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Sewage treatment as viewed from both water conservation and solid separation

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ABSTRACT; A city's water supply and sewerage system can be compared to blood circulation. In the human body, the kidneys remove the waste products from the blood stream, whereas in the city, the treatment plant is utilized to separate the solids from the sewage. The kidneys, in fact, are not only to remove the waste, but also to recover the treated water for reuse. For total environmental protection, we need therefore, on the one hand, to treat the sewage with advanced technologies to meet the criteria for various reuses while, on the other, the additional quantity of separated solids are also required to be treated and disposed of properly. To treat the solids known as sludge, the first concern is to reduce its water contents. In the present paper, sludge dewatering is evaluated from the aspects of the filtrate quality as well as its quantity, and a study is made of a comparison of the filtrate quality between pressure and vacuum filtration.

KEY WORDS; sewage treatment, water conservation, solid separation

1. Introduction

As in the city, there is an inpounding reservoir (the vena cava) in the human body, pumped by the heart. The heart has two parts, right and left. In the city, the right part is called a low-lift pump, to pump the in-take water to the purification plant, the lung of the body. In fresh form, the blood is pumped again by the heart to the aorta, but this time it is done by the left part, a high lift pump.The aorta is, in fact, an elevated tank giving pressure to the arteries, which are followed by the capillary system (water distribution system).

Thereafter, the used blood is treated by the kidneys as well as the liver. From an environmental engineer's view, the kidneys can be considered as sewage treatment plants, while the liver, an industrial wastewater treatment facility.

At the kidneys, waste products contained in the blood stream are removed in the form of urine. The blood after passing through the "treatment plant," i.e. the kidneys, returns to the vena cava via veins. The blood is then pumped to the lungs again where it becomes oxygenated for reuse (Fig.1).[1)]

The above shows nature's way of reuse, and man's technology can do it too with city's sewage treatment and water conservation.

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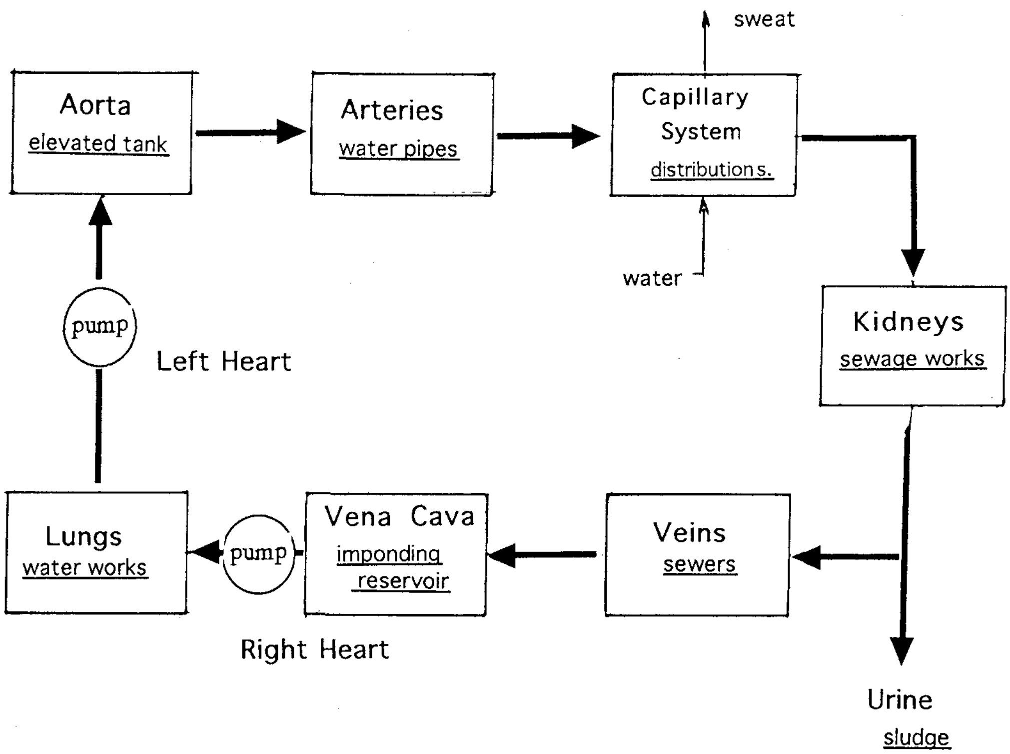

Fig.1 An environmental engineer's view on blood circulation

Water is a city's life blood. Water in a city maintains human's activity, just as blood within a human body sustains life. In view of the growing water demand and the limit of nature's water supply in many municipalities of the world, it is important that recycling and reuse of city's wastewater be conducted as the way of body's blood circulation.

As in blood circulation, if a goal of complete water reuse with no discharge of treated wastewater can be attained, then the sewage treatment system will be environment-sound. The only escape from the system is sludge, which is the solids separated from the treated wastewater, being equivalent to the urine separated from the blood stream.

In this regard, an optimum conceptual design for the city's sewage treatment is that both water conservation and solid separation be considered together as a single system, since a high level of solid separation will certainly lead to a high quality of recycled water.

To optimize the solid separation system, a subsystem such as sludge dewatering is needed to be evaluated from its side effects on the total water environment. To really evaluate the sludge dewatering process, analysis should include, among other things, the quality of the filtrate, which eventually enters into the water stream.

2. Solids separation in the sewage treatment system

Sewage, which is essentially a water consisting of solids, is said to have been treated when the solids were separated from the water. In a series of conventional treatment processes, solids are firstly removed from settling tanks as sludge, which is then concentrated by thickening, dewatering, and drying.

In an ideal treatment, the sludge is dewatered to a final dry cake for disposal, while the water removed is entirely conserved for reuse. In this regard, it will be most environment-sound that the final sludge cake obtained is completely dried to give a minimum volume, whereas the removed water is large in its amount and clean in its quality.

Sludge dewatering can be done either with chemical conditioning or without. From the viewpoint of environmental water quality protection, the process without chemicals should be a better choice, and therefore, sludge dewatering in the present study was made completely without chemical addition.

3. Sludge dewatering subsystem

Solids separated from the wastewater in the form of sludge usually has a high content of water ranging from about 90 to 99%. Therefore, the primary concern following solid separation from the wastewater is dewatering.

In sludge dewatering, attention has been paid traditionally only to the decrease in moisture content of the sludge. Considering a total environmental conservation, it is suggested that attention is also needed to be paid to the quality of water removed.

To investigate how the methods of dewatering affect the quality of water removed, two methods of mechanical dewatering by filtration, i.e., the pressure and vacuum filtrations, were compared for its filtrate quality based on an analysis of the factors involved in the dewatering. Suspended solids(SS) was employed as a parameter of the filtrate quality.

Dewatering factors were given as: (1) type of filter media, (2) sludge layer thickness, and (3) applied pressure or vacuum. The three factors were each given three levels, resulting in a total of 27 combinations.

Both filtration experiments were made at a random order with a constant filtration time of 60 min. The characteristics of the sample sludge were: total solid 3.3% (of which 79.6%, volatile), suspended solids 3.0%, specific electric conductivity 2,800 μS/cm, alkalinity 580 mg/l, and pH 6.0.

In the 27 experimental runs (Table 1), the filtrate SS as obtained with pressure filtration ranged from 0.30 to 2.00%, whereas for vacuum filtration it varied between 0.03 and 1.30%. Vacuum filtration gave better filtrate quality than pressure filtration in 26 experimental runs out of a total of 27.[2)]

As generally recognized, the improvement of filtrate quality was accomplished at the expense of the amount of water removed. However, it was not the case for vacuum filtration as compärared to pressure filtration. For example, to obtain the same amount of filtrate volume of about 50 cu. cm, the filtrate SS was 1.3% while

Table 1. A comparison of filtrate between the pressure and vacuum filtrations

No.	Type of filter cloth		Sludge layer thickness (mm)		Filtration pressure (MPa)		Suspended solids (%)	
	PF	VF	PF	VF	PF	VF	PF	VF
1	β		10		0.03		0.73	0.076
2	β		10		0.06		0.34	0.100
3	β		10		0.1		0.78	0.760
4	γ		10		0.03		0.54	0.078
5	γ		10		0.06		0.53	0.180
6	γ		10		0.1		0.58	0.930
7	β		20		0.03		0.38	0.066
8	β		20		0.06		1.20	0.038
9	β		20		0.1		0.96	0.410
10	γ		20		0.03		0.52	0.052
11	γ		20		0.06		0.95	0.280
12	γ		20		0.13		1.10	0.650
13	β		30		0.03		0.71	0.078
14	β		30		0.06		0.78	0.062
15	β		30		0.1		1.60	0.210
16	γ		30		0.03		0.76	0.066
17	γ		30		0.06		0.62	0.210
18	γ		30		0.1		1.70	0.570
19	α		10		0.05		1.40	0.310
20	α		10		0.06		2.00	0.420
21	α		10		0.1		1.50	1.200
22	α		20		0.03		1.50	0.032
23	α		20		0.06		1.70	0.450
24	α		20		0.1		1.90	1.100
25	α		30		0.03		1.10	0.140
26	α		30		0.06		1.00	0.140
27	α		30		0.1		2.00	1.300

PF : Pressure filter
VF : Vacuum filter

Filter cloth specification
α : PF – 8044
β : PF – 401
γ : P – 2088

it was as high as 2.0% for pressure filtration. The results showed that vacuum filtration was better than pressure filtration in terms of total environmental water conservation.

The above investigation was considered only as a preliminary study of the dewatering subsystem where no chemicals were added. However, it is a common practice to add chemicals for the kind of sludge dewatering. Chemical addition not only causes increase in sludge volume, but also tends to release chemical components into the water removed from the sludge. Nevertheless, studies of the subsystem needs also extending to the dewatering with chemical addition. In the meantime, options other than mechanical means should be included in the dewatering evaluation.

4. Concluding remarks

In an ordinary sewage treatment, many attempts have been made toward the system's optimization, however there are very few instances on the optimization of the sludge treatment subsystems.

Besides sludge dewatering, there are many other subsystems with respect to sludge management. In this connection, a paper entitled "Optimum paths of sludge management: a conceptual design for sewage treatment as viewed from total environmental conservation" was presented.[3)]

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