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Atmosphere Water Vapour As Main Sweet Water Resource in the Arid Zones of Central Asia

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***Abstract*—**It has been shown that the solution of water shortage problem in Central Asia closely connected with inclusion of atmosphere water vapour into the system of response and water resources management. Some methods of water extraction from atmosphere have been discussed.

***Keywords*—**potable water, water resources, water problems, water scarcity.

I. Introduction

THE solution of water shortage problem in Central Asia closely connected with inclusion of atmosphere water vapour into the system of response and water resources management. During the 20^{th} century, the world population tripled while sweet water consumption increased by 13 times. The total consumption of sweet water increased from 400 cubic kilometers in 1900 to 3500 cubic kilometers in 2000 [1]. During the nearest 20 years increase of water consumption by another 1000 cubic kilometers is anticipated. Hence, deficiency of potable quality sweet water is increasing in many regions of the world including Uzbekistan.Water pollution keeps on increasing. In Uzbekistan, majority river-beds are polluted in moderate or high level. Industrial waste, agriculture, and populated areas are the main sources of pollution [2]. The potable water situation in Karakalpakistan and Khorezm oasis evokes the most concern. Provision of potable water in agriculture was 21.4% in Karakalpakistan, 23.2% in Khorezm oasis by beginning 1990 while the average level in Uzbekistan was 52% [3]. Mineralization of potable water keeps on increasing. In Nukus, that index reached 1.5 g/l in 2000 and keeps on increasing [3]. In Ustiurt, potable water is practically unavailable.Renewable land waters that are concentrated in the rivers, lakes, and water reservoirs are traditional sources of sweet water. Mainly, land water resources of Central Asia are determined by surface flow of Syrdarya and Amudarya Rivers (annual average 37.203 Km^3 and 79.280 Km^3 respectively). The total volume of the 60 water reservoirs in the vicinity of the Aral Sea is 64.5 Km^3. The next source of potable water is underground water. In Central Asia, the deposits of underground water make 43.5 Km^3 including water of potable quality that amounts to 4.31 Km^3 only. Thus, sweet water resources within Amudarya and Syrdarya Rivers deltas are estimated at about 185.3 km^3.

90% of the total water take in Central Asia is spent for irrigation of agricultural lands [4]. To produce 1 t of row cotton only 17 thousand litres of water are needed [2]. Near 10% of water are spent for industrial and municipal needs. Suffice to say that near 6 cubic meters of water are needed to produce daily ration of foodstuffs.Thus, the above quantitative estimations confirm that there is tendency for increasing of water tension in the nearest years to come, given all available water resources in Central Asia.With this regard, the Declaration of Environment Protection Ministers of the UN European Economic Commission region including Central Asia that was adopted in Kiev in May, 2003, supported publication of new water initiatives in the region." [5].

These initiatives include development of non-traditional way of sweet water production. These include transportation of icebergs, desalting of salty sea water, collection of water contained in fog, collection of water precipitated in form of dew, condensation of water vapour in atmosphere by means of special devices [6]. The review provided in [7] shows that the last option only is acceptable for Uzbekistan.

The atmosphere contains near $1.29 \cdot 10^3$ Km^3 of water [6]. Comparison of the quantity of evaporating water and water in atmosphere shows that rate of water renewal is 45 time during a year. Thus, condensed atmosphere water vapour is the main source of sweet water.

In order for atmosphere to share, so to say, a portion of its water condensation devices are needed. Such passive type installations, where water vapour is condensed naturally, were operated in Crimea on the sides of Feodisia mountains, "karis" system in Central Asia [8,9].

Recently, active type condensers are being developed that utilize forced air cooling [9].

The main advantages of the method of water extraction from atmosphere vapour by means of condensation installations consist of the following:

- the source of potable water is not *renewable* only but fast *recoverable* too;
- the environment is not polluted, i. e. the method is *environmentally safe*;

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- the potable water that can be produced is of *high quality*, it contains by 2-3 orders of toxic material concentration of which is defined by sanitary requirements, does not practically contain pathogenic bacteria, well aired [1];
- at least twice as *cheap* as compared with desalting installation;
- *autonomous with regard of place and time of operation* that spares the society of necessity to resolve many the most acute social and political problems related to water use in Central Asia including Uzbekistan. [8-12].

At present, there are two approaches to the solution of the problem: condensation and absorption ones. The first approach is based on cooling air to the dew point, and the second one on absorption of atmosphere moisture by special sorbent.

To determine moisture content in atmosphere measured in cm of condensed water the following equation was derived

$$W = 0.1629e_0 + 0.3665 ,$$

where e_0 - vapour pressure by Earth surface in hPa.

Using connection between e_0 and W, and applying geographic information system (GIS), geographic distribution of atmosphere moisture content in various seasons was mapped.

Winter. Over Ustyurt plateau, water deposit in atmosphere makes 0.9 - 1.0 cm, that in the central part of Qizilqum Desert is 1.1 – 1.2 cm, and in South-East this is 1.3 – 1.4 cm. This distribution means that 5 Km^3 of water are present in atmosphere over the territory of Uzbekistan that equals to the amount of water in a water reservoir 10 m deep and with the surface area 500 Km^2.

April. In this month, 1.5-1.7 times increase of moisture content occurs. In North-Western and Northern parts of Uzbekistan, atmosphere deposit of water is 1.4 – 1.6 cm, in the South-East and Farghona Valley this is 2 – 2.3 cm.

Summer. Increase of atmosphere moisture content continues over the whole territory of Uzbekistan. Minimum deposit of water is over the central and Eastern parts of Qizilqum desert making there 1.7 – 2.3 cm. The largest deposits of moisture are present in South Aral Sea region and Eastern part of Farghona Valley, i. e up to 3.1 cm.

In total, about 10 Km^3 of are contained in the atmosphere over Uzbekistan that corresponds to the amount of water in a water reservoir 20 m deep and with the surface 500 Km^2.

October. The least deposits of water are present over the Northern and central parts of deserts (1.2 – 1.4 cm), and the largest are present in South-East and East of Uzbekistan (1.8 – 2.0 cm).

In annual average, there are about 1.7 cm of water in the latitude range 41° to 60° North [10]. These data are practically very close to those we obtained.

Let us to specify the existing types of condensing installations.

These are air water machines: BBM-100, BBM-10000, BBM-30000 (‘BBM’ stands for air water machine in Russian).

BBM-30000 is a stationary type machine that is designed for extracting up to 30 tons of water a day from air. BBM-30000 features water preparation unit, too.

The power consumption of the machine is about 250 KW. For instance for Kuwait, where the cost of KWh is 0.015 USD, the cost of produced water does not exceed 4.5 USD/1m^3.

“Rosa” (Dew) project. The project provides for receiving water with two type installations:

“Rosa 1” is device of a stationary design built of standard modules and units on a rigid water-proof basement used for accumulation of the condensate;

“Rosa 2” is a device of module design. Depending in capacity and design it may be manufactured both as module version and mounted equipment of structures, vehicles etc. The device, in this case, uses additional sources for decreasing temperature of moist atmosphere air, including refrigerating machine working on various energy sources.

The “Rosa” type condensation systems allow receive sweet water using the natural daily temperature course and installed condensation surfaces. This systems secure producing the cheapest sweet water and may be put into operation fast. For Damascus water supply, for instance, the most immediate demand equals 400 thousands cubic metres a day. The cost of the project is 400 m USD approximately and will be repaid in a year after beginning of the engineering works.

For comparison, desalting plants of the same capacity will cost 500 m USD. And annual power consumption will cost at least 100-150 m USD, while operation cost for the “Rosa” type systems practically equal zero.

The cost of 1m^3 of produced water is 0.15 Euro approximately.

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This the period of stable average temperature over 16° C makes 141 to 144 days in North-Western part of the republic and up to 195 and even 207 days in its Southern regions. This period varies from 39 to 57%, respectively, in percentage to the total number of the year days. Over the main part of the desert territory of Uzbekistan, mean daily temperature over 16°C is observed during 44-50% of days.

Specification of the value by the regions has been mapped using GIS technology.

Thus, in the closest 10-12 years atmosphere water vapour will turn to be the main natural resource for obtaining potable water in the arid zones of Uzbekistan that needs to be accounted for while planning and managing water resources in the region. Using the resources of atmosphere water vapour is a factor of sustainable development of Uzbekistan in 21 century.

References

[1] Pomomarenko V. The Problem 2033 – Internet. http//:www.micoslavie.ru/library/pr2003.html. – 31 p.

[2] Киевский доклад. Проект раздела 8. Напряженность водного режима. Homepege www.eea.int – 20 с.
[3] Атаниязова О.А., Константинова Л.Г., Ещанов Т.Б., Курбанов А.Б. Аральский кризис и медико-социальные проблемы Каракалпакистана: Нукус. Билим. 2001, - 117 с.
[4] Диагностический доклад для подготовки региональной стратегии рационального и эффективного использования водных ресурсов Центральной Азии. ООН. 2002. – 54с.
[5] Декларация министров окружающей среды региона Европейской экономической комиссии ООН. Пятая конференция. Киев. Украина. 21-23 мая 2003г. Интернет. – 298с.
[6] Алексеев В.В., Березкин М.Ю. Пресная вода из атмосферной влаги для аридных районов. Интернет. Webmaster @ intersolar, - 2003, - 4с.
[7] Батурина Л.Г., Петров Ю.В. Нетрадиционные способы получения пресной воды. Избранные вопросы гидрометеорологии. – Ташкент: САНИГМИ, 2003.- с.16-28.
[8] Алексеев В.В., Березкин М.Ю. Пресная вода из атмосферной влаги для аридных районов. Интернет. Webmaster @ intersolar, - 2003, - 4с.
[9] Алексеев В.В., Березкин М.Ю. Пресная вода из атмосферной влаги для аридных районов. Интернет. Webmaster @ intersolar, - 2003, - 4с.
[10] Снопков В.Г. О корреляции между содержанием водяного пара в атмосфере и характеристиками влажности воздуха у поверхности Земли. – Метеорология и гидрология, , № 12, 1977, - с. 38-42.
[11] Проект "Роса" (третья редакция – 01.06.04). Internet. 2004. – 9 с.
[12] Алексеев В.В., Рустамов Н.А., Иванов В.Н., Дубовская В.А. Экспериментальное изучение процесса наземной конденсации влаги для практического использования. Вести МГУ. Сер. 5. География. 2004. № 1.