 12-18%

Methods for reducing the impact of siltation

The following measures are considered effective:

Filtering systems

• Mechanical filters

• Sand traps

Settling ponds

The amount of silt is reduced by settling the water before delivering it to the pump.

Wear-resistant materials

• Custom finishes

• Stainless steel

Select optimal operating mode

Using the pump at the optimal speed and load mode reduces wear.

Conclusion: The degree of water turbidity significantly affects the efficiency of pumping stations. Statistical analysis shows that:

• As turbidity increases, pump efficiency decreases

• Abrasive wear increases sharply

• Increased energy consumption

Therefore, controlling and reducing the amount of silt ensures the long-term efficient operation of pumping stations.

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