

special
chemical
technologies



JAKUSZ 
challenge turns into success

JAKUSZ



Ladies and Gentlemen,

Several years ago, special chemical applications became one of the main areas of JAKUSZ interests. Together with the production of blast-proof containers and ammunition disposal lines, chemical technologies developed by us belong to most sought-after solutions in Poland and all over the world.

JAKUSZ SpaceTech, our subsidiary established especially to develop new chemical technologies, achieved numerous successes. The flagship in this area are projects conducted together with the European Space Agency. ARIANE 5 rockets, using our environmentally friendly fuel, participate in exploration of the space – and this is just one of the promising projects on which we work. The challenges drive our development, and contribute to successes of our Customers and company.

We are looking forward to our cooperation.

Bartosz Jakusz
CEO of JAKUSZ Sp. z o.o.

Modern solutions

High quality

Complex projects

Individual approach

Environmental concern



JAKUSZ well-established position in the global defense market

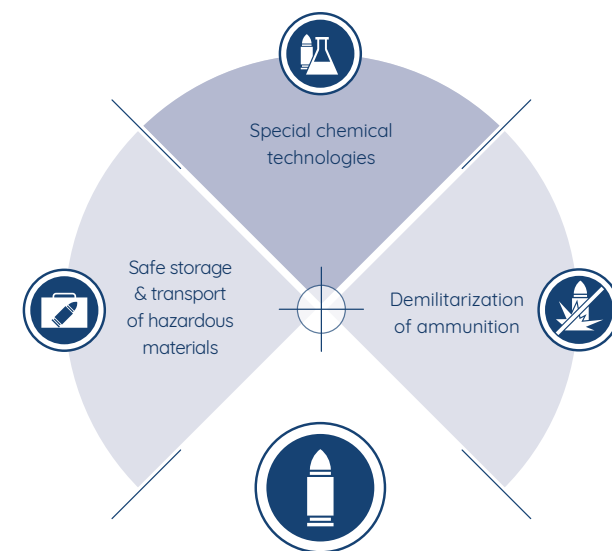
JAKUSZ Sp. z o.o. (Ltd.) is a Polish company with a well-established position on the defense market, and 35 years of experience in the design and implementation of special products and technologies. Our major strengths are our own construction, production and laboratory capabilities, comprehensive solutions, and experienced engineering team.

The latest achievements of the Company include successful execution of the technological projects in Asia, Central Europe, North Africa and Middle East. We also succeeded to perform R&D programs for the European Space Agency concerning oxidizers and propellants (solid and liquid).

High quality and modernity of offered equipment and technologies combined with our flexibility and close cooperation with the customers are the most valuable areas in the company's image, created over the years.

The company's portfolio is composed of three areas of activities:

- safe storage and transport of hazardous materials (hazardous materials blast-proof & storage containers, designated for military and civilian customers),
- industrial demilitarization of obsolete ammunition (mobile, containerized ammunition disposal lines, including recycling technologies),
- development and implementation of special chemical technologies (for defense and civilian applications).





Range of JAKUSZ services

JAKUSZ Sp. z o.o. has the extensive know-how in ammunition disposal, mechanics, automation, and chemistry, while its competencies acquired during execution of research and development programs translate into products optimally suited to specific customer requirements. Company activities are based on internally designed solutions and on R&D projects developed together with Polish and international experts.

In the area of chemical products, the company focuses on setting up of the technological lines for production of special chemicals, including high-energy explosives, components of explosive compositions, and propellants (solid and liquid).

The company offers complex services for technological lines, including:

- **design,**
- **construction,**
- **assembly,**
- **commissioning,**
- **testing,**
- **start-up**

together with training of line operators and technical support.

Projects executed by JAKUSZ concern installations of various production capacities, starting with the laboratory scale up to extensive production complexes with complete logistic facilities.

Research & Development Center

The JAKUSZ Research & Development Center runs various R&D programs, including space and ammunition applications, insensitive explosives, liquid propellants, oxidizers and binders. With its extensive experience and innovative design engineering, JAKUSZ Center can both develop new technologies and adapt existing technological solutions to special wishes of our customers.

Technological lines designed by the R&D Center are based on the latest solutions available on the market in terms of safety, process automation and environmental protection.



Offered technological lines

The design of technological lines enabling production with the environmental impact limited to the minimum is of crucial importance for the company. Wherever possible, closed systems for water and liquid raw materials circulation are selected.

Furthermore, “green” components, e.g., solvents, are used in the production process, which are environmentally friendly, while offering the same efficiency as traditional ones.

The offered technological lines can be used for manufacturing of the following chemicals:

- **High energy explosives:** Octogen (HMX), Hexogen (RDX),
- **Plasticizers:** Di-n-propyl Adipate,
- **Components of explosive formulations and propellants:** Al-Powder,
- **Liquid propellants / Oxidizers:** Hydrogen Peroxide (HTP),
- **Binders – rubbers:** HTPB, CTPB, PB, IPB, and IHTPB,
- **Liquid propellants:** DMAZ,
- **Ion liquids** – used as explosives and liquid propellants.

Production lines under the JAKUSZ brand ensure repeatability and required capacity of production process, while maintaining high safety standards consistent with strict European regulations. The lines are equipped with a modern control module, usually based on the PLC controller, ensuring high safety of the production process. With the use of the latest process automation solutions and CCTV monitoring of key production line areas the range of operations performed by operators and the number of personnel can be limited. Furthermore, a model of production organization can be flexibly modified.



HMX / RDX production line

- Allows production of HMX (Octogen), grade B, in a crystalline form, as per MIL-DTL-45444C, and of RDX (Hexogen) Type I, in a crystalline form, as per MIL-DTL-398D.
- Octogen and Hexogen have many military applications, e.g. HMX in a form of pressed charges or in a mixture with TNT is used for filling of heads of anti-tank missiles. HMX is also used as a base for solid propellants, perforating charges and mining initiators (i.e., “shock tubes”). Hexogen is used as a filling of HE ammunition (in a form of Composition B), as well as a component of plastic explosives and reactive armors.
- The HMX technology is based on the non-acetic method, ensuring the highest purity of the final product. Octogen is made in the process of hexamine nitrolysis. The production process is carried out in two stages. During the first stage, an intermediate product, dinitropentamethylenetetramine (DPT), is obtained by batch nitrolysis of hexamine. In the second stage, DPT is converted into HMX in its stable form β in a continuous process. At both stages, the reaction takes place in a nitric acid environment and does not require the use of substances included in the list of poisons.
- Hexogen is resulting from the reaction of hexamethylenetetramine (hexamine), with nitric acid (V) of a minimum concentration of 98%.
- On a customer’s request, the line can be designed for alternate production of both materials, i.e. HMX and RDX, or can be dedicated to just one of them.
- The line capacity and granulation classes are customized to customer needs.



Hydrogen Peroxide (HTP) production line

- Allows production of high purity 98% Hydrogen Peroxide (HTP) as per military standard MIL-PRF-16005F.
- Hydrogen Peroxide is a strong oxidizer used in the rocket industry, and also as liquid propellant in a monopropellant configuration.
- HTP has similar chemical and physical properties as hydrazine commonly used in the space industry, therefore, it can successfully replace it.
- The production method is easy to apply, economical, and environmental friendly.

Production line for rubbers, e.g.: HTPB / CTPB

- Free-radical polymerization allows production of HTPB – Hydroxyl-terminated polybutadiene, and of CTPB – Carboxyl-terminated polybutadiene.
- Solution polymerization with lithium compounds (anionic polymerization) enables production of the following rubbers: PB – Polybutadiene, IPB – Isoprene – polybutadiene copolymer, IHPTB – Isoprene – polybutadiene polymer with hydroxyl groups at chain ends.
- These polymers have numerous applications in the military industry, improving propellants by increasing their mechanical properties, resistance

to humidity, and durability, e.g., HTPB is a binder of heterogeneous rocket fuels.

- Produced 1,4-Cis-polybutadiene is widely used in the rubber industry as a base for rubbers of various hardness and grindability, used, for example, in car tires.
- Easy and relatively economical production process.
- Quality control covers a broad range of properties of all rubbers.



DMAZ production line

- Allows production of 2-Dimethylaminoethylazide – liquid propellant.
- DMAZ has similar chemical and physical properties as hydrazine, commonly used in the space industry, and can successfully replace it.
- Big advantage of DMAZ is that it undergoes a spontaneous (hypergolic) ignition in contact with some oxidants.
- The most important parameters of DMAZ include its high purity from 90 to 99%, boiling point of 135°C, ignition point of 29.4°C, and density around 0.93 g/cm³.

Ion liquids (ILs) production line

- Enables production of one of three generations of ionic liquids, depending on properties the cation and anion structures are supposed to provide, for instance: TSILs, energetic ILs, catalysts for chemical reactions, bactericides and fungicides, analgesic, and anti-inflammatory products.
- Ionic liquids, like hydrogen peroxide are environmentally friendly, and classified as environmentally friendly rocket propellants (“green propellants”).
- ILs can replace or limit the use of preparations consisting of several compounds, are easy to handle,

and do not require additional safety measures. Therefore they are less hazardous to people and the environment, and this is very important from the perspective of further development of rocket systems based on new propellants.

- Produced ILs are characterized by their high purity, ranging from 90 to 99%.
- Ion liquids have many applications e.g., as solvents with a broad spectrum of activity, and in liquid chromatography, biocatalytic reactions, electrochemistry, energy production, and organic syntheses.



Di-n-propyl adipate production line

- Allows production of high quality liquid Di-n-propyl adipate as per MIL-D-22346B, a military standard for liquid propellants.
- Di-n-propyl adipate is used as a plasticizer in the military industry and in production of plastics, especially polymers, improving their chemical and physical parameters;
- The production method is based on a synthesis of adipic acid and n-propyl alcohol through the esterification reaction.
- At specific conditions, a conversion rate of nearly 100% may be achieved.
- The production process is conducted in an automatic system.

Aluminum powder production line

- Allows production of high quality and purity Al-Powder, with an average particle size of 15 μm .
- The production method is based on the close-coupled atomization of molten metal stream by its exposure to pressurized inert gas.
- Inductive heating used in the process is a modern, cost-effective solution as well as an alternative to electric furnaces.
- The key advantages of the atomizer include:
 - very simple process operation via LCD-Display and appropriately coupled control panel;
 - flexible and economic batch production, giving a high value metal powder, with particles of spherical shape and smooth surface;
 - extraordinary, high stability of the process ensured by the optimized nozzle systems;
 - excellent efficiency of powder, a wide particle size range, due to the use of replaceable, modular atomization nozzles and hot gas atomization.
- The line includes high-performance production equipment, manufactured by European suppliers i.a. by INDUTHERM Erwärmungsanlagen GmbH.



Gas treatment technology

JAKUSZ offers a number of solutions for gas treatment, customized to requirements of our customers. Systems for treatment of the air and technological gases are designed and selected to ensure the most effective and the safest treatment process.

Depending on a contamination type, a dry or a wet method is selected. The dry method is based on the use of various sorbent and adsorbent agents. In the wet method, the main gas treatment process occurs in devices containing the absorbing liquid (columns, scrubbers), while adsorption filters can be used at the last stage, after drying of the process gases.

The devices that may form components of the gas treatment system include:

- cyclones and dust removal chambers,
- afterburners,
- absorption columns and scrubbers,
- condensate eliminating and coalescent filters, mechanical filters,
- sorbent dosing systems, with recirculation,
- pulse bag filters,
- adsorption filters,
- fans,
- emitters.

Possible applications for the described technology:

- treatment of gases in industrial and chemical processes,
- treatment of gases in combustion, thermal or high temperature processes,
- treatment of ventilation air containing particulate solids or hazardous substances,
- treatment of gases in processes conducted in pressure chambers, including post detonation gases in blast-proof containers manufactured by the Company,
- safe collection of post detonation gases samples for laboratory analysis (via cylinders).



The JAKUSZ SpaceTech Research Laboratory

The JAKUSZ SpaceTech Research Laboratory, operating within the structure of the JAKUSZ Research & Development Center, develops analytical testing methods and conducts laboratory tests. It cooperates with the Polish universities and international organizations, including the European Space Agency (ESA). JAKUSZ SpaceTech produces environmentally friendly liquid propellant, HTP, of 98% concentration, used as a substitute of carcinogenic hydrazine. It also researches options for optimizing the currently applied production and testing solutions, as well as develops new technologies, starting with propellants, through active ingredients of drugs and dietary supplements, and ending with semi-products for the cosmetic industry.

The services offered by Research Laboratory include a wide spectrum of tests and chemical analyses, such as:

- Determination of chemical substances characteristics by testing their physicochemical properties (density, viscosity, pH),
- Stability testing of substances, depending on time and temperature,
- Determination of corrosive and oxidizing properties,
- Determination of polymer molecular weight by gel chromatography, and determination of a mass after incineration,
- Determination of the acid, iodine or peroxide value,
- Substance identification by FT-IR infrared spectrometry,
- Determination of substance content by various methods, including ion chromatography, titration, and other,
- Performance of non-standard tests, on a customer requests,
- Consulting services on quality control of customer's products.



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