Conditions for the Effective Use of Anti-Filtration Coating Types in Uncoated Channels

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ABSTRACT

The proper consideration of the filtration process is one of the most significant and challenging challenges in the design of earthen channels. The hydraulic properties of the current channels and the makeup of the channel soil must be considered in order to lower the cost of filtration in unlined channels. The quantity of filtration taking place in the soil bed is calculated when both sides of the channel are coated with concrete. Additionally, it was shown that utilizing a screen constructed of the local raw bentonite clay as an anti-filter coating in unlined channels can greatly minimize the amount of filtration, based on the measured values. The article outlines how to choose a theoretical foundation in the right way for reducing filtration costs.

KEYWORDS: *Channel, soil, filtration, flow, coatings, hydraulic parameters, water, seepage, flow, bentonite, concrete, bitumen, clay, etc.*

Introduction

Important global concerns include lowering the costs associated with building and running subsurface irrigation networks, guaranteeing their technical dependability, minimizing filtering procedures, and improving the effectiveness of water resource usage. In this regard, a lot of focus is being put on the creation of techniques for improving the operational dependability of channels and decreasing the filtration process. [9]

One of the most pressing challenges, in particular, is the study of filtration processes and the creation of specific, effective techniques connected to lowering filtration consumption in canals and raising the effectiveness of main canals.

In order to carry out the duties outlined in other regulatory law documents relating to this activity, the Cabinet of Ministers continues to prioritize the prevention and reduction of filtering processes in uncoated canals. Today, a variety of operational, engineering, and constructive solutions are used to mitigate water losses caused by filtering from irrigation canals. A generalized complex of modern

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measures, recommendations and technical solutions for reducing water lost due to filtration is being developed to increase the efficiency and reliability of the channels. [1]

Methodology

The typical amounts of water lost each year as a result of filtering in the canals are now A.N. The following empirical formulas were presented by Kostyakov to calculate water losses for 1 km of canal length based on processing data of the results of direct observation of water losses from canals (increase of the groundwater level). [1,2]

In highly permeable soils

$$\sigma = \frac{3.4}{Q^{0.5}} \tag{1}$$

In moderately permeable soils

$$\sigma = \frac{1.9}{Q^{0.4}} \tag{2}$$

In impermeable soils

$$\sigma = \frac{0.7}{Q^{0.3}} \tag{3}$$

According to the results of calculations using these formulas, Table 1 shows these relative losses per 1 km of channel length in % of flow rate *Q*. [1,2,4]

Table 1

Q m³/*sec*	Water loss in soils σ %			Q m³/*sec*	Water loss in soils σ %		
	High conductivity chan	**Medium transmission chan**	**Low conductivity**		**High conductivity chan**	**Medium permeable**	**Low permeability**
0,5	4,82	2,51	0,86	10	1,08	0,76	0,35
1	3,4	1,9	0,7	15	0,88	0,64	0,31
2	2,4	1,44	0,58	20	0,76	0,57	0,29
3	1,96	1,23	0,5	30	0,62	0,49	0,25
5	1 ,54	1	0,43	50	0,48	0,4	0,22
8	1,2	0,83	0,38	100	0,34	0,31	0,18

It is necessary to correct the amount of filtration obtained in places where groundwater is not very deep, by adding the following correction coefficients: [2,10]

Table 2

Water consumption in the canal m³/s	**The depth of underground water. m**					
	2-2,5	**3**	**5**	**7,5**	**10**	**15**
0,3	0,82	-	-	-	-	-
1,0	0,63	0,79	-	-	-	-
3,0	0,5	0,63	0,82	-	-	-
10,0	0,41	0,5	0,65	0,79	0,91	-

20,0	0,36	0,45	0,57	0,71	0,82	-
30,	0,35	0,42	0,54	0,66	0,77	0,94
50,0	0,32	0,37	0,49	0,60	0,69	0,84
100	0,28	0,33	0,42	0,52	0,58	0,73

The largest rates of filtration losses from canals are seen in the early years of operation, when the groundwater level along the canal reaches its peak level, according to many years of experience operating trunk canals. As the lowest groundwater table rises and pavement cracks and joints become plugged, the value of seepage losses reduces over time. [9,10]

Using N.N. Pavlovsky's formula, we may calculate the filtration losses in channels with continuous circulation in channels with soil cores: [2,4,6]

For channels with a trapezoidal shape $\frac{b}{h} < 4$

$$Q_f = 0.0116 k_f \mu (B + 2h) \quad (4)$$

If then $\frac{b}{h} > 4$

$$Q_f = 0.0116 k_f \mu (B + A * h) \quad (5)$$

here:

Q_f = 1 km seepage waste water consumption in the length of the channel, m^3/s

k_f - is the creep coefficient of the ground soil below the channel, m /sut

B - the width of the channel in the water section, m,

b - width along the bottom of the channel, m,

h - depth of water in the canal, м

μ and A – the coefficient of consideration of the flow to the side, (is determined according to the table).

Coatings can be split into two primary categories based on the types of anti-filtration coating that unlined channels have and how they are used:

1) protection - protection of the bottom and slopes of the channel from erosion and mechanical damage by washing and floating objects; fasteners made of stone and reinforced concrete slabs belong to this type of coating;

2) impermeable - with the main purpose of reducing filtration losses, they include: clomatage, screens made of polymer materials and compacted soil, asphalt-concrete and bituminous coatings, poured concrete, concrete and reinforced concrete coatings.

The operational circumstances, as well as the technical and financial features of the channel, are the key determinants of coating type.

For the following reasons, it is advised to install concrete covers in unlined channels: a) to reduce water loss due to filtration; b) to prevent waterlogging and secondary salinization of lands; c) to prevent channel bed deformation; g) to increase the size of the channel by reducing its roughness; d) to improve the channel's working conditions; and e) to use in water supply channels to improve water quality. [2,5,9]

The following approximate symbols for pre-calculation can be used to determine the filtration coefficients based on the type and properties of the soil: [6,11]

- Dense clays -0,01 m/day

- Clay and heavy sandy soils -0,01-0,05 m/day
- Average sandy soils -0,05-0,1 m/day
- Light sandy soils -0,1-0,4 m/day
- Supes -0,4-0,6 m/day
- Dusty sands -0,6-1,0 m/day
- Fine sands -1,0-3,0 m/day
- Sand-gravel soils -3,0-5,0 m/day
- Gravel-pebble soils - 5,0 more than m/day

The properties of the soil composing the channel bed, the geological-engineering and hydrogeological conditions, the dimensions of the channels, and other factors must be taken into consideration while selecting the type of anti-filtration measures or coating.

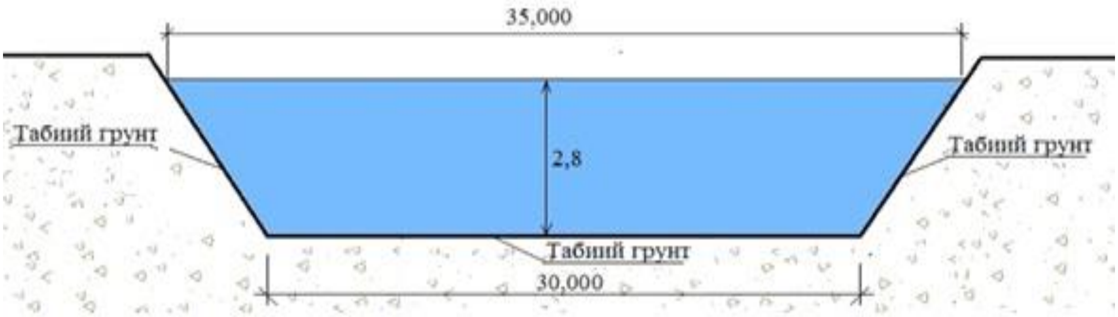
The following numbers for various anti-filtration measures describe the estimated value of lowering the volume of filtration losses: [6,11]

- cover with poured concrete - 70-80 percent
- precast concrete - 65-70 percent
- concrete-film coatings - 95-98 percent
- polyethylene film screens - 60-98 percent
- Mud screens - 60-70 percent
- asphalt concrete - 75-85 percent
- chemical processing - 50-70 percent
- artificial clomatage - 30-50 percent
- Bentonite coating - 80-90 percent
- deep compaction in soils connecting channel beds - 50-60 percent

When the channel bed is designed in highly permeable soils, they allow to reduce water wastage by up to 90-95% and last for many years. Covering the channel bed with concrete covers is primarily used in systems where water is very scarce, in system parts and structures where water speed control is necessary, and when the channel bed is necessary. In medium soils, concrete covers should be 7 to 15 cm thick; in loose soils, they should be 18 to 20 cm thick. Reinforced concrete coverings and slabs should be laid with a thickness of 5-8 cm. The slope of the channel's side wall is between one and five. The structural seams (per 3–4 m) and (each 10–12 m) are typically filled with bitumen and mastic. [2,6]

Results

Since the cross section of the ShFMK channel $Q_f = 0.0116 k_f (B + Ah)$ is primarily trapezoidal, $\frac{b}{h} > 4$ uncoated channels are used as a research subject in an effort to reduce the filtration process. The filtration consumption is calculated using the formula. [6,9]



1-расм. Қопламасиз тупроқ ўзанли канал кесими.

Ўтказилган тадқиқот ва ҳисоб ишлари натижаларига асосан бир погонометр канал узунлиги учун фильтрация сарф миқдори 1 км канал узунлиги бўйича миқдорда сув исроф бўлаётганлиги аниқланди.

Каналнинг икки чети бетон қопламали тупроқ ўзанли участкаларида сувнинг чуқурлиги 3,0 м ёки сарфи 50 м^3/с дан ортиқ бўлган каналларда бетон қопламалар қалинлиги музлаш ва тўлқинлар таъсири каби барча юкланишларни ҳисобга олган холдаги хисоб-китоблар билан аниқланади.

Based on the results of research and calculations, it was found that the amount of filtration consumption for one meter of channel length is $Q_f=3,8*10^{-2} м^3/с$ 1 km of channel length and amount $Q_f=0,38 м^3/с$ of water is being wasted.

Calculations that account for all loads, such as freezing and wave action, are used to determine the thickness of concrete linings in channels with a water depth of 3.0 m or a flow rate of more than 50 m^3/s on both sides of the channel.

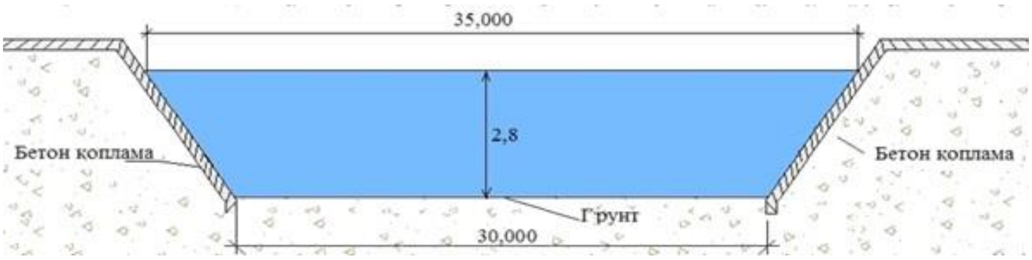


Figure 2. The bottom part of the channel is covered with concrete on both sides.

It was determined that the amount of filtration consumption for one meter of channel length is $Q_f=2,7*10^{-2} м^3/с$ and $Q_f=0,27 м^3/с$ amount of water is being wasted for 1 km of channel length.

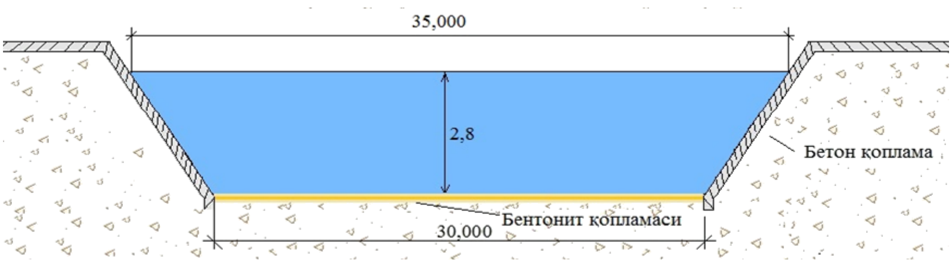


Figure 3. Channel section with bentonite coating on both sides of the concrete bottom.

It was determined that the amount of filtration consumption for one meter of channel length is $Q_f=0,013*10^{-2} м^3/с$, and it is possible to reduce water consumption by $Q_f=0,013 м^3/с$ per 1 km of channel length.

The Northern Fergana Main Canal's sections 2-3 underwent research, and the findings showed that the channel bed's filtration consumption was measured at a distance of 4173 meters in the second section. Based on the calculations, it was discovered that Q_f^{grun}=99357 m^3/day of water is lost from the soil.

The implementation of the anti-filtration screen technology using the local raw material bentonite clay, according to the research findings, resulted in a reduction of Q_f^{bent}=4632 m^3/day in the filtration in the uncoated canals. Economic efficiency at the research object's distance, L=4173 m, results in a total water saving of Q_{iq}=94725 m3/day. (Table 3). We can irrigate 4-4.5 thousand hectares of cultivated land during the vegetative period, as shown by the computation of water saved.

Table 3.

Picket	L	Δb	ω_f	$K_f^б$	Q_f^{gr} sutka	$Q_f^б$ sutka	Q_{iqt} m^3/sut
PK 396+00							
	1500	30	45000	0,037	34560	1665	32895
PK 411+00							
	1500	30	45000	0,037	35424	1665	33759
PK 426+74							
	1173	30	35190	0,037	29373	1302	28071
Total					**99357**	**4632**	**94725**

Conclusion

As a summary of the research, we can state that the application of the anti-filtration screen method using local raw bentonite clay results in a significant reduction in the quantity of filtration in unlined channels. Since the project does not contain the concrete channel bed, it is necessary to soften the bed by 10 to 15 cm for this purpose. Applying Fergana region Logon bentonite clay in the amount of 8 kg per 1 m^2 up to 3-5 cm is done prior to softening. Then the soil is softened with the help of a cultivator to 10-15 cm. 4 kg of bentonite clay is sprinkled on the softened surface up to 2 cm per 1 m^2 and plastered with the help of existing technical machines. This method reduces the filtration process in the canal bed by 80-90%.

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