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Water cleaning test in Aral Sea Region with the purpose of obtaining drinking and irrigation waters.

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Abstract

Almost all states of the Middle Asia faced with a deficiency of fresh water. The problem of the fresh water, especially, drinking water has been a major concern in the Aral Sea region, where desiccation of the Aral Sea has become an ecological catastrophe. Deficiency of the quality drinking water is due to the fact of inaccessibility and the poor quality of water from the natural sources, but also due to the poor water treatment technologies in the major cities of the region. Within the framework of the project "*Improvement of the quality of drinking and irrigation water in the Aral Sea region by cleaning equipment and sorbents produced in the Czech Republic*" testing of various types of water treatment technologies has been conducted in order to find the most advantageous method of water treatment, taking into account the quality of the water but also considering the maintenance costs of the equipment.
In order to take into account the various seasonal changes of preliminary characters of the water, the testing of the water treatment equipment has been conducted during the winter and summer times of 2006.
As a result of these testing and lab analysis the optimal water treatment method has been found, which can be used in the region.

Keywords: Aral Sea region, drinking and irrigation water, water treatment technologies, reverse osmosis, dissolved substances.

INTRODUCTION

Republic of Uzbekistan is one of the countries in Central Asia. The population of the country is 26.800.000 and the area is 447,400 km^2. Uzbekistan is a dry, landlocked country of which 11% consists of intensely cultivated, irrigated river valleys. More than 60% of its population lives in densely populated rural communities.
Uzbekistan is now the world's second-largest cotton exporter and fifth largest producer; it relies heavily on cotton production as the major source of export earnings. Other major export earners include gold, natural gas, and oil.
At present, the main environmental problem of not Uzbekistan only but of the Central Asia region is desiccation of Aral Sea and it consequences.
The Aral Sea, once the fourth largest lake in the world, has shrunk more than 60% since 1960, because of the massive cotton irrigation. Drying-out of the Aral Sea is resulting in growing

concentrations of chemical pesticides and natural salts; these substances are then blown from the increasingly exposed lake bed and contribute to desertification.

The main sources of contaminate solution came from:

- Industrial wastes. (The government estimated in 1995 that only 230 of the country's 8,000 industrial enterprises were following pollution control standards)
- Buried nuclear processing. (Uranium is mined and processed near the overpopulated Ferghana Valley)
- Agricultural chemicals.

Large-scale use of chemicals for cotton cultivation, inefficient irrigation systems, and poor drainage systems are examples of the conditions that led to a high filtration of salinized and contaminated water back into the soil. As a result, the supply of fresh water has received further contaminants. An official in Uzbekistan's Ministry of Environment estimated that about half of the country's population lives in regions where the water is severely polluted.

Poor water management and heavy use of agricultural chemicals also have polluted the air. Salt and dust storms and the spraying of pesticides and defoliants for the cotton crop have led to severe degradation of air quality in rural areas.

The degradation of the Aral Sea area has also reduced habitat and species diversity in Central Asia. In 1960, the Aral Sea region was the home of 70 species of mammals—now, 32 species of mammals; 310 species of birds – at present, 160 species of birds; 5 - 7 kinds of livestock fodder no longer grow in region.

Each year, wind whips 45 million metric tons of salty and contaminated dust into the air, contributing to health problems such as respiratory infections, tuberculosis, anemia, kidney diseases, diarrhea and cancer. This massive environmental disaster affects about five million people.

It is possible to reduce an environmental impact on the health of Aral Sea region population by improving the access of population to safe drinking water. Building of the municipal water treatment plants requires heavy capital investments and Uzbekistan with transition economy is not ready for it yet. And that’s why the organization of network for small water treatment facilities is one of the possible ways to improve the situation, and a widely distribution of household water treatment devices to population as well.

MATERIALS AND METHODS

Since the year 2004, the Institute of Tropics and Subtropics bas been implementing the development project in Uzbekistan on „Improvement of the Quality of Drinking and Irrigational Water in the Aral Sea Region by Cleaning equipment and sorbents produced in the Czech Republic“.The main aims of the project are the development of small water treatment facilities infrastructure, improvement of water management and environmental protection, and improvement of safe water supply to the Aral Sea region.

Within the framework of the project testing of various types of water treatment technologies has been conducted in order to find the most advantageous method of water treatment, taking into account the quality of the water, but also considering the maintenance costs of the equipment.

For this purpose the Mobile Experimental Station is used. MES is a railway container that has an equipped laboratory and testing water treatment devices which are used for laboratorial analyses and treatment of chosen water samples.

Methodology

The methodology used in the research:

1) Collection of water samples from some of the chosen places in Khorezm and Aral Sea region.

2) Laboratory analyses of these samples in Mobile Experimental Station, definition of water chemical composition and the level of its pollution.
3) A water sample was treated by every water cleaning device, and then already treated water was re-analyzed.
4) At the end, there was made an evaluation of water cleaning devices' efficiency.

In order to foresee possible seasonal changes of monitored water parameters, the testing of the water treatment equipment was done in winter and summer of 2006.

Places of samples collection
For water sampling there have been chosen the following places in Khorezm and Karakalpakstan:
- Muynak town – water well (Azhinets str.91);
- Nukus town, the capital of the autonomic Republic of Karakalpakstan – irrigational canal, the water supply of the Republican children anti-TB sanatorium;
- Urgench town – water well, water pipes, irrigation canal.

Monitored water characteristics
The main water characteristics in the research were following: magnesium (Mg), calcium (Ca), chlorides, sulfates, dissolved substances, pH, temperature and conductivity.

Testing water treatment equipment
During these experiments the following equipment was used:
ELEKO - Electro-coagulation unit for drinking and pool water treatment. This unit works without any chemical or biochemical substances and can be used for drinking water treatment, pool water treatment or as a coagulation unit within EGGIS technology line.
EGGIS - Electropulse wastewater treatment system. The EGGIS technology can be used for cleaning a whole variety of industrial wastewaters and namely for municipal wastewater treatment. The EGGIS functioning principle is based on governed electromagnetic impulse field affecting the polluted water while it flows through the reactor. The cleaning process makes no or very little use of chemicals and coagulants.
Envirolyte ECO 120 is designed for purifying tap water that doesn't meet the WHO health standards. Not only does it kill all bacteria and viruses in the water, but also reduces heavy metal content and produces pleasant-tasting potable water, retaining most of its beneficial mineral contents. Water purification in Envirolyte ECO-120 is achieved by oxidation and reduction that destroy and neutralize all hazardous substances.
AQUEL 400 using a method of water treatment called Reverse Osmosis. This device is designed for the final treatment of drinking water in households, restaurants, hospitals and etc., and is suitable for municipally treated drinking water. Device contains a mechanic filter, an osmotic membrane, UV lamp and mineralizator.
The **eSpring** water treatment system is designed for use with any municipally treated drinking water source or potable well/bore water. This system is to combine ultraviolet light technology with a multi-stage carbon-block filter.
IVK-filter (Uzbek product). IVK system is intended for purification of drinking water from heavy metal ions, radionuclides, nitrates, pesticides, phenols, dioxin and bacteria, to decrease water hardness and remove suspended solids. It consists of three columns to remove suspended solids, organic and inorganic contaminants, and disinfecting unit.

RESULTS AND DISCUSSION
Water quality is determined by comparing the physical and chemical characteristics of a water sample with water quality guidelines or standards. Water quality is neither a statistic condition of a system, not can it be defined by the measurement of only one parameter.

One of the most important water characteristics for the water treatment technologies is a content of dissolved substances.
For this research we choose 6 water samples taken from typical water sources in the region – water well, water pipes (town's water-supply), and irrigation canal. Lab analysis of these samples showed its pollution level before the treatment by water purifying devices, and changes of the main characteristic (content of dissolved substances) after treatment.
Results of these tests are shown in Figures 1 – 6.
After having compared the water treatment efficiency there have been chosen three the most effective devices: AQUEL 400, ECO-120 and IVK (Uzbek product)
The samples of tests are present in Annex.

CONCLUSION

All tested equipment reacted on water contents differently. As a result of these testing and lab analysis the optimal water treatment method has been found, which could be used in the Aral Sea region.
The most effective devices were: AQUEL 400, ECO-120 and IVK system.
Taking into account the specific conditions (high water pollution, inefficient process of municipal water treatment, and bad technical condition of water-supply) in the Aral Sea region in order to reach the best treatment parameters it is recommended to use the following technological sequence:

1) Remove suspended solids by different type of mechanical filters
2) Decrease of total water hardness, in our case achieved by IVK filter
3) Decrease of dissolved substances including salt by Reverse Osmosis system

As the Reverse Osmosis system decreases the content of useful minerals, there must be done re-mineralization before water supply to the end consumer.

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ANNEX

Fig.1. The content of dissolved substances in the sample 1. The changes of the content of dissolved substances after the treatment by different types of water cleaning devices.

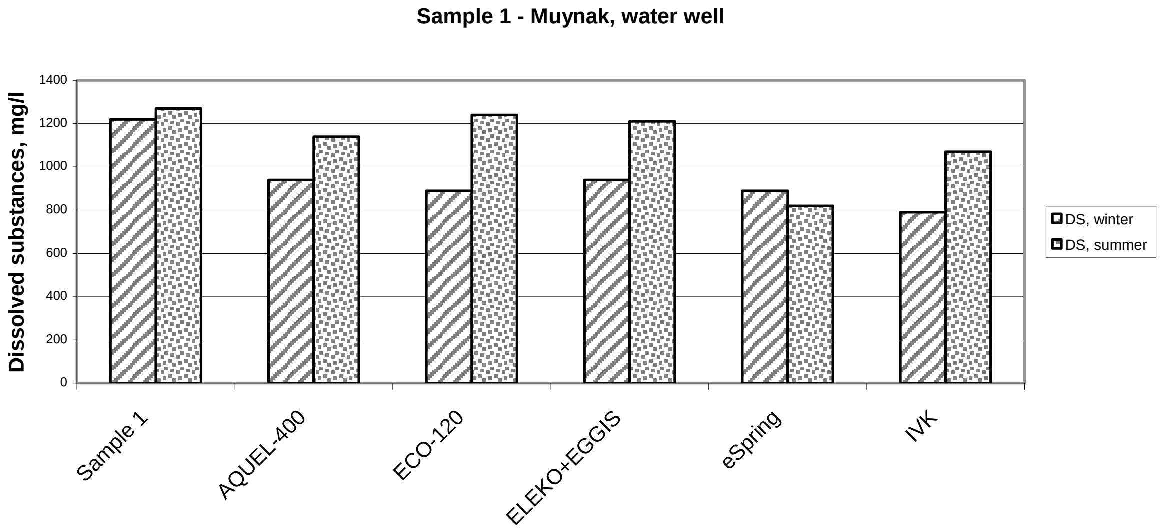

Fig.2. The content of dissolved substances in the sample 2. The changes of the content of dissolved substances after the treatment by different types of water cleaning devices.

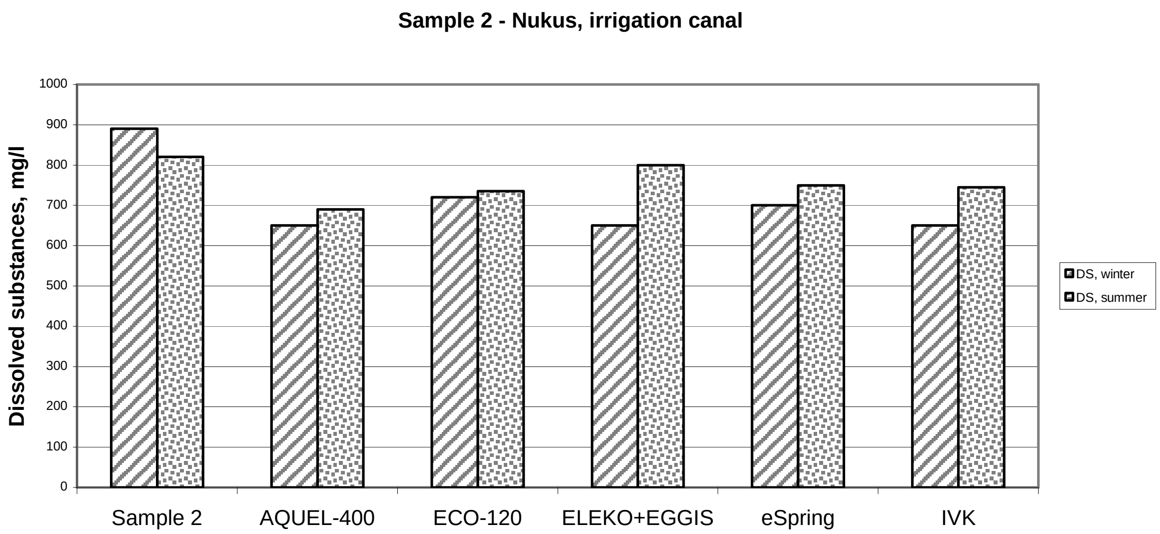

Fig.3. The content of dissolved substances in the sample 3. The changes of the content of dissolved substances after the treatment by different types of water cleaning devices.

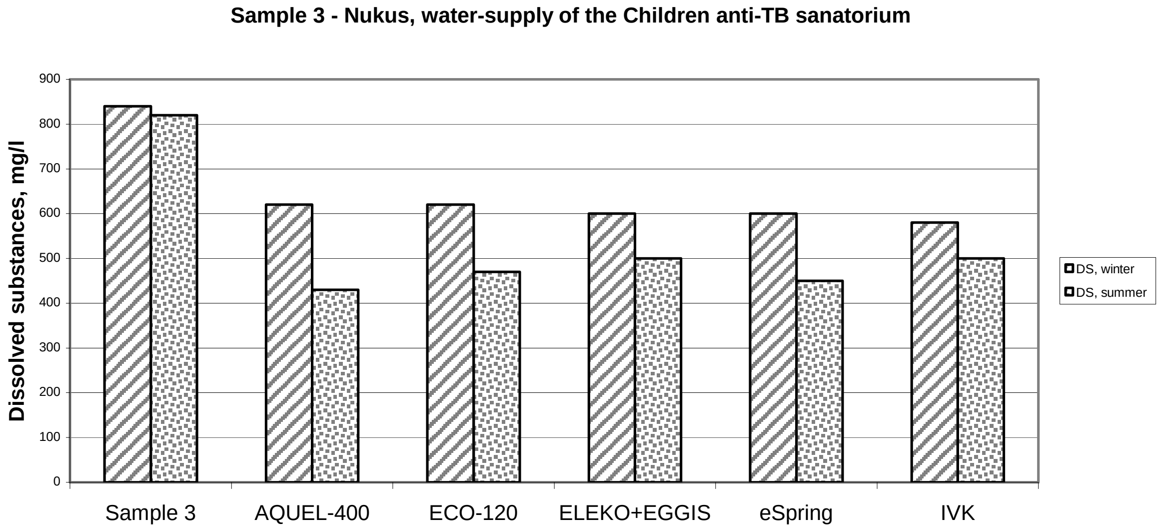

Fig.4. The content of dissolved substances in the sample 4. The changes of the content of dissolved substances after the treatment by different types of water cleaning devices.

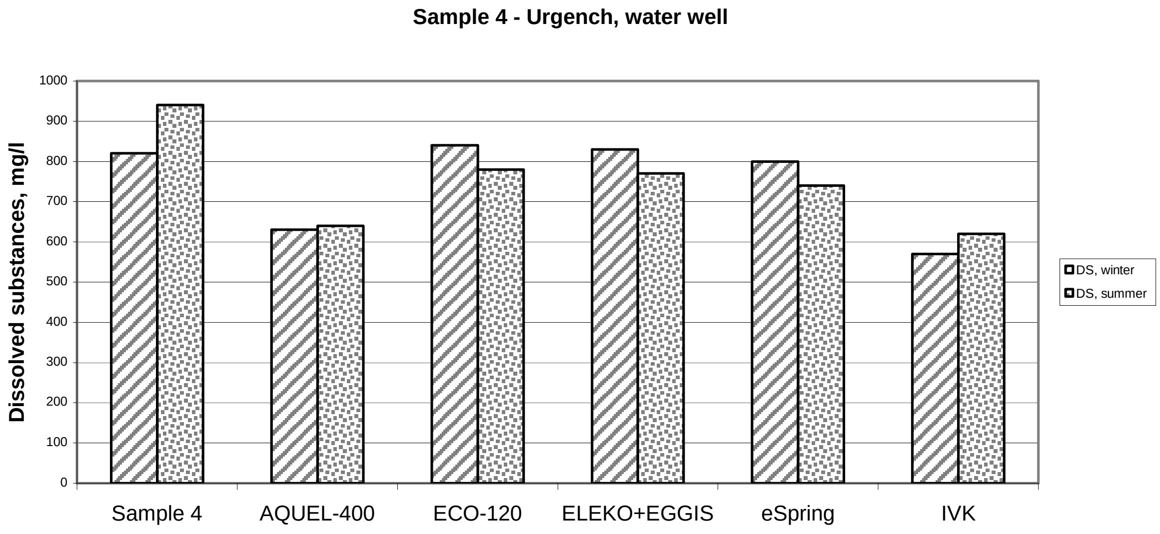

Fig.5. The content of dissolved substances in the sample 5. The changes of the content of dissolved substances after the treatment by different types of water cleaning devices.

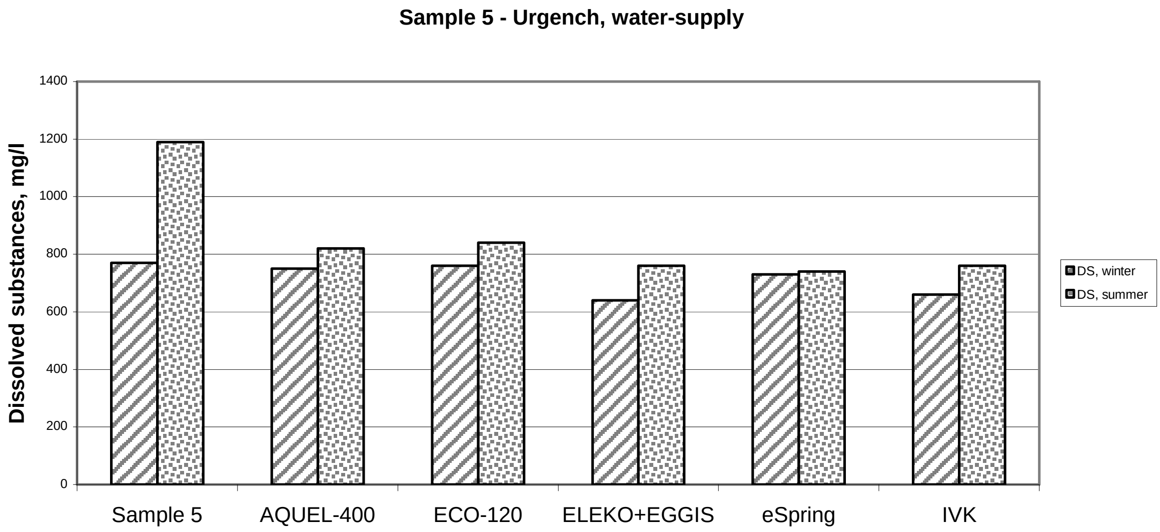

Fig.6. The content of dissolved substances in the sample 6. The changes of the content of dissolved substances after the treatment by different types of water cleaning devices.