Technical Paper

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Radon Removal by OxTube Process

Introduction

The main principle in radon separation applied in OxTube, developed by SansOx, is to displace the soluble radon by air gases in aeration. The OxTube treatment is a continuous, hermetic and efficient mixing and dissolving process. It displaces dissolved ingredients by more soluble ingredients like air gases, pure oxygen, ozone and carbon dioxide. Low pressure suction, cavitation and impulse generated by the kinetic energy of the flowing liquid in the tube are applied in the process.

Radon Removal System - case

OxTube Radon Removal System developed by SansOx consists of Ejector Module, Booster Module and GasRemox, and necessary Fitting Modules. Ejector Module separates the soluble radon by displacing it by more soluble air gases. Booster Module generates a mixture of separated radon, air and water. GasRemox after the Booster Module separates water and gas mixture by gravity. The gas mixture is lead to separation tank by gas pressure caused by a compressor. A gas pump and water separator can be used.

Radon gas removal rate of 45 Bq/l from a ground water has been reached with the system described below. The separation system doesn't content any movable parts nor components. The process is steady and reliable despite of fluctuations in amount of radon in the ground water.

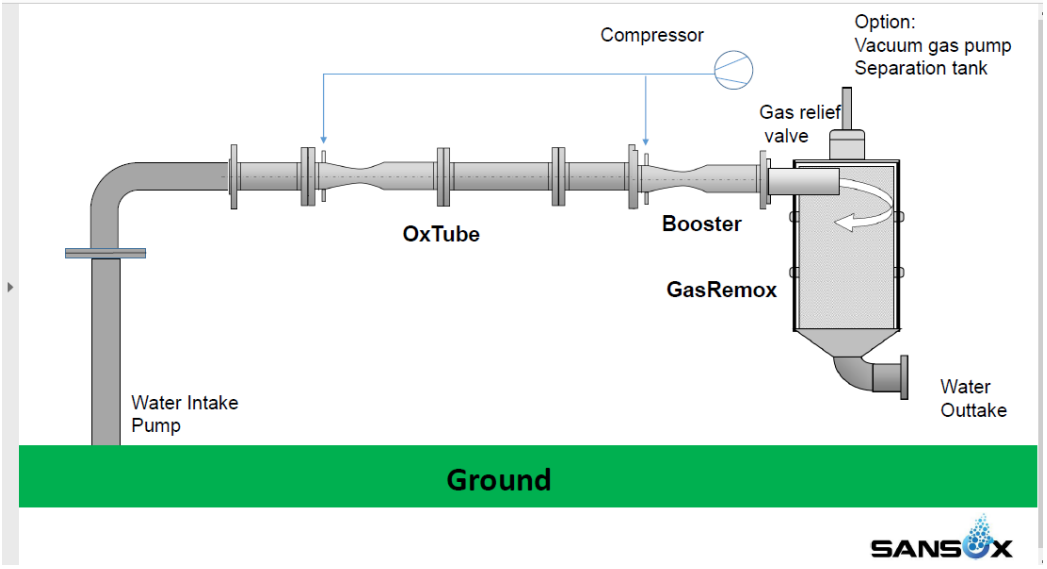

Fig. 1. Radon removal set-up.

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Table 1. Soluble Radon Gas Removal from raw ground water with two OxTubeDN100 in line and air feed. Radon is removed under the limit and replaced with air gases within 2 second process time.

Water Flow	Date of Sample	Monitoring Data					Rn Concentration Bq/l		Rn Removal Bq/l		
		Pressure psi					Raw Water	Treated Water	Reduction Bq/l	Reduction %	Aceptance
		Pump out	OxTube 1	OxTube 2	Distr. Line	Δ					
62.5 m³/h	1809-19	60	52	48	60	0	55	9	46	83.6	Passed
	1909-19	60	52	48	60	0	50	8	42	84.0	Passed
	2309-19	60	52	48	60	0	53	4	49	92.5	Passed
	2409-19	60	52	48	60	0	52	5	47	90.4	Passed
	2509-19	60	52	48	60	0	51	4	47	92.2	Passed
	2609-19	60	52	48	60	0	47	5	42	89.4	Passed
	3009-19	60	52	48	60	0	43	8	35	81.4	Passed
	0110-19	60	52	48	60	0	52	7	45	86.5	Passed
	0210-19	60	52	48	60	0	45	6	39	86.7	Passed
	0310-19	60	52	48	60	0	47	6	41	87.2	Passed
	0710-19	60	52	48	60	0	57	8	49	86.0	Passed
	0810-19	60	52	48	60	0	56	6	50	89.3	Passed
	0910-19	60	52	48	60	0	50	5	45	90.0	Passed
	1410-19	60	52	48	60	0	42	6	36	85.7	Passed
	1510-19	60	52	48	60	0	52	6	46	88.5	Passed
	2810-19	60	52	48	60	0	50	7	43	86.0	Passed
Requirement							52	11		79.0	

Theoretical background for radon removal system

OxTube Process in Brief

A new hermetic water treatment called OxTube Integrated Clarification and some of its applications are presented here. There are many ways and combinations to apply this new water treatment technology. In order to understand the phenomena itself only basic principles are presented here. The applications selected are presented briefly by key results and measures achieved.

OxTube water treatment treats the water in flowing condition in its hermetic tube. It separates soluble ingredients from the water, splits molecular and ionic structures, activates molecules, and clarifies the water and replaces the separated molecules by air gases. This all happens within a second or less in its seamless process. The air gases are sucked by the vacuum effect in the nozzle zone and led directly in middle of the main flow. The water, gases and separated molecules are mixed evenly as a foggy low gravity mixture. The meeting probability of the molecules is high and so, chemical reactions follow immediately in the hermetic condition. Next the foggy mixture is turned back to liquid with overdosed gas bubbles.

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In Fig.3 the principle of OxTube Water Treatment is presented with a functional prototype visually. There are four main functions following each other seamless in one tube or in separate modules by function. The water is clarified and dissolved with desirable ingredients, e.g. air gases in the tube within a second or less. The molecules separated from the water and injected or sucked in the water flow meet each other in separation, activation and clarification zones with high probability. Finally. overdosing dissolves in the clarified water. The entire clarification process is very well controlled due to its hermetic procedure.

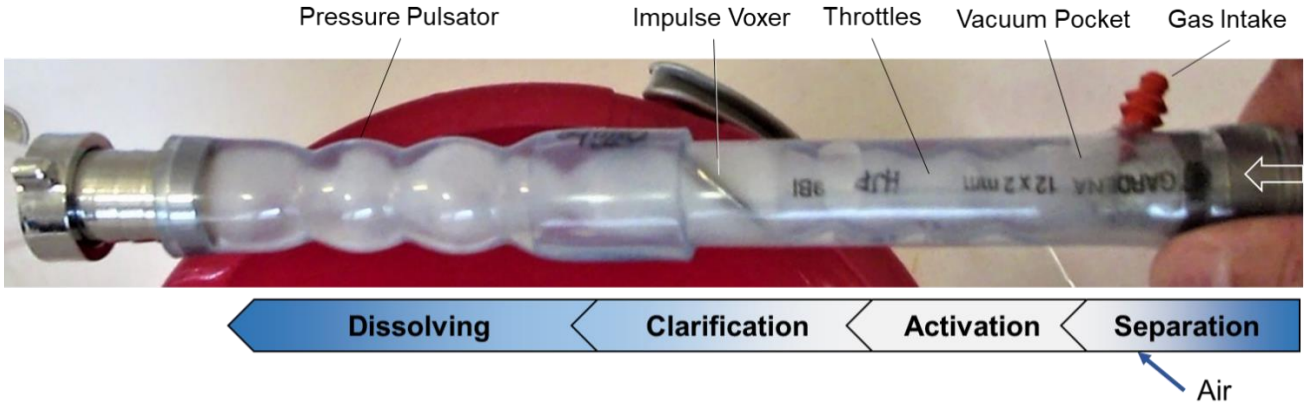

Fig. 3 OxTube Water Treatment Process illustrated visually with air suction. The seamless treatment of clarification and replacement dissolving is performed within a second or faster. The water is all the way an even mixture of air, water and water drops. Meeting probability of molecules is very high.

Fig. 4 shows the molecular separation and activation. The Swiss Alpen tap water is run through OxTube without air or any other additives in a glass bowl. The run water turns turbid, in this case white turbid, which can be seen on the picture right. Most of the separated molecules are reactive. The turbid water clarifies slowly in the air. Water temperature used in the tests varies from 12 to 41 ºC.

Fig. 5 shows the fast post-clarification of the activated water by running only two seconds OxTube treated water in the bowl with air overdosing (picture middle) and the turbidity vanishes (picture right). When the tap water is run through OxTube its air channel open, the activated water clarifies in the tube already, turbidity doesn't exist, and further, air dissolving is efficient due to separation of soluble ingredients, Fig. 4. Some results of the replacement dissolving of air gases and oxygen in water are presented in Fig. 5.

Dissolving efficiency is presented in Fig. 7 by early stage research and two applications. Due to the present technology development the efficiency is improved and devices are become much more compact and smoother by the active flow sections.

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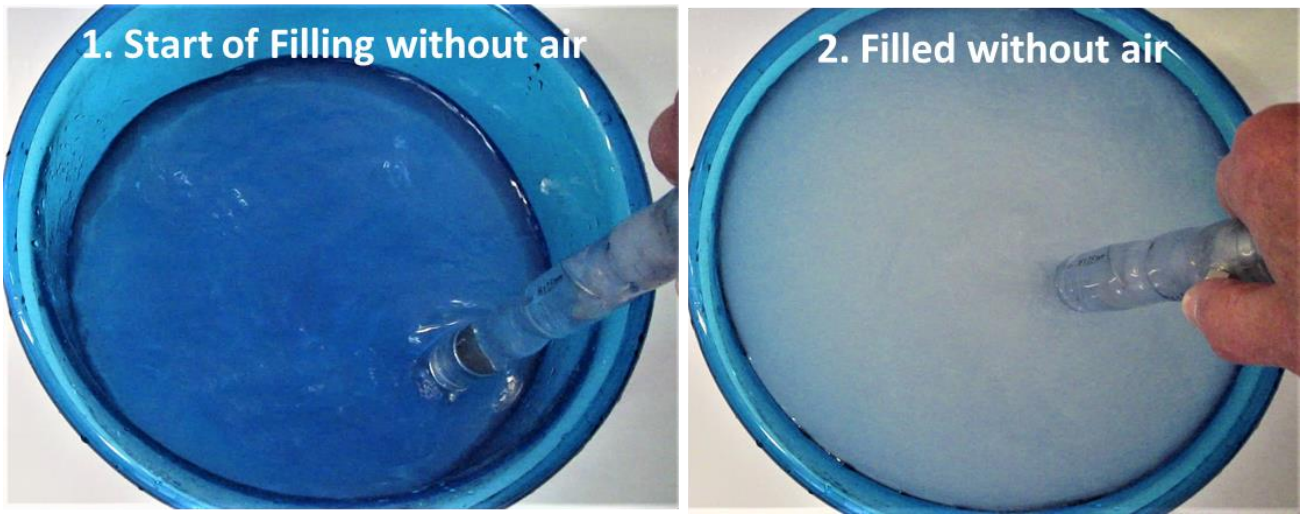

Fig. 4 Soluble Ingredients Separation and Activation of Swiss Alpen Tap Water illustrated without air suction, clarification and replacement dissolving, i.e. only with separation and activation. Water temperature is 23 ºC.

Fig. 5 Separated and activated tap water left, two second post-clarification of the activated tap water with OxTube and air suction middle, Clarification and Dissolving of two seconds with OxTube Integrated Clarification and air right.

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Fig. 6 The Swiss Alpen tap water filled through OxTube air channel open. The separation, activation, clarification and dissolving happen in the Tube less than a second.

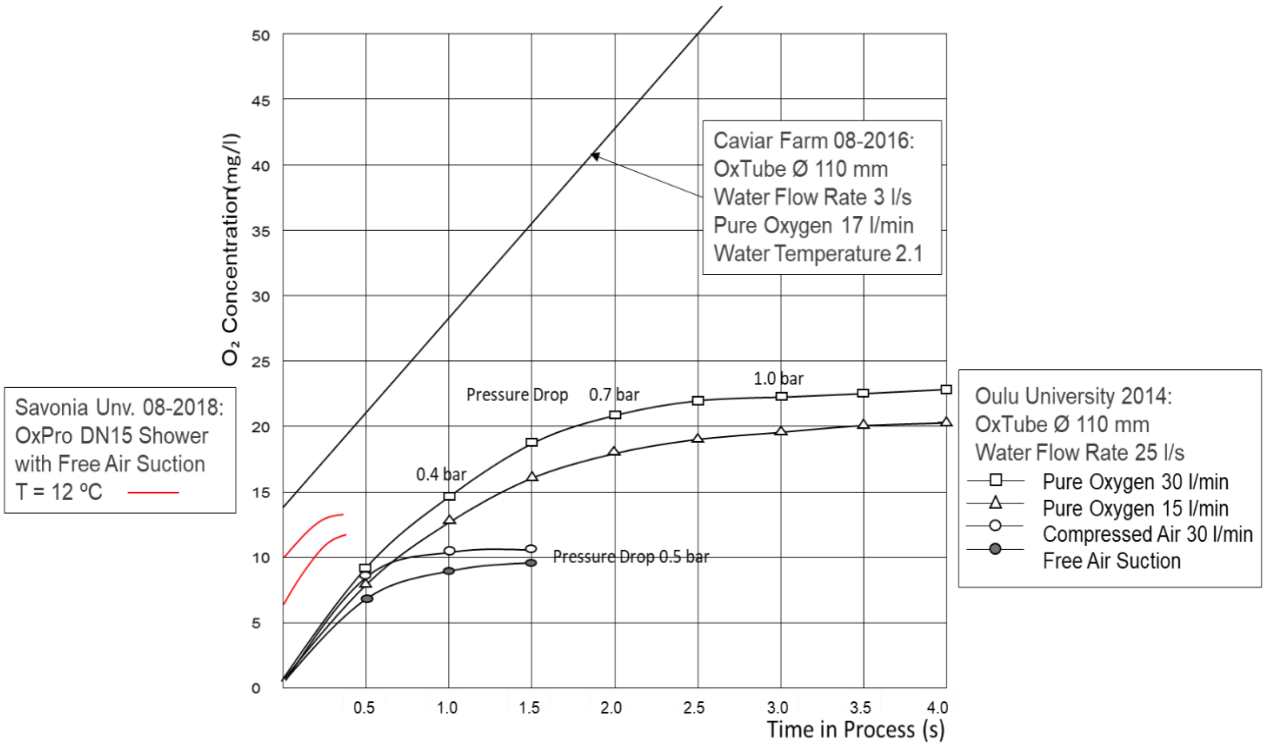

Fig. 7 Replacement Dissolving Efficiency by early research and two applications

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Dissolving efficiency of OxTube is presented in Fig. 7. In practice the DO level of 55 mgO_2/l was achieved in three seconds process time with pure oxygen feed. This can be guaranteed for the natural waters in normal health condition. The concentration of 55 mgO_2/l can be exceeded with overdosing of pure oxygen that increases probability to fill all diffusion places in the liquid. Almost all other soluble ingredients can be displaced by maximizing concentration of more soluble ingredients.

Fig. 8. Stainless steel OxTube.

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