



**Sigma** d.o.o.

**HLOOROGEN**



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## PLANTS FOR MIXED DISINFECTANT PRODUCTION

**OksiHLOOROGEN®**

Bringing the set of international laws in the area of environment protection, signing the Rotterdam Convention, Agency for Chemicals establishing ( respects R.E.A.C.H.) in November 2009 which operationally started to work in March 2010, adoption of the Law on Transport of Dangerous Cargo being in accordance with ADR/RID/AND, explicitly classified gas chlorine – the most commonly used disinfectant for drinking water – as toxic matter (Cl<sub>2</sub>;UN Br: 1017; UN class of danger: 2.3 – toxic gas; UN risk: 8; T-toxic; N-dangerous for environment).

In that context, recommendations of all relevant international institutions are pointed to the fact that, instead of gas chlorine, in exploitation should be used only its derivatives not being categorized as dangerous / toxic matter. According to R-phrases (Risk Phrases) defined by **Annex III of Directive EU 67/548/EEC**, this chlorine is marked with **R 23-** poisoned, possibility of inhalation and **R 50-** very toxic for living world in water.

Because of its toxicity, transport of this chemical is very risky. This chemical comes to Serbia via railway transport, in accordance with Rule Book on International Railway Transport of Dangerous Goods on relation Subotica border- Dimitrovgrad border.

Gas chlorine transport via roads is more dangerous because in Serbia doesn't exist any categorization of road tunnels. Lack of this categorization is contrary to the Law on Dangerous Cargo Transport, in the part relating to dangerous matter transport via roads, in accordance with European Agreement on International Road Transport. Considering all tunnels on state roads in the Republic of Serbia, only newly built tunnel on bypass of Belgrade is in line with needed standards. According to the Rule Book on the Way of Transport of Dangerous Matter in Road Traffic ("Official Gazette of SFRY 82/90"), an issuer of approval for transport may request from the buyer i.e. carrier of such cargo to provide some special security measures (Article 26 of that Rule Book), stipulating also motorized convoy of vehicles accompanied by police. If that cargo is to pass over bridges, through tunnels or shunting stations, it is required to make an internal plan for emergency situations ( Law on Transport of Dangerous Cargo, Article 54; "Official Gazette of RS" No. 88/2010).

Taking into consideration all stated above and in order to respect The Rule Book on Hygienic Quality of Drinking Water (“Official Gazette of FRY” No. 42/98 and 44/99) and to realize stipulated concentration of residual chlorine of 0,5 mg/l, and in emergency situations 1 mg/l, it is required to chlorinate the water or to treat it with some of chlorine derivates, which confirms above stated fact how important chemical in strategic way that is.

With stated set of laws and Rule Books and the Law on Planning and Building, all rules on behavior in environment protection are regulated. Water disinfection technology usage, meeting all criterions of international and domestic legislation from the area of environment protection, certainly has its justification.

In collaboration with the team of PhDs working on Faculty of Technology and Metallurgy Belgrade and Faculty of Natural Science (Department for Chemistry) Novi Sad Sigma d.o.o. company developed technology that meets all above stated requirements and produces a device complied with those requirements, under the name HLOOROGEN® (patented according to the Right of International Priority, upon application YU 09.10.2003. P-2003/0796, under No.50648- Intellectual Property Office of the Republic of Serbia and Document on the Patent No. 00013 upon Registration R-72/08 dated on 09.10.2003- Intellectual Property Office Montenegro) which confirmed performances with its long-term use in dozens of water systems. HLOOROGEN® device for production of sodium hypochlorite (NaClO) diluted solution, of concentration of ~1% of equivalent chlorine; (Cas No: 7681-52-9; Xi-irritating), on the place of consumption by electrolysis from water solution of salt (NaCl), fulfills all requirements of safe device, in accordance with domestic and international legislative practice from the area of water disinfection and environment protection. Such plants with totally secured technology are recommended by EU Directives, as alternative to gas chlorine. **According to Dangerous Substances Directive 67/548/EEC** and additional changes and amendments of **Dangerous Preparation Directive 88/379/EEC** and classification of sodium hypochlorite solution, solution with concentration less than 5% is considered as not dangerous.

Sigma d.o.o. Company from Kula has developed a new device that, on the place of consumption, in totally safe way, from salt and water, using electrical energy, produces the **MIXED DISINFECTANT**. MIXED DISINFECTANT is a mixture of equivalent chlorine (in shape of hypochlorous acid (HClO) and hypochlorous ion (ClO) and chlorine dioxide (ClO<sub>2</sub>). Its function is based on chemistry of oxygen compounds of chlorine. Newly developed device is named OksiHLOOROGEN® and is logical continuation of vision and mission of Sigma d.o.o. Company. Development of device for mixed disinfectant production is intended for solving some special problems of disinfection of waters in Vojvodina and waters containing humic substances. It is not recommended to perform disinfection of waters having such quality with conventional preparations for disinfection.

Conventional chlorination of such waters has a consequence in creation of organochlorine compounds such as trihalomethanes (THM) that are toxic for people, and chloroform is potentially cancerous. It is a reason for intensive research of composition and

structure of humic matter, as well as technological procedures providing their efficient and cost-effective removal from water.

Sigma d.o.o. Company's Development Sector, with the team of PhD's from Faculty for Technology and Metallurgy from Belgrade and Faculty of Science from Novi Sad, Department for Chemistry, Cathedra for Chemical Technology and Environment protection, has developed above mentioned device OksiHLOOROGEN® whose production solves above stated problems of disinfection of waters. Although belongs to new generation of disinfectants, it has kept its characteristic being present also in conventional chlorine and it is keeping of residuals in distribution system, preventing reinfection with keeping the reached quality of water.

Alternative to conventional chlorination of such water is its treatment with chlorine dioxide (ClO<sub>2</sub>) that, according to R-Phrases (Risk Phrases) is defined by Annex III of EU 67/548/EEC with mark R 6- explosive in and without contact with air, R8- combustible in contact with flammable matters, R-26 very toxic when inhaled, R34- causes burns and R 50-very toxic for living world in water.

Mixed disinfectant is, in the same time, effective disinfectant and strong oxidant capable, except of disinfection, to neutralize both inorganic impurities such as ammonia and sulphides of iron and manganese and causes of color, odor and taste of water, as well as humic matter. In that way it improves total quality of water, without disinfection by-product. Therefore, OksiHLOOROGEN® device represents a perfect choice for small water systems that are not capable to perform complete treatment of waters containing humic matters (natural organic matters) and inorganic impurities.

Problem of quality of drinking water sources in AP Vojvodina is shown in STRATEGY OF WATER SUPPLY AND PROTECTION OF WATERS IN AP VOJVODINA, Official Gazette of APV, No 1 2010. Quality of underground waters in AP Vojvodina, observed from the aspect of content of natural organic matters (NOM) is uneven, starting from waters of high quality not containing NOM or containing small quantity of the last up to waters that must be subject to complex procedure of processing because contain high quantities of NOM. Quality of water changes from aquifer to aquifer and also from location to location of water source when the same aquifer is in charge. Because of NOM presence, for artesian aquifers in Vojvodina and very often also for free aquifers, very characteristic are so called yellow waters that have specific taste and are used as drinking water in many settlements.

Content of organic matter in these waters, expressed through consumption of potassium permanganate, amounts 20-150 mg/l, in extreme cases over 200 mg/l. Influence of natural organic matters on quality of drinking water is multiple. Their presence directly determines drinking water parameter values but also affects a choice of technology for its preparation. Primarily, they give specific coloration to water because they themselves are colored (brown-yellow), as well as specific odor and taste. The most significant influence of NOM to drinking water quality is creation of **by-products in its disinfection with chlorine, as with**

**disinfectant (the best known are trihalomethanes) that are cancerous matters in most cases.** Except of that, if there is no disinfectant enough (or disinfection is not optimized) they influence microbiological malfunction of drinking water, because they are a suitable base for development of microorganisms. This is also pointed by a high percentage of hygienic malfunction of drinking water in settlements supplied with underground waters, containing NOM, such as Kikinda and Zrenjanin where this percentage amounts even up to 100%.

From everything stated above, it is seen that OksiHLOOROGEN® is a device providing a mixed disinfectant with characteristics of individual disinfectants. Result of stated is preparation that simplifies water processing technological procedure, followed by increase of efficiency of that procedure itself. Table 1 shows comparable view of the most commonly used disinfectants and their efficiency.

Table 1: Comparable view of disinfectants and their efficiency

	Gas chlorite	Industrial sodium hypochlorite	Calcium hypochlorite	Chloramination(chlor + ammonia)	Chlorine dioxide	Ozone	UV radiation	Sodium hypochlorite on place of cons.	MIXED DISINFECTANT
<b>Efficient</b>	yes	yes	yes	yes	yes	yes	yes	yes	<b>yes</b>
<b>Safe</b>	no	no	no	no	no	no	yes	yes	<b>yes</b>
<b>Creates residual</b>	yes	yes	yes	yes	no	no	no	yes	<b>yes</b>
<b>Removes trihalomethanes</b>	no	no	no	yes	yes	yes	yes	no	<b>yes</b>
<b>Removes chlorites/bromates</b>	yes	yes	yes	yes	no	?	yes	yes	<b>yes</b>
<b>Removes Biofilm</b>	no	no	no	no	yes	no	no	no	<b>yes</b>
<b>Removes Algae</b>	no	no	no	no	yes	yes	no	no	<b>yes</b>
<b>Supports micro-flocculation</b>	no	no	no	no	yes	yes	no	no	<b>yes</b>
<b>Removes odor and taste</b>	no	no	no	no	no	yes	no	no	<b>yes</b>
<b>Easy to be maintained</b>	yes	no	no	no	no	no	no	yes	<b>yes</b>
<b>Low costs of usage</b>	?	no	no	no	no	no	no	yes	<b>yes</b>

This device has been projected as a mini factory using, as raw material input, solution of table salt and elect. power for creation of mixed disinfectant whose function is based on chemistry of oxygen compound of chlorine. Due to total concentration of app. 0,5% of totally active substances, MIXED DISINFECTANT meets all requirements of law, Rule Book and Directives on Dangerous Substances and, being like that it is possible to characterize it as totally non-dangerous substance, and OksiHLOOROGEN® as absolutely save device, in accordance with domestic and international law practice in the area of disinfection of waters and environment protection.

System is automated, requires minimum maintenance and it is very simple to be used. In serial production, SIGMA d.o.o. from Kula has OksiHLOOROGEN plants of 50 gr/h, 125 gr/h, 250 gr/h, 500 gr/h and 1000 gr/h of mixed disinfectant.

WITH MODULAR CONNECTION, IT IS POSSIBLE TO PRODUCE THE PLANTS OF 2,3 OR MORE KG OF MIXED DISINFECTANT PER HOUR.