Although chemical weapons have been produced since the beginning of the twentieth century, there is still no ready practical solution for their detoxification. Accordingly, in this time period, only the rather one-sided process of stockpiling takes place. The public now realizes the immanent threat associated with a dangerous state of chemical weapons stockpiling, and during the last decade this public perception has led to a large-scale search for practical measures to solve the problem.

Burning is believed to be the most reasonable means of destruction of stockpiled chemical weapons. In practice, three methods have been developed to attain this goal: common incineration, plasma chemical processing, and high-temperature detoxification.

The best achievements in the development of these methods have been obtained at the following sites: the method of common incineration has been most successfully practiced in the United States at the world’s two largest sites for chemical weapons destruction; the best technical results in plasma chemical supertoxicant detoxification have been obtained at the complexes of the Mozer-Glazer Company, Switzerland, and in the town of Muenster, Germany. The method developed in Russia is based on high-temperature detoxification with the employment of rocket technologies.

1. The Technological Process

The technological process is based on the thermo-chemical method of transformations of a substance to be detoxified and includes a number of sequential stages: high-temperature decomposition (T=2000-3000°C), re-oxidation and chemical bonding of decomposed elements, a multi-stage system of neutralization and suppression of final low-toxic compounds. In accordance with the nature of physicochemical processes the realized thermal mode occupies an intermediate position between common burning (T<1500°C) and plasma-chemical detoxification with a specific temperature level on the order of tens of thousands degrees. A selected working temperature makes it possible to overcome an essential disadvantage inherent in common burning which results in the formation of high-toxic intermediate dioxin class compounds, as well as to avoid the main shortcomings of a plasma-chemical process that is extremely complex and expensive. Consideration of a number of ecological, energy, and economic parameters in the process allows for an approach which yields an optimal solution to the problem.
2. The Scientific and Methodological Basis

The scientific and methodological basis for the developments comes from the latest achievements in aerogas dynamics with unbalanced chemical conversions, supersonic multistage ejectors, and design and construction methods used in the development of rocket engines.

The engineering facet of the unit is based on the employment of technologies developed in the rocket industry. For this reason, a technical aspect of the unit differs principally from that of standard incinerators and reaction chambers for plasma detoxification where all the processes take place in compliance with a so-called "burning in volume." The main working elements of the unit -- combustion chamber of a missile engine, reaction chamber, neutralizer, absorber -- are located in a sequential line and operate on the principle of process formation in a high-velocity stream. To complete the unit, prefabricated components and machines of missile engines are used. This made possible a high energy capacity, small dimensions, and a high level of automatization of the unit.

3. Results

The results of the work include the entire complex of sequential stages of the fabrication of the unit and optimization of the technological process on its basis. Samples of main types of compounds containing chlorine, fluorine, sulphur, and phosphorus were tested. In the final stage of this work the following samples were detoxified: trichlordiphenyl (PCB class), the pesticides hexachlorocyclohexane, dichlordiphenyltribromphenol, dichlophos, and carbophos, as well as disinfection liquids on a phenol base. As stable results of main ecological parameters the following levels of concentration were achieved: HCl - 14 mg/m³ with a permissible limit (30 mg/m³); HF - 0.14 mg/m³(2 mg/m³); SO - 0.01 mg/m³(50 mg/m³); and PH₃ - 0.23 mg/m³.

An integral chromatographic-mass-spectrometric analysis of samples of absorbing water solution and solid precipitate for the class of polychlorides containing dioxin within the precision limits showed that dioxins were not discovered.

For the detoxification of the most widely spread toxicant of trichlordiphenyl and hexachlorocyclohexane types in terms of 1 ton of a substance to be detoxified requires: 300-400 kg of oxygen, 30-40 kg of kerosene (diesel fuel), 400-600 kg of burnt lime, 10-20 kg of carbamide, 3-4 tons of cooling water.

The unit is operated by three men.

In 1994, a commercial module of the unit for the detoxification of those pesticides prohibited for use was constructed under the order of the Ministry of Agriculture of the Russian Federation. With an output of up to 1 ton per hour of substances to be detoxified, the dimensions are 4.5 x 1.8 x 1.5 m, which allows for the production of the unit in a portable version. The first technical tests carried out in the Ryazanskaya region confirmed proper operation of all the systems of the unit.

At present the developments performed are at the stage of commercial testing.

The cost of materials used for the operation of the unit is essentially lower as compared with similar commercially produced units.