"UNICHIM & EP" ("The Urals Research chemical Institute with an Experimental plant") is the oldest research institute of the chemical industry of Russia. It was established in 1930. Currently the company forms part of the "Rostec" state corporation. The Institute comprises research laboratories that develop the production procedures and know-how for new chemical products for the Russian military-industrial complex and for non-military applications, as well as the equipment for such chemicals' production, and a pilot production facility where the new chemicals and equipment get produced, an engineering department, and various other structures.

The "UNICHIM & EP" corporation's many years of successful business can be judged by the number of patents it holds and of the products it exports to various countries around the world.

The DCh-100 local automated plant producing a highly efficient and economical "Chlorine Dioxide and Chlorine" Compound Disinfectant (CD) from readily-available raw materials (sodium chlorate, sodium chloride, and sulfuric acid) for drinking, waste and sewage water treatment and disinfection is an example of the innovations developed by the "UNICHIM & EP" corporation for non-military applications. It is a result of many years of work of a large team of researchers and engineers, putting into our disposal a water-treatment process that achieves new qualitative levels in terms of the equipment's and the treated water's parameters in comparison with everything else used in water treatment.

This project was awarded the highest honors by the "XXI Century's High-Tech" 10th Anniversary International Forum – a golden figure of St. George (in 2009), as well as more than fifteen other awards at various international fairs dedicated to innovation.

Based on CD's implementation at more than 25 facilities currently it is possible to make objective conclusions on the product's efficiency, environmental safety and effectiveness compared to other means of water disinfection for the utilities' water supply systems.

1. Economic benefits.

In the table below you'll find a comparative of ratios of specific operating costs of disinfecting a cubic meter (1 m³) of drinking water under various disinfection procedures and their combinations at the average equivalent dosages of disinfectant. The data takes into account implementation of chlorine safety assurance measures, maintaining and implementing sanitary protection zones, the costs of a hazardous production facility risk liability insurance (in the case of using liquid chlorine), maintenance of electrolyte baths and waste management, maintenance of UV-plants and ozone generators, the need for
pretreatment (in case of UV-treatment) and for additional water purification to remove harmful byproducts (ozonizing treatment), the costs of transportation, loading and unloading operations in the central band of Russia's regions.

Comparative table of cost ratios (specific operating costs) of disinfecting a 1 m³ of potable water through different disinfection procedures and their combinations at the average equivalent dosages of disinfectant. (*)

<table>
<thead>
<tr>
<th>Item #</th>
<th>Disinfectant's designation</th>
<th>Comparative cost ratios of treating a 1 m³ of water</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&quot;Chlorine Dioxide and Chlorine&quot; Compound Disinfectant</td>
<td>1,00</td>
</tr>
<tr>
<td>2</td>
<td>Liquid chlorine</td>
<td>2,22</td>
</tr>
<tr>
<td>3</td>
<td>Market-type hypochlorite (imported) Mark A</td>
<td>4,06</td>
</tr>
<tr>
<td>4</td>
<td>Electrolysis hypochlorite (obtained in-situ) Mark E</td>
<td>2,74</td>
</tr>
<tr>
<td>5</td>
<td>UV + Liquid chlorine</td>
<td>2,62</td>
</tr>
<tr>
<td>6</td>
<td>UV + Hypochlorite Mark A</td>
<td>3,91</td>
</tr>
<tr>
<td>7</td>
<td>UV + Hypochlorite Mark E</td>
<td>3,24</td>
</tr>
<tr>
<td>8</td>
<td>Ozone + Liquid chlorine</td>
<td>3,83</td>
</tr>
<tr>
<td>9</td>
<td>Ozone + Hypochlorite Mark A</td>
<td>5,11</td>
</tr>
<tr>
<td>10</td>
<td>Ozone + Hypochlorite Mark E</td>
<td>4,79</td>
</tr>
<tr>
<td>11</td>
<td>Potassium permanganate + Liquid chlorine</td>
<td>9,80</td>
</tr>
<tr>
<td>12</td>
<td>Potassium permanganate + Hypochlorite Mark A</td>
<td>11,01</td>
</tr>
<tr>
<td>13</td>
<td>Potassium permanganate + Hypochlorite Mark E</td>
<td>10,45</td>
</tr>
</tbody>
</table>

(*) Specific operating costs of water disinfection per 1 m³ using the CD were conditionally taken as the base value.

Thus, from the above data it is clear that the use of the CD reduces operating costs of water treatment by a factor of 2 to 11, depending on the technology used.

To give you an example, implementing the DCh-100 at certain water treatment facilities using underground waters and replacing liquid chlorine with CD resulted in a reduction of operating costs by 2.8-3 times, and in case of surface water at one of the facilities – by 3.04 times.

Moreover, based on own and international experience the use of chlorine dioxide (it being the main active component of the composition of the Chlorine Dioxide and Chlorine Compound Disinfectant) allows
you to remove biofouling and rust in the distributing network pipes, preventing any new formations from appearing. The clogging up and the reduction of the cross-section of pipes is therefore "blocked". Calculations show that after 5 years of operation any pipes transporting water treated with chlorine or hypochlorite become 50% clogged. This leads to an average increase of 50% in the consumption of electricity by pumps pumping the same volume of water and, as a consequence, to the reduced service life of the motors and pumps, their premature wear and damage, resulting in additional costs to repair or replace them. Since using the Compound Disinfectant eliminates the above mentioned additional hydraulic resistance of pipes, the economic benefit is obvious. Based on the experience of operating the DCh-100 installations, the removal of deposits takes 4 to 9 months depending on the condition and extent of a piping network.

**Using the Compound Disinfectant:**

1. Eliminates the need to implement sanitary protection zones around water treatment units, as required in the case of using liquid chlorine;
2. Eliminates potential environmental hazard to the public and staff in connection with the storage, transporting and handling of liquid chlorine;
3. Removes water treatment facilities from the class of hazardous production facilities associated with the use of liquid chlorine;
4. The installations of the DCh-100 type generate neither harmful gas emissions nor liquid waste, as opposed to electrolysis plants installed by the water utilities to produce sodium hypochlorite in-house;
5. Improves working conditions of attendant staff;
6. Eliminates toxic carcinogenic OCs from water;
7. Eliminates the need to use of special closed filters as in the case of water ozonation;
8. Eliminates the need for an additional purification of water from the harmful ozonation by-products.

**3. Decontaminating effectiveness of Chlorine Dioxide and Chlorine Compound Disinfectant:**

The CD's effectiveness compared to traditional chlorination is characterized by:
- Higher decontamination and oxidation capability (10 times);
- Strong disinfecting effect in a wide pH range;
- Dramatic effect on spores, viruses, and algae;
- Improvement of the impurities coagulation and flocculation processes;
- Extended (up to 7-10 days) prolonged action in the water supply networks;
- Removal of biofilms and microbial fouling deposits in the installations’ equipment and distributing pipelines, and the consequent prevention of biofouling as such.

As compared to ozonation and ultraviolet irradiation treatments:
- Comparable decontamination effectiveness;
- Prolonged disinfecting effect;
- Competent replacement of UV- and ozone-treatment along with eliminating the need for additional chlorination.
4. The "UNICHIM & EP" Company does the engineering, supervision of mounting and installation, warranty and post-warranty servicing of plants producing the Chlorine Dioxide and Chlorine Compound Disinfectant, carries out water treatment facilities modernization projects. Introducing a new technology in water disinfection, as a rule, means completing a research work related to the study of a particular source of supply and of quality of its source water, reviewing the disinfectant dosage selection and other stages of water treatment. The "UNICHIM & EP" Company being a research organization copes well with this task, and never leaves a project until positive results of the implementation are obtained.

The DCh-100 type plants for CD production are fully automated, safe, do not require permanent attendance, consume little power (power consumption does not exceed 0.1 kW), have small dimensions (1000*1000*320 mm), and the water treatment facilities' modernization entails basically organizing a separate warehouse for the reagents. The plants come with a 12 months warranty period, starting from the commissioning date, or 18 months from the date of purchase, whichever comes sooner. The DCh-100 Make 0,1, DCh-100 Make 0, 5, DCh-100 Make 1,0K, and DCh-100 Make 2,0K produce correspondingly 100, 500, 1000 and 2000 grams of chlorine dioxide per hour.

The RosTechNadzor-assigned service life of the plants is 7 years. After an inspection and audit of the installation it can be extended by another 7 years.

All the necessary approvals for Russia and the Customs Union's countries authorizing the Chlorine Dioxide and Chlorine Compound Disinfectant and the DCh-100 series plant for the CD production have been obtained. Patents have been taken out in Ukraine and Kazakhstan for the DCh-100 plant.

The developed product has received positive opinions from leading Russian water treatment organizations.

Thus, it can be concluded that the Chlorine Dioxide and Chlorine Compound Disinfectant is the single currently existing universal and highly effective, environmentally safe replacement for the liquid chlorine, as well as for other disinfection procedures, enabling you to produce a better and safer drinking water (and hence reduce the morbidity rate, improve the quality of life and increase the life expectancy of the population) **while substantially reducing the water treatment operating costs.**
Further information is available at our website www.unichim.ru

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