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Deuterium Depleted Water-New Studies About Isotopic Distillation Obtaining Process

C. MLADIN[1,*], AL. POPESCU[2], I. STEFANESCU[3] and A. OUBRAHAM[3]

[1]Mecro System, 100P, Timisoara Blvd., Bucharest-6, Romania
[2]Department of Chemistry, Craiova University, Craiova, Dolj, Romania
[3]National R & D Institute for Cryogenics and Isotopic Technologies-ICIT Rm. Valcea,Valcea, Romania

*Corresponding author: E-mail: cristian_mladin@mecrosystem.ro; adelina_preda@yahoo.com

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A series of experiments have shown that deuterium depleted water has beneficial effects for life. The deuterium concentration interest area for deuterium depleted water is in the range 20-110 ppm. Deuterium depleted water is obtained by isotopic distillation under vacuum. Advanced studies have been conducted on the process of obtaining deuterium depleted water by isotopic distillation process. Deuterium concentration in deuterium depleted water was analyzed by mass spectrometry.

Key Words: Deuterium depleted water, Isotopic distillation, Mass spectrometry.

INTRODUCTION

Water plays an important role in socio-economic activities, like an indispensable element for starting and developing any activity. Searching for sources of water over time mobilized multiple energies. For human being, fresh water is the most important source of water. Fresh water reserves are relatively small and limited and shrink every year due to pollution of natural waters by discharge into them of untreated or insufficiently treated wastewater[1]. A significantly increased number of pollutants, require more advanced and more expensive treatment methods than classical ones, which are becoming unsatisfactory.

The protection of quality of water has become not only a measure of health, but also a growth means of the reuse degree of water, because the rate of water use is dependent by its physicochemical and bacteriological qualities.

Today, the world is spending huge amounts of water research. A very important conclusion of these researchers is that the glacier water, which is thousands years old, is pure, and has outstanding biological qualities because of the low deuterium content[2]. For example, agricultural crops irrigated with water from the glacier, productivity increased by 60 %. While these studies were carried, a major priority appeared-the study of heavy water, used in the development of nuclear technology, which led to the stagnation of deuterium depleted water research. Only in the 90's, independent research collectives from several countries started to make more intense studies on this topic of deuterium depleted water. After years of studies the main conclusion of scientists is the following: the heavy water with high content of deuterium has, mostly, negative biological effects, but the deuterium depleted water is a real elixir for health.

In Romania, deuterium depleted water is produced from many years by the National Research and Development Institute for Cryogenics of Ramnicu Valcea.

EXPERIMENTAL

We obtained deuterium depleted water with deuterium content about 25 ppm D/(D + H), from natural water with a deuterium content of 144-150 ppm, using a vacuum isotopic distillation technology.

Today, there are known several deuterium separation methods: (a) distillation, (b) chemical exchange water-hydrogen sulphide, (c) catalyzed chemical exchange water-hydrogen, coupled with water electrolysis.

We made research and experimentation works in order to obtain process and product quality improvements. For these works we used a water isotopic vacuum distillation installation.

Using this installation, we performed a series of mathematical modeling of the process, in order to obtain an efficient technology to produce deuterium depleted water.

In these mathematical modeling we had the possibility to vary working parameters to obtain maximum separation performance.

It is known that specific analysis methods and techniques with deuterium depleted water watching $^2H/^1H$ isotope ratio determination[3].

Isotope ratio analysis method is generally used for: (a) determination of deuterium content between the natural concentration to 1 ppm, (b) origin authentication of water samples, (c) environmental studies (meteoric water line of rainfall).

We made the isotope ratio analyses using a mass spectrometer with magnetic sector IRMS (isotope ratio mass spectrometer) in continuous flow, Finnigan Delta V Plus type, coupled with GasBench II module for preparation and separation.

The sample preparation is made in two steps: first step is pre-processing (for example: equilibration with mix 2 % hydrogen in helium) and the second step represents the automate conversion of processing samples in correspondent gaseous (for example: hydrogen), processing its by eluent gas (helium) and the introduce inside of mass-spectrometer in same time with reference gas (for example: hydrogen with 99.9999 % purity)[4].

Isotopic composition of water is presented by comparison with isotopic composition of ocean water-SMOW etalon (Standard Mean Ocean Water).

$$D/H_{SMOW} = (155{,}76 \pm 0{,}05)\,x10^{-6} \quad (1)$$

Because of small variation of isotopic abundance, the absolut value of raports is not measured, but the difference toward a selected standard[4]. The expression of this result is presented in δ units calculated by formula:

$$\delta = \frac{R_{proba} - R_{standard}}{R_{standard}} \times 1000 \quad (2)$$

Isotopic composition of water, determinated by mass-spectrometry, is presented in per milion ($^{0}/_{00}$) deviation from SMOW etalon. These deviations are δ D for deuterium:

$$\delta D \, ^{0}\!/_{00} = \frac{(D/H)_{proba} - (D/H)_{SMOW}}{(D/H)_{SMOW}} \times 1000 \quad (3)$$

The software tool provides control data and enables the automation mode of operation, data acquisition, data processing, machine diagnostics. All GasBench & Delta V Plus IRMS coupling parts are controlled by the computer.

Measurement and calculation modes are conducted online using software, which automatically performs all necessary corrections for such statistical analysis type.

Each sample is analyzed twice and if the two values are within the precision of the device, the analysis is considered as correct one.

Analysis results are automatically printed by the computer. The listing includes the following: number of performed experiment, date, name of sample and standard, arithmetic mean, standard deviation, relative deviation, relative deviation of the sample concentration from standard.

RESULTS AND DISCUSSION

Our interest is to obtain deuterium depleted water and its derivatives with deuterium concentration between 20-120 ppm.

The derivatives are made for human and animal consumption, using water with low deuterium content. The derivatives can be obtained on different, independent installation or in the same installation where deuterium depleted water is produced.

The experimental control of isotopic continuous distillation process is done by isotopic and physico-chemical analyses in technological flow[5]. Because the deuterium depleted water is resulted from a process of distillation, it is devoid of minerals. In this situation, special attention is paid to the drinking water transformation process.

The framing of deuterium depleted water in drinking water parameters was done by several mineralization methods like (a) mixtures with highly mineralized water (sea water), and (b) mixtures with pharmaceutically pure minerals. Optimal final recipes will be made depending on the direction of use.

Fig. 1 presented the flow diagram for obtaining deuterium depleted water. In this diagram is presented the operation process till to obtain the deuterium depleted water.

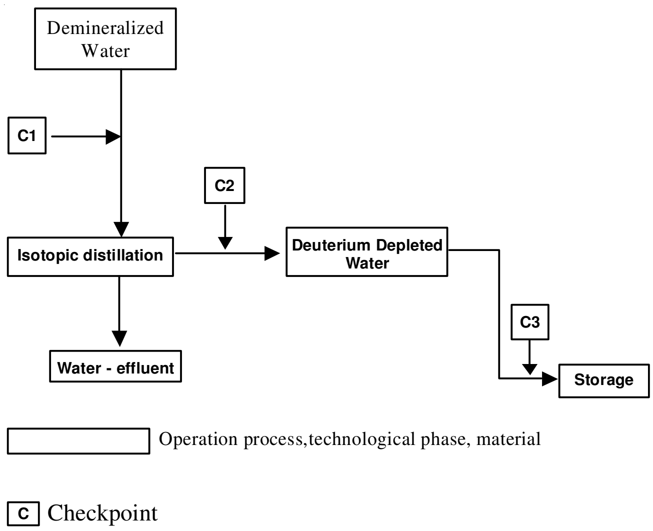

Fig. 1. Flow diagram for obtaining deuterium depleted water

In the tests period made on the deuterium depleted water installation, we analyzed several batches of deuterium depleted water. The results of analyses are presented in Table-1.

TABLE-1
PARAMETERS OF DEUTERIUM DEPLETED WATER

Deuterium content of deuterium depleted water (ppm (D/D+H))	20 ÷ 110
pH	6.5 ÷ 7.5
Conductivity (µS/cm)	Max. 5
Oxidizability (mg/L)	Max. 5
Cu^{2+} (mg/L)	< 0.1
Fe^{2+} (mg/ L)	< 0.1
Ca^{2+} (mg/L)	< 0.1
Mg^{2+} (mg/L)	< 0.1
Cl^{-} (mg/L)	< 0.1

Conclusion

The characteristics of deuterium depleted water obtained by isotopic distillation of water is similar to distilled water, except deuterium content (Table-1). In geographical area of Romania, deuterium concentration in rivers is ranged[6] between 146-147 ppm.

Deuterium concentration in the body of a human being adult is about 12 to 14 mmol/L. Although it does not seem much, if we compared this amount with other vital elements, it is observed that deuterium is present in the body in an amount six times higher than calcium and ten times higher than magnesium.

A series of experiments have shown that deuterium depleted water has beneficial effects on cell division. The cell division process is slower if the cells are put in deuterium depleted water medium. This result could be a proof of the anti-aging of deuterium depleted water. There are also researchers who claim that the deuterium depleted water in various forms of solutions, ointments, food can be used for specific preventive and curative health treatments, like for health maintenance, cancer tumors, skin diseases, insomnia, osteoporosis, etc,[7-9]. Taking into consideration the growing interest in deuterium depleted water, we intend to continue our studies in the obtaining process of deuterium depleted water and its derivatives.

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