Together, let's green up our environment!

Management of industrial and medical wastes, contamination elimination and other environmental technologies of Palota Group

KEXPORT

Your Greennovative Partner

Profile of Palota Group

More than 30 years of experience in management, treatment and recycling of industrial wastes and effluents (yearly about 20-30 thousand tons), hospital and medical wastes (about 8 thousand tons/year), and cleaning up of contaminations (total of about 10 million tons of polluted residuals, soil, sludge, groundwater)

Highly educated and experienced engineers and environmental experts (8 with PhD's) for **planning, installation and operation** of the relevant technological systems

Company Group with specified members and a total staff of about 300 in Hungary, experience in Central & Eastern Europe including Romania, Serbia, and Bulgaria

Collaborations outside of Europe including Kuwait, Saudi-Arabia and Indonesia, and advisory in India, Africa, and Mongolia

Total annual turnover about 25 million EUR

Operation of **waste treatment and recycling sites**, hazardous waste **incinerator**, wastewater and sludge **treatment plant**, **waste transport fleets**

Operation of **own laboratory** for accredited sampling and analytical investigation of air, water, soil, food, medicines, as well as for carrying out technological experiments

Environmental advisory including due diligence site assessments (EDD), integrated pollution prevention surveys (IPPC) and impact assessments (EIA)

Research and technology development activities, cooperation with universities and R&D-centres

Relevant certifications (ISO 9001, ISO 14001, ADR, etc.) and application of high-level safety standards

Active **member in the Environmental Export Cluster** (KEXPORT)

Competitive advantages

Utilizing **problem- and site-specific technologies** created through high level engineering, ongoing research, and laboratory testing, innovative and economically viable solutions using best available practices (BATs)

Long-term expertise **installing and running large-capacity treatment systems**, as well as the essential high-level safety applications for environmental impact reduction, fire and explosion prevention, and health protection, **extensive network** of expert firms

Experience working together on **technology transfer**, providing services to international clients, expanding businesses abroad, and providing international consulting services in South Asia, Africa, and India's growing areas

Main clients

Oil companies: MOL Hungarian Oil and Gas Co., ÖMV Petrom, Lukoil Romania, Saudi Aramco and Kuwait Oil Co.

Production companies: SUZUKI Motors, SAMSUNG SDI, ROCHE, GRUNDFOS, GlaxoSmithKline, SK Battery, THYSSEN Group, Kronospan-MOFA Hungary, ALSTOM Hungary, CHIO Hungary, Astra Studios

Chemical companies: Johnson & Johnson, EGIS Pharmaceuticals, TEVA Pharmaceutical Industries, Borsodchem, MEDIMPEX Pharmaceuticals, Richter Gedeon Pharmaceuticals, BVM Budapest Chemical Works, Pharmachem

Hungarian national companies: PAKS nuclear power plant, MÁV state railways, national public road operation company

Medical centres: more than 60% of the Hungarian hospitals and other medical service units

Technology highlights

HAZARDOUS SOLID WASTES

Safe collection and treatment of hazardous, generally toxic and/or flammable industrial wastes, determination of their most feasible disposal or reuse

Development and operation of **waste incinerators,** generation of **energy from waste** by incinerating non-hazardous and hazardous wastes, production of refuse derived fuel (RDF)

Development of **recycling** systems **for battery residuals**

Country wide **medical waste collection and treatment** systems, application **steam sterilizers** for cost effective treatment

INDUSTRIAL LIQUID WASTES

Treatment of technological wastewaters using a wide range of methods, particularly **wet air oxidation and thermal hydrolysis** technologies for the elimination of organic pollutants and cyanide

Large scale **treatment of oil-industry effluents** via separation and selective treatment of oil, water and solid fractions

Recovery of liquid hazardous wastes, **used organic solvents** and **NMP** (N-Methyl-Pyrrolidone) from industrial effluents

Reuse of pyrolysis oil generated from plastic and rubber waste materials using innovative catalytic hydrogenation technology

CONTAMINATED SITES

Complete site remediation with cleaning of polluted buildings, machinery, as well as soil and groundwater

Development and operation of **large capacity ex situ soil cleaning systems** using direct thermal desorption and soil washing

Cost effective **groundwater cleaning using biologically activated organo-mineral**

ENVIRONMENTAL CONSULTING

Environmental **site assessments (due diligence)** for multinational clients according to international standards

Complex **management of contaminated sites** carrying out appropriate investigation and site-specific risk assessment, as well as planning and execution of relevant cost-effective remediation

Environmental **impact assessment** studies for development sites and application of **integrated pollution prevention control systems** for operation sites carried out with related authorisation processes

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Key technologies and services offered by Palota Group are described in next chapters.

Please, contact us, if you are interested in cooperating with us.

Together, let's green up our environment!

Content

HAZARDOUS SOLID WASTES

Solid industrial waste treatment

Technology focus

Appropriately collected hazardous wastes are safely transported to specific **treatment sites**. The usually toxic and/or flammable solid materials are temporarily stored selectively to avoid any uncontrolled chemical reactions that can lead to fire and explosion, as well as to prevent air, water, and soil contamination.

Numerous physical and chemical processes are applied based on the very various forms of hazardous waste that are received and their potential for reuse or disposal. Laboratory analyses are used to regularly monitor their composition, and the amounts are carefully recorded. Site activities are carried out under strict authority control, fire & safety standards, and emissions are appropriately controlled.

Treatment of liquid hazardous wastes is described in separately.

Application

Hazardous wastes are mostly generated by **chemical, pharmaceutical, mechanical and food industries**. Typical harmful solid residuals are used powder chemicals, sludgy sediments of technological effluents, wrapping and packaging materials contaminated or mixed with hazardous materials. **Polluted building residuals and soils,** mostly asbestos and slags are also treated as hazardous materials.

Technical details

Hazardous solid wastes that have been received are **carefully weighed and categorized**. Materials that are readily reused, such as packing materials and fragments of metal, plastic, and wood, are quickly separated and cleaned. The rest is eliminated as hazardous waste.

The composition, key physical and chemical parameters are analysed in own laboratory for **appropriate classification** to determine their treatment and disposal method. This investigation mostly includes the determination of their calorific value, concentration of pollutants, and water content.

The hazardous materials are then **shredded, mixed with conditioning additives**, and occasionally wetted with liquid wastes or dried and the liquid phase is separated by decantation, filtering. Finally, they are re-packed appropriately for **selective temporary storage**. Storing areas are roofed, well paved, and provided with secondary containment (spilling) retention, as well as fire alarm and prevention systems. Additional substantial activity is the cleaning of used and contaminated machinery, vehicles and containers using chemicals and water.

Final disposal of the pre-treated hazardous solid wates is determined according to their composition. They are primarily incinerated, but also deposited to landfills. Specific solution for disposal is their stabilization and application as cover material on existing large-area waste deposits that are provided with appropriate pollution prevention.

Experiences

Palota Group has **long-term experience** with efficient treatment, disposal and recycling of different hazardous and other wastes generated mostly in industrial processes. It receives annually about 10 k tons of solid hazardous wastes in a year, mostly industrial sludges, contaminated packaging materials and polluted building residuals.

PHOTOS

Re-packaging

Temporary storage

Hazardous waste incineration

Technology focus

Incineration is efficiently applied **for disposing of wastes,** also dangerous residuals **that are difficult to reuse or recycle**, materials. They are utilised as **refuse-derived fuels (RDF)** in incinerators specifically tailored to wastes and in conventional burning units added to other combustible materials.

Safe waste incineration requires precise execution of different **well-synchronized activities** including waste preparation, appropriate dosage into the burning units, usage of generated energy, appropriate treatment of flue gases, wastewaters and burnt residuals before their emission or evacuation.

Application

Incinerated hazardous wastes are typically contaminated wrapping and packaging materials, used solvents and other chemicals, industrial sludges and medical wastes.

Refuse derived fuels (RFD) are efficiently utilised particularly at power plants and cement factories, for example contaminated plastic residuals that are appropriately prepared for incineration.

Technical details

Operation of waste incinerators is carried out according to the following scheme.

Solid wastes are temporary stored in recipient bulk containers, roughly sorted and shredded, then homogenised before forwarded for incineration. Liquid wastes are transferred directly into the oven in closed pipeline system from their storage tanks.

The **appropriate mix of waste materials to be burned** are determined according to their composition and combustion parameters that are examined by laboratory investigation. Many types of solid, liquid, and gaseous wastes can be burned that are differently combustible. In this aspect, key technological element is the determination of the optimal waste mix composition for the incineration.

Burning is mostly carried out at temperature of about 800-900°C in specific, mostly rotary drum furnaces in case of large capacity incinerators, while smaller units are mostly provided with fixed ovens. Natural gas or electricity is used only for heating up the furnaces, the burning units are even cooled during the process.

Generated **flue gas is burnt after,** at temperature of 1100°C to reach necessary combustion-efficiency. Steam is produced from **generated heating energy** that is used directly in other waste technologies or for electricity generation via steam turbines.

Cooled **flue gas** (150-300°C) is **cleaned before release** to meet relevant air emission limits. The applied technology uses calcium-hydroxide powder and liquid natrium-hydroxide to eliminate acidic pollutants, activated carbon to adsorb volatilized pollutants (such as dioxins, furans, mercury), as well as sack filters to remove flying dust. Additional dioxin adsorber is also applied, if necessary.

High-level process control is utilised within the plant, sensors are applied at key technological steps, collected data are recorded and processed automatically by computers. Technological wastewater is cleaned on the site and partly recycled. The quality of generated flue gas, burning residuals (ash) and outlet wastewater is continuously monitored to meet pollution prevention requirements.

Smaller units are operated similarly, but with simpler technological elements according to the quality and quantity of utilised waste materials.

Application of **hazardous wastes as refuse derived fuels (RDF)** specifically includes appropriate selection of collected wastes, determination of calorific value and burning conditions of the utilisable materials, as well as identification of generated hazardous components during burning and their technical effects, environmental impacts. The operation of a general incinerator is appropriately adopted then to the use of a specific RDF according to these conditions.

Experiences

Palota Group is **experienced in planning, installation and operation** of large capacity waste incinerator plants, as well as smaller burning units, mostly concerning hazardous wastes.

A **waste incinerator plant** has been operated **since 1990 in Hungary** (Győr). It is currently allowed to receive 12 k tons of waste in a year (1.4 t/h), mostly hazardous wastes (90%). The plant produces energy by steam generation (3-4 t/h) that is used partly directly in other waste treatment technologies, as well as in electricity production. Operation is carried out by high level standards controlling the quality of received wastes, air emission and other environmental impacts.

A similar waste incinerator plant was commissioned **in 2012 in Romania** (Slobozia), but with larger capacity of 23 k tons of waste per year. Palota Group played key role in installation of the plant and supervises its operation.

An incinerator of hazardous medical wastes has been utilised with capacity of about 3.5 kt/year (9.6 t/day) since 1992. The combustion unit involves fixed oven with 2 gas burners, off gas afterburner connected to steam generator, off gas cooler and cleaner units.

PHOTOS

Burner

Loader

Medical waste management

Technology focus

Medical waste **collection, transportation and treatment** regionally carried out in well synchronised and safe system.

Strict public health protection and hazard prevention rules are applied for each related activity. Appropriately certified collection tools and containers are provided for the clients, public transport is carried out according to relevant international ADR rules, gathering and treatment sites are operated according to high-level safety protocols. Urgent hazard prevention services are provided for accidental medical waste related events on the site.

A **well-planned network** of collection points and recipient stations is set up according to the locations where medical waste generation and volumes of pertinent materials occur. The necessary treatment capacity is provided by using the appropriate technologies for the collected infectious and chemically hazardous materials. Utilizing the proper **electronic information system** with real-time data gathering and evaluation, its complex management is successfully carried out.

Application

Service is applicable to **health service units, medical centres, hospitals and research organisations,** that generate infectious and other medical hazardous wastes.

In Hungary, with a population of about 10 million residents, annually about 9-10 k tons of medical wastes are generated countrywide. The number of hospital beds is about 60,000, thus an average of about 0.35 kg hazardous waste is generated daily for each bed. This means that the main part of medical wastes (about 8 k tons/year) originates from hospitals.

Palota Group receives the major part of all the medical wastes generated in Hungary. They mostly involve single-use medical tools and clothes, blood and plasma storage and processing tools.

Technical details

The different **medical wastes are collected separately** according to their proposed treatment and disposal, while strictly **selectively** from other wastes. Clients are provided with certified, single-use paper boxes, plastic sacks, bins, cans (capacity from 0.6 up 60 litres) for onsite collection and temporary storage (generally maximum for 48 hours). All these containers are appropriately labelled and provided with safety warning descriptions. Appropriately packed medical wastes are collected directly from the clients or received at gathering stations, where they are weighed and appropriately stored before passing for final disposal.

Transportation is carried out according to internationally recognised safety specifications (ADR), mostly using special closed box trucks and lorries that are also equipped with tail lift and weighing machine. Transported volumes are strictly recorded and documented, the carriers are provided with necessary safety tools and warning labels, specific attention is paid to maintain hygienic conditions.

Treatment and related disposal methods are determined according to the hazard characteristics of the collected medical wastes. Infectious, but otherwise not hazardous materials are sterilized and disposed of as communal wastes. Residuals with toxic or flammable chemicals are mostly incinerated, while landfilling is very limited. *(See details in chapters of hazardous waste incineration and medical waste sterilization.)*

A complex **electronic information system** is used for up-to-date recording and real-time management of medical waste collection and transport.

Experiences

Palota Group has **30 years of experience** in medical waste management collecting and treating about 8 k tons of medical wastes in a year. About half the collected amount is sterilized the other half is incinerated. Four sterilization units and one incinerator are operated exclusively for medical wastes, but significant amount is also passed to own hazardous waste incinerator plant. Safety collection containers are provided to the clients, specific ADR qualified carriers are in use for transportation and complex information system is applied for management of material streams.

Model calculations are available for setting up similar regional scale medical waste management systems concerning optimal technical solutions **with necessary investment and operation needs**.

PHOTOS

Collection tools

Removal from the site

Medical waste incinerator

Sterilization of medical wastes

Technology focus

Sterilisation is applicable for **disinfecting wastes that would otherwise not be hazardous**. Treatment is carried out **within steam in high pressure vessels (autoclaves)** typically with low-and medium capacity. This is an affordable and technically simple method to transform of the originally hazardous materials to non-hazardous wastes that can easily be disposed of as communal wastes.

Without sterilization and cooling, these wastes can be stored onsite for a maximum of 48 hours and afterwards collected and transported as hazardous wastes at a higher cost. Therefore the using low-medium volume sterilizers near the waste's point of origin (hospitals) is economically warranted.

Application

Infectious medical, but chemically non-hazardous **wastes,** any used materials such as bloodied scrubs, diapers, swaths, sharps, or any by-products from operations are treated via sterilization. Hospitals and

national health agencies have strict rules for handling materials contaminated by pathogenic microbes, human body residuals, or originating from the treatment of particularly virulent diseases.

This technology **is not** appropriate for treatment of used medicines and other chemicals, animal residuals, amalgam containing wastes, cytotoxic and cytostatic medicines, as well as any packaging contaminating with these materials.

These **low-medium volume equipment** are ideal for larger hospital centres or regional collection points, where 3-6 tons of infectious waste accumulates daily.

Technical details

The process begins within the medical centre itself, where the medical waste is collected in so-called one-way packaging (bins, thick plastic bags or boxes). This precaution avoids any transfer of pathogens to the population or to works. Once at the treatment site, these packages are **loaded** into the treatment unit.

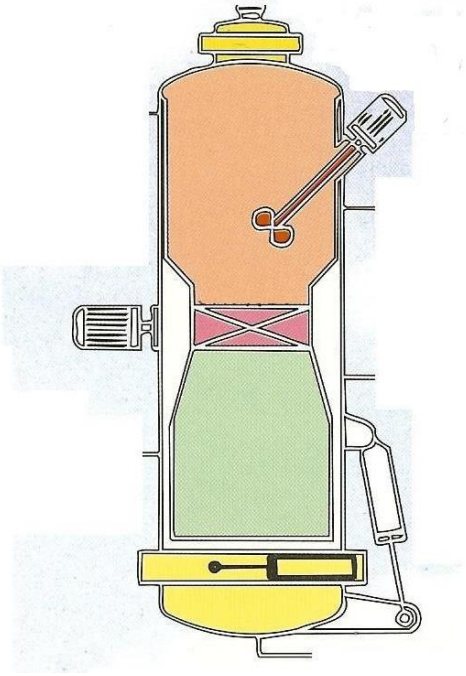
Within the autoclave, the waste is homogenised into 2cm pieces via a special **mixer and grinder** process. The cutting knifes are hardened and arranged with special geometry for required efficiency. Their rotation direction is changed frequently for separation of larger non-cuttable pieces and avoiding technical damages.

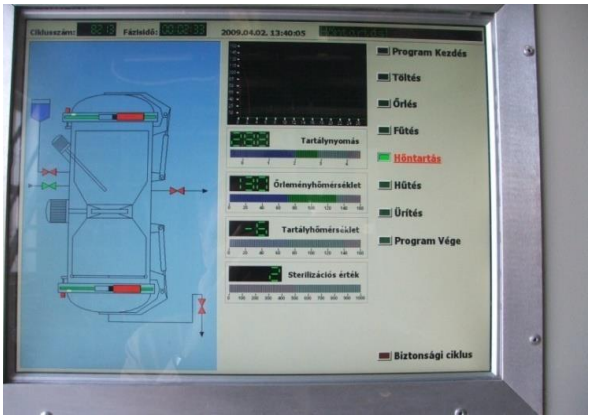
Sterilization is performed by **using steam in the autoclaves** at a pressure of 3.8 bar and temperature of 138 C° for a minimum of 10 minutes. This allows the residual germ number of pathogenic microbes to decreases below 10^{-8} within the treated waste material, to achieve the necessary safety level as required by human health standards.

The typical autoclave size is: 0.3, 1 and 2 m^3 with treated waste amount of about 40, 120 and 240 kg in one 40-60 minutes operation cycle.. About 3-6 tons of wastes can be treated with this equipment in one day. The maximum steam consumption of 270, 370 and 500 kg/ha is provided separately.

The temperature of the output material is reduced to 40-50 C° by cooling down the autoclave itself with circulating water in its double vessel wall. The original volume of treated medical wastes decreases by approximately with 20-40% during the treatment. The sterilized material can then be **disposed of as communal wastes**.

Operation is **automatically controlled**, the treatment is accomplished in confinement as to avoid all **recognisable emissions**, just odour is generated during loading and releasing. Subject to regular microbiological monitoring, the effluent is discharged into the public sewer system without the need for specific cleaning.





Experiences

Palota Group has had a long term **experience with installation and operation of waste sterilisers.** Currently, four 1 or 2 m3devices are utilized.

As the **licence owner for the CLAVE sterilizer technology** (models: TDS 300 / 1000 / 2000), the Group looks forward to technology and know-how transfer cooperations both on the regional and international markets.

PHOTOS

Steam sterilizer on operation

HAZARDOUS LIQUID WASTES

Industrial wastewater cleaning

Technology focus

Treatment of industrial wastewaters is based on **physical and chemical separation** of contaminants. The goal is to achieve water cleanliness levels that allows its discharge into the public sewer system to be treated in public wastewater plants. The removed materials can be occasionally reused, but generally it is further treated and disposed as hazardous wastes. In other cases, the **contaminants** of the wastewaters are **decomposed** mostly by oxidation, thermal hydrolysis or other chemical reactions.

The different methodologies are appropriately designed using a **wide range of technical equipment** tailored to the tasks. Output quality is strictly monitored to meet technological and environmental requirements.

Application

Technological wastewaters are produced by **pharmaceuticals, cosmetics, paints and adhesives, metal processing** (car manufacturing, surface treatment), and **food production** (slaughterhouses, milk and ice-cream production facilities, wineries, canning facilities, fish farms, etc.) processes.

Technical details

The **treatment** of industrial wastewaters mostly includes neutralisation of highly acidic or alkaline effluents, extraction of pollutants by coagulation and flocculation using appropriate metal salts, polyelectrolytes and other additives. Final phase separation is achieved via flotation, settling or screening. The generated sludge containing the removed pollutants is dried, then further treated and disposed of as solid hazardous waste, mostly via incineration..

At times, **specific treatments** are carried out depending on the presence of different kinds of pollutants that can be removed or decomposed using specific physical and chemical methods. Contaminants are separated typically using evaporation (concentration), encapsulation, adsorption and absorption techniques. In other cases, they are decomposed with application of catalytic or non-catalytic oxidation-reduction processes and other chemical reactions.

The following specific technologies are the ones mostly used:

Concentration (thickening) by evaporating the effluents' water content fraction is basically used for decreasing the volume **of liquid wastes** for further storage and treatment. It is also applied for separation and recovery of inorganic and organic materials in wastewater that have

higher boiling point than of the water, such as salts, photo-chemicals and oils. This method may be applied only when the treated wastewater does not contain volatile pollutants.

Wet air oxidation is used to decompose different **polluting organic components** of industrial wastewaters by using injected oxygen at high pressure (120 bar) and high temperature (300-350°C). The process is carried out in a high-pressure vessel, with no added supplementary heat or chemicals necessary. Generated gases are separated and treated; water effluents are discharged.

Thermal hydrolysis is particularly applied to decompose **cyanide** in effluents without oxygen use and addition of any chemicals. The process is carried out at 80 bar pressure and 205°C temperature with residence time of 60 minutes. Extra heat is necessary for the reaction. Cold inlet and hot outlet waters are passed through in the same heat exchanger for recovering energy. Generated decomposition gases are separated and fixed in ammonium hydroxide solution.

Experiences

Palota Group has been operating **a wastewater treatment plant** in Hungary since 1994 with capacity of 150,000 m^3 per year (~430 m^3/day). About 60% of received liquid wastes are technological effluents with mineral oil, vegetable oil and fat, as well as with other contaminants such as cyanide and toxic metals (particularly chromium). A composting unit is also operated at the site for treatment of non-hazardous sludges.

Mobile wastewater cleaning unit (capacity of 1.5 m^3/h) is also used for treatment of wastewater with inorganic pollutants (typically chromates, heavy metals) and neutralisation of alkaline or acidic effluents. The equipment basically includes treatment container, sedimentation tank and sludge filter-press. Additives are applied automatically via using pH and ORP sensors.

A special 1 m^3/h capacity **water evaporator unit** is also in use. It is heated with steam, the evaporated water condensed and discharged into the public sewer system, while the thickened materials are collected in 1m^3-containers.

Wet air oxidation unit with capacity of 0.25 m^3/h has been operated since 1995. It is also applied also for thermal hydrolysis at lower temperature without oxygen injection.

Thermal hydrolysis unit was installed 20 years ago and is still operated with 1.5 m^3/h capacity for elimination of cyanides from technological wastewater of a pharmaceutical production plant.

Treatment (recently) of 11,000 m^3 highly acidic and alkaline effluents originating from degreasing and passivation of steel tubes and tanks at a brand new chemical plant.

PHOTOS

Condensation (evaporation) unit

Mobile wastewater treatment unit

Thermal hydrolysis unit

Treatment of oil-industry effluents

Technology focus	Crude oil extraction (mining) and refinery processes generate a significant amount of **oily-water effluents with varying sediment content**. Treatment technology is focused on the **effective separation** of these phases and reuse of the cleaned oil and water. Overfloating oil is decanted, then the oil, water and solid material fractions of the collected effluent are separated using centrifuges. As the required quality of treated oil and water is achieved, they are returned to oil production processes or appropriately disposed of. The remaining oil-contaminated sediments are treated separately using large capacity ex situ soil cleaning systems *(described in relevant chapters).*
Application	**Oil-water effluents generated by oil industry** in large volumes are generally collected and **temporarily stored in open air basins**, so called oil ponds. These basins are usually equipped with appropriate lining to prevent leaking and infiltration into the natural soil layers. Free oil phase is overfloating, while solid particles are sedimented, so oily water is located intermediately. These materials are regularly removed from these storage areas and need to be treated appropriately for possible recycling.
Technical details	**Liquid phase extraction** includes the removal of deposited oily effluent from its storage areas (typically from oil ponds) using high-capacity screw pumps and transfer to treatment containers. Free-phase oil is removed as separately as possible. Oily water is decanted, then the residual sludge is conditioned, homogenized and its **oil-water-sediment content is separated** using tree-phase centrifuges and by adding emulsion breaking and coagulating chemicals. Oily water is **further treated** by using two-phase centrifuges or mobile wastewater cleaning units. Outlet sludge can be treated as oil contaminated soil using different methods. **Recovered oil** has less than 1% water content with the processed **water** generally reaching a petrol hydrocarbon content of less than 100 mg/l. Separated solid material contains about 3-5% hydrocarbons and are treated further using capacity thermo-desorber or by composting (*see chapter large capacity ex-situ soil cleaning systems).*
Experiences	**Removal and treatment of annually 10,000 m^3 oil-water effluent** at oil ponds of Al-Khafji Joint Operation (Saudi Arabia) in the period of 2014-2019, in cooperation with Alghanim International (Kuwait)

Removal and treatment of around 60 k tons of floating hydrocarbons, oily water and liquid sludge during cleaning up of petroleum ponds in West-Romania in the period of 2009-2012, in cooperation with Vivani Salubritate SA. Additionally, about 273 k tons of oil polluted sludge and soil was treated separately using thermo-desorption technology.

PHOTOS

Oil pond in Saudi Arabia

Oil pond in Romania

Three-phase separator centrifuge

Regeneration of organic solvents

Technology focus

Organic solvents are **regenerated through fractional distillation.** In this way contaminated organic solvents are cleaned, extracted from containing wastewater or their reusable fractions are separated from mixtures. Dichloro- -methane, acetone, isopropyl-alcohols (IPA), methyl tert-butyl ethers (MTBE), methyl isobutyl ketones (MIBK) are the typical materials recovered via this technology.

Specific distillation is applied for the recovery of **used N-methyl-2-pyrrolidone (NMP)** solvent generated mainly during Li-NMC battery production. The technology is suited for generating an industrial grade NMP for reuse.

Application

Used organic solvents are **typically generated in pharmaceutical and chemical industry** (cosmetics, paint, adhesive production), as well as in metal processing and surface treatment technologies.

NMP is an organic compound used in the petrochemical, polymer and **battery industries** as solvent, exploiting its nonvolatility and ability to dissolve diverse materials.

Technical details

The technology includes fractional distillation of **halogenated or halogen free synthetic organic solvents**. The resulting technological effluents are primarily decantated and dewatered, if necessary. The applied technology consists of a **steam-heated distillation column and a cooling unit**. As the treated materials are highly flammable, the equipment must be fire and explosion safe, as well as provided with automatic process control. Recovered solvents are reused according to their quality that is examined in the company's own accredited laboratory. Residual wastewater is further treated if necessary and finally discharged.

NMP-recovery technology begins with the analysis of received effluent, to determine its water and heavy metal content. According to these parameters, the appropriate treatment method is applied. Distillation of NMP is carried out at a temperature of 200C^{o}, then condensed and separately collected. The distillation residuals typically contain **reusable graphene and metals**, such as nickel, manganese and cobalt that can be recycled..

Experiences

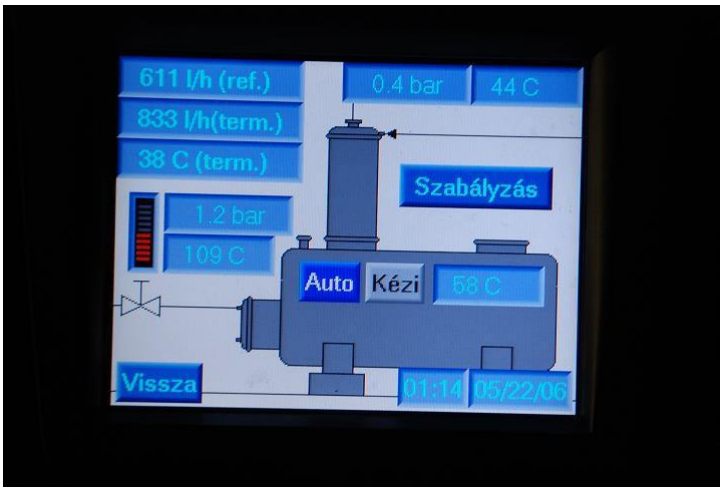
A special, 10m^3/day distillation unit was developed within a successful R&D project about 10 years ago. About 1-2 k-tons of used organic solvents have been treated annually since then. Particularly successful recovery is carried out for materials such as: ethyl acetate and methyl alcohol from alkaline effluent, toluene and tetra-hydro-furane from mixture with di-chloro-methane.

About 1,000 tons/year of **NMP containing effluents** are treated by the Group. Currently, technology is under development to gain higher efficiency and capacity, while the results are promising.

PHOTOS

Distillation unit of solvents

Control unit



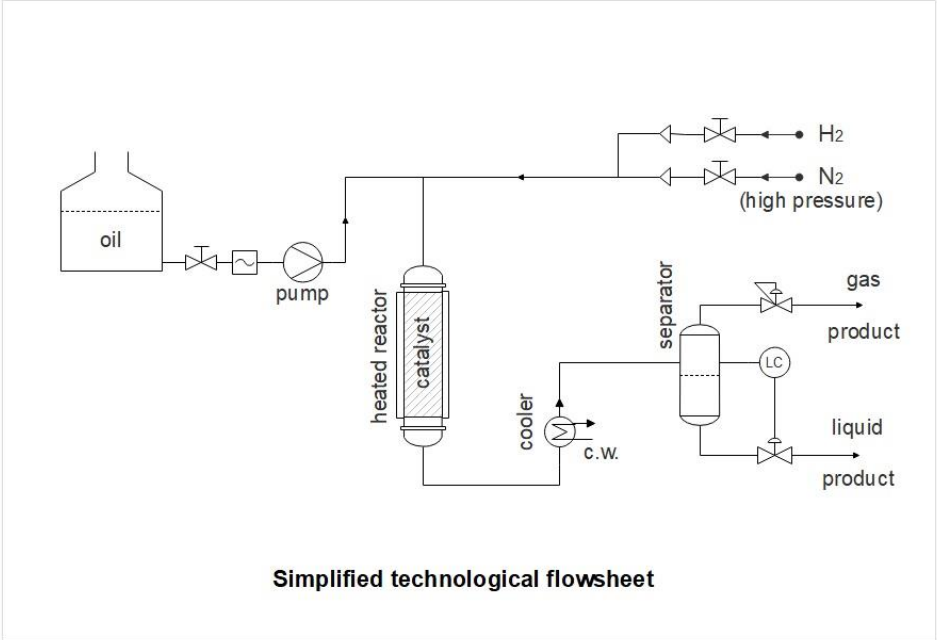
Pyrolysis oil refinement

Technology focus

Rubber tyre and plastic wastes are increasingly processed by cracking pyrolysis technology to generate reusable gaseous and liquid hydrocarbons. The liquid phases, oils are hard to reuse, therefore our technology is being enhanced to improve their quality by gaining **stable and odourless liquid hydrocarbon fractions.** with higher market value. We apply specific catalytic hydrogenation process that is developed particularly for the treatment of pyrolysis oils.

Application

The main **problem with the oil fractions generated during pyrolysis** is their instability and varying quality. The liquid pyrolytic oils have high content of olefins (35-40%) and aromatic hydrocarbons (about 35-60%), so they tend to form resinous, sedimentary precipitates that foul technological equipment. Their high sulphur content (up to 2%) causes corrosion and results in extremely unpleasant smell. These conditions significantly limit the reuse of pyrolysis oils in their original form as fuel and other specific oil products.



Simplified technological flowsheet

Technical details

The petrol and diesel fractions obtained by distilling the **pyrolysis oil are hydrogenated** by our technology. According to the *simplified technological flowsheet below,* the hydrogenation process is carried out **in a heated reactor** in the presence of appropriate catalyst by adding high pressure hydrogen and nitrogen. Output materials are cooled, while the gaseous and liquid fractions are subsequently separated.

Appropriate temperature, pressure and catalytic materials are needed for the necessary stabilization (mainly by decreasing its olefin content to 1-3%) and desulfurization of pyrolysis oil fractions. The resulting products are clear and less odorous

Experiences

Palota Group **developed its basic catalytic hydrogenation process during 2018-2019.** The technology is particularly suited for the stabilization and desulfurization of pyrolysis oil fractions. A **follow up R&D project** is in process to achieve a more effective treatment of the residual olefins and sulphur containing compounds through a hydrogenating process and by optimizing the catalyst types as well as increasing the lifetime of the regenerated material. The results should be more economically suitable for higher scale production.

Through **regional cooperation with Slovakia, Palota** is recently launched an operational scale pyrolysis plant.

PHOTOS

Experimental equipment

Treated pyrolysis oil

CONTAMINATED SITES

Clean-up of polluted sites

Technology focus	**Complete site remediation** includes cleaning or demolition of abandoned buildings and machinery, collection, removal and disposal of deposited wastes, cleaning of contaminated soil and groundwater. Wide range of different ex situ and in situ cleaning technologies are applied according to local conditions.
Application	Site remediations are executed when a given site's use is limited due to present pollution or when it poses unaffordable risk to surrounding land uses and nature. They are carried according to **clean up targets** specifically determined by the results of former site investigations and related risk assessments. Usually authorities oversee and approve the specific remediation process.
Technical details	Palota Group applies a **wide range of techniques** for cleaning up of contaminated sites. At times methods are combined as necessary. Typically, the polluting materials (deposited hazardous materials and wastes, tainted building residuals) are removed first from the site and appropriately disposed of. The soil and groundwater are subsequently cleaned using a variety of remediation techniques including soil washing or changing as necessary. **Polluted soil and groundwater** are mostly extracted and treated by using high-capacity cleaning systems, as the ex-situ methods are faster and more controllable. Well-developed relevant techniques are available, as they are similarly applied for treatment of solid and liquid hazardous wastes. The cleaned soil and groundwater are then recycled on the site as much as possible. In-situ treatments are also applied occasionally, particularly the enhanced biodegradation of organic contaminants in soil. *See also relevant Chapters of 'Large capacity soil cleaning systems', 'Treatment of oil-industry effluents' and 'Industrial wastewater cleaning'.*
Experiences	Successful **elimination of chloroform contamination** at a storage site of a pharmaceutical company, treatment of around **400 m^3 extracted groundwater** (In Hungary, it is still the only one successfully completed

cleaning of a medium polluted with organic solvent containing halogens.)

Demolition of buildings, selected deposits of inert building materials (49.3 tons), removal and reuse of iron wastes (2.4 tons), and **appropriate disposal of hazardous wastes (2.6 tons)** at a 10-ha site of former chemical factory, where pesticides and insecticides had previously been produced (carried out within short time, 6 months, and under the strictest safety measures and scrutiny of the public and responsible authorities)

Removal and disposal of **300 tons of solidified bunker fuel** (tar) and subsequent cleaning of 2 x 10,000 m^3 storage tanks at a central heating plant of Budapest

Removal and disposal of around 12,000 tons **of heavily contaminated soil** with organic pollutants at a former waste burning site of a pharmaceutical company in the period of 1997-2008

Removal and disposal of ~20,000 **tons of hazardous wastes** containing tetra-chloro-benzene from a former landfill site of a chemical company

Pump and treat technology for cleaning of **10,000 m^3 groundwater contaminated with polyaromatic hydrocarbons** (PAHs) at a former railway sleeper manufacturing site in 2021-2022, as well as carrying out monitoring

Removal and **disposal of around 9,600 tons of soil, pump & teat cleaning of 26,525 m^3 groundwater** contaminated with organic pollutants at stations of the Hungarian Railways in the period of 2002-2014, and supplementary groundwater monitoring until 2019

PHOTOS

Clean up of railway loading site

Treated site

Large capacity soil cleaning systems

Technology focus

Significant amount of polluted solid geological mediums (mostly soil) is cleaned effectively by using large-capacity ex situ treatment systems. Different inorganic and organic contaminants are **washed out** by applying water and chemicals. Volatile organic pollutants are separated by evaporation by applying **thermal desorption**, while easily biodegradable organic contaminants are decomposed using enhanced simple biological processing, i.e., **composting**. These technologies are carried out with the help of heavy machineries that provide appropriate conditions for quick and large-volume treatment. Cleaned soil is then reused while contaminants are mostly eliminated or just separated during the process.

Application

Ex situ soil cleaning is generally used, when polluted soil bodies need to be excavated for appropriate remediation of a site or contaminated solid geological mediums are separated during other cleaning processes such as reclamation of oil ponds.

Technical details

Palota Group applies **soil washing** for cleaning soil that is contaminated with organic compounds that can be separated by using water and flotation.

Input soil is shredded to particle size of maximum 5 cm and loaded into washing unit with application of strong water jets. Here contaminants and soil particles smaller than 2 mm are removed and passed into treatment tanks. **Larger particle-size soil fraction is** further **washed** and evacuated by using screw conveyors.

The **mixture of washing water, fine soil fractions and pollutants** treated with pH-levelling and surfactant chemicals during stirring in the **conditioning** tanks. The prepared mixture is then forwarded into separation containers, where **contaminants** along with the chemicals are **coagulated and floated over** using intensive air sparging. Sediment soil slurry is thickened in cyclones, then finally filtered out, while pollutants are removed from washing water using press-filters.

The **efficiency of cleaning is about 80-99%**, the capacity of applied equipment is 25-35 tons of contaminated soil per hour. Water consumption is 4-6 m^3/h, as main part of washing water is recycled.

Thermal desorption is applied for treatment of soil with volatilizable organic pollutants, typically petrol hydrocarbons.

Contaminated soil is **shredded and homogenized** to have particle size less than 50 mm. It loaded into the treatment unit via feeding hopper and loading conveyors.

Thermal desorption is carried out in a large heated rotating cylinder, where **organic pollutants** (especially petrol hydrocarbons) are **volatilized and evaporate** at temperature of 275-350°C. Soil is passed through the desorption unit by screw conveyors, the temperature of treated soil is lowered to 70°C before evacuation using pulverized water.

Exhaust material is let through cyclones to separate dust and the **organic evaporates are oxidised in an after-burner** at temperature of 800-870°C. The hot burnt gases are then cooled to 170°C in heat exchangers, neutralized using calcium-hydroxide and finally filtered before releasing to air. The volume and concentration of emitted materials meets relevant air protection limits.

Composting technology (enhanced biodegradation) is used for the cleaning of soils moderately contaminated with organic compounds (typically with petrol hydrocarbons up to 5%) that are not toxic to decomposing microbes. Polluted soil is mixed with structuring materials (mostly agricultural by-products) and as necessary with nitrogen and phosphor containing fertilizers. The mixture is piled, and optimal oxygen and moisture content is maintained for **effective biodegradation** by regular remixing, watering and continuous coverage.

Experiences

Onsite treatment of **lindane contaminated soil using soil washing** system in the Town of Torda (Romania), total volume cleaned was around 80,000 tons in 2010-2012 in cooperation with Vivani Salubritate SA

Removal and treatment of about 273,000 tons of oil polluted sludge and soil using thermo-desorption units during cleaning up of petroleum ponds in West Romania in the period of 2009-2012, in cooperation with Vivani Salubritate SA (About 60,000 tons of liquid phase was treated separately.)

Palota Group maintains **one soil washing, 3 thermal desorption units and soil composting equipment**.

PHOTOS

Soil washing unit

Thermal desorption unit

Composting site

Biologically activated organo-mineral for groundwater cleaning

Technology focus

Natural organo-minerals generally have a **high capacity for adsorbing and simultaneously decomposing different contaminants**, thereby being an effective component within technologies for cleaning polluted soil and groundwater.

Alginite is a specific oil-shale that was discovered and is still mined in Hungary. After an appropriate industrial process and microbiological enhancement, alginite can be effectively used for adsorption as well as the biodegradation of organic contaminants.

This application leads to cost effective and environment friendly remediation technologies, as the cleaning agent is of natural origin with enhanced cleaning capacity.

Application

Alginite contains mainly clay minerals (mostly montmorillonite), as well as about 30-35% lime and 10-20% organic materials.

Due to its complex composition, it **effectively adsorbs a wide range of inorganic and organic contaminants** such as heavy metals and other toxic elements, as well as petrol hydrocarbons, BTEX compounds, polycyclic aromatic hydrocarbons, aliphatic and aromatic halogenated hydrocarbons. During treatment, the **biodegradation** of organic pollutants can be significantly enhanced with the simultaneous application of decomposing micro-organisms.

Appropriately prepared and microbiologically activated alginite can effectively be used for treatment of polluted soil, wastewater and contaminated groundwater, as well as polluting gaseous components.

Technical details

Specific pump & treat technology was specifically developed **for the application of alginite** for the cleaning of groundwater contaminated with hydrocarbons.

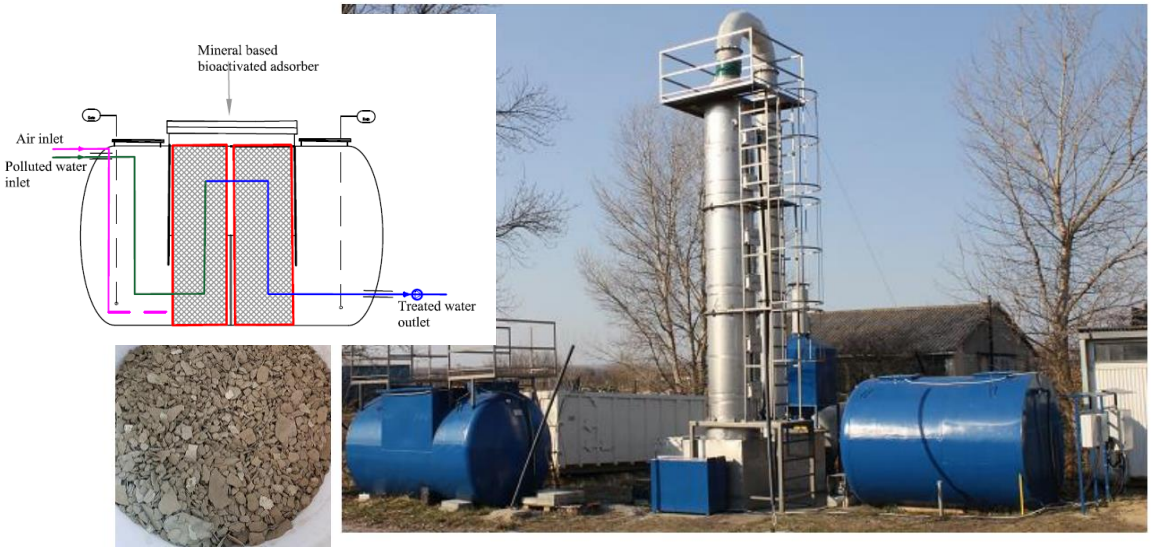
Mined alginite is appropriately grinded and sieved, then inoculated with selected decomposing microorganisms with natural origin. This prepared cleaning agent is then **filled into** filtering compartments of a **treatment tank**. Contaminated groundwater is extracted from subsoil and passed through the treatment tank along with continuous aeration. (See technological flow-chart below.)

The process is controlled remotely by application of censors and real time data management. The quality of inlet and outlet groundwater is monitored by frequent analysis.

The operation of the **groundwater treatment** tank using alginite is determined based on site specific conditions, considering the types and the concentration of pollutants present in the groundwater. If

necessary, its application can be supplemented with other water cleaning techniques such as decantation and sedimentation, filtering, air stripping, etc.

Experimental equipment for groundwater treatment tank applying Alginite



Experiences

With its research partners, Palota have recently carried out an **R&D project** for cleaning of hydrocarbon polluted groundwater with application of appropriately prepared and microbiologically activated Alginite.

This innovative remediation method was successfully tested in 2021 at a contaminated site using a pilot installation with a capacity that is suitable for normal operation. At the test site, the extensively contaminated groundwater, with polycyclic aromatic hydrocarbons (up to 1,000-2,000 µg/l), is treated using the Alginite technology in combination with air stripping and filtering with activated carbon.

The concentration of polycyclic aromatic hydrocarbons (PAHs) and other less significant pollutants (petrol hydrocarbons and BTEX compounds) in the treated groundwater were **efficiently decreased to below the relevant site specific clean up target value** (in case of PAHs ≤150 µg/l) that had previously been determined by the environmental authority.

Due to the successful pilot, the application of the developed groundwater cleaning system is presently maintained and operated for the site's remediation by Palota Group as per and the relevant authorial requirements.

As result of the R&D project, the application of alginite for cleaning of contaminated groundwater has been **patented**.

ENVIRONMENTAL CONSULTING

Due diligence site assessments

Technology focus

Environmental due diligence site assessment (EDD) is carried out to provide understanding of the **environmental liability and compliance situation** of the concerned site.

The survey is basically performed and presented in order to identify the **existence and likely extent of environmental issues** associated with the current and historical site operations that can have a material impact on either the value or the operability of the investigated property.

Additionally, it can enhance the value of the asset, e.g. existence of transferable permits or emission offsets, abatement equipment, etc. The existing environmental performance is also assessed also towards **good household and national standards**.

Application

Environmental due diligence is generally carried out **in case of acquisition of a site** or its owner/user company. It is also useful tool **for self-audit**, particularly when several sites are assessed using the same methodology.

EDD is applicable to all sites with past and/or present operations including effective offsite activities that had or have any environmental impact. Typically, production plants, warehouses and office facilities are examined, but abandoned or unutilised properties also where historical or offsite environmental impacts are expected.

Technical details

The assessment is performed according to **the internationally recognised ASTM-standard E-1527-13 and ISO 14001 guidelines** as applicable locally. Main goal is to identify any environmental liability and compliance issues of the site and its operations. Additionally related basic health and safety topics are also assessed.

To meet these goals, the following **scope of work** is performed:

- Review of material collected by the facility supplemented by specifically requested environmental documents as they pertain to local conditions,
- Site inspection of the facility including a site walk-over, interviews with available members of the management team and photo documentation,
- Review of data, assessment of available historical, geological, hydrogeological and topographical maps for the area and of materials collected during the site visit,

- A review of available information from public and authorial databases (as available within timeframe);
- **Identification of key issues, and actual or potential future environmental liability risks or key non-compliance issues, as well as determination of materiality issues**,
- Preparation of a report collating all the information obtained for the sites investigated and presenting the findings and recommendations in a summarised form.

As applicable to the site, mostly the **following topics are examined**:

- handling, storage and use of (hazardous) materials,
- water and wastewater management,
- emissions to air, external odour and noise load,
- presence of PCB and asbestos containing materials,
- contamination in soil and groundwater,
- flood and fire risks,
- general health and safety issues.

During the assessment, the **relevant legal rules and the specific authority requirements** to the site are carefully considered, the availability of appropriate permits for facility usage and operation is thoroughly checked, with particular focus on environment related items.

In case of identified potential pollution or other unclear environmental impacts, **relevant investigations are also carried out**. The presence of asbestos or PCB containing materials in buildings, contaminants in soil and groundwater, emitted pollutants to air and the water systems, as well as noise load to sensitive neighbourhood areas are typically examined.

Experiences

Our senior environmental consultant has **more than 20 years of substantial experience** in environmental consulting with major expertise in environmental due diligence site assessment.

He has carried out **about 100 EDD surveys** at production plants, warehouses and office facilities mostly in Hungary, but also in Romania and Poland, mostly in relation to acquisition of the site or the owner/user company as part of complex due diligence (also technical, legal, financial).

Generally, the involved **clients were multinational companies** such as MASSIVE, PHILPIS, RADICIFILM, TESCO, MICHELIN, LEVI STRAUSS, GENERAL MOTORS, RYNART, MODINE, NIKE, PEPSI.

Management of contaminated sites

Technology focus

The management of contaminated sites is a **complex activity** generally covering exploratory investigation, associated risk assessment, necessary remediation and follow up monitoring. It aims to provide legally and technically feasible, as well as cost-effective site-specific solutions for **handling the polluted mediums with allowable risk**.

Application

Contamination at a site occurs in case of **polluting activities** when hazardous materials get out into the environment. These include leaks of storage tanks, spills in large amount, deposits without protection or directly into natural geological mediums.

Caused contamination in natural mediums (mostly in soil and groundwater) is generally considered when pollutants are observed in concentration exceeding their natural occurrence. Related **threshold values** (warning limit values) are mostly defined by applicable environmental regulations, but internationally accepted reference values are also available for evaluation.

Once contamination is identified, further actions are carried according to the relevant environmental regulations and best practices.

Technical details

Primarily, the polluting **contamination sources** are illuminated or isolated, with released hazardous materials cleaned up, collected, and removed.

Next, the **investigation of the polluted mediums** (mainly soil and groundwater, but also deposits, construction and machinery elements) focuses on identifying the contamination level and its spatial distribution. Field tests and geophysical surveys are carried out to determine contamination hot spots and their potential spreading. Sampling and analytical investigation of polluted mediums are then performed in an optimal way designed according to the preliminary observations.

Geological, hydrological and other natural conditions are also examined that influence the behaviour and transportation of contaminants in subsurface layers. Mostly groundwater and geotechnical field tests, laboratory measurements are carried out, then the potential spreading of pollution is determined by hydrodynamic modelling.

The potential contamination receptors (human and other natural beings) are identified, and relevant **risk assessments** are elaborated for determination of maximum allowable concentration and amount of contaminants at the site. This establishes safe parameters and conditions for actual and future land uses concerning the potential exposure of human and natural receptors. This assessment is based on

modelling using site data and reference values. As needed, supplementary ecotoxicological tests are also carried out.

As the site's maximum allowable level of pollution is identified, decisions can be made on further actions. Clean up targets and related **remedial measures** are determined, and the necessary soil and groundwater cleaning technologies are planned and designed for execution.

The efficiency of the clean-up activities is supervised during the process with **residual contamination** being generally **monitored** after termination of the remediation.

Experiences

One of our senior environmental experts has **20-year experience** in complex management of contaminated sites. He **completed investigation, risk assessment and remediation procedure** at 6 oil industry sites contaminated with petrol hydrocarbons, as well at site investigation with risk assessment and preparation of clean-up plan at 2 larger former railway sites contaminated with toxic metals, petrol and halogenated hydrocarbons.

Impact assessment and integrated pollution prevention control

Technology focus

Environmental Impact Assessment (EIA) is the assessment of the environmental consequences of a plan, policy, program, or actual development projects prior to the decision to move forward with the proposed action.

Integrated Pollution Prevention and Control (IPPC) is a regulatory approach aimed at preventing or reducing the environmental impact of concerned activities. It involves a comprehensive and integrated approach to identifying and controlling all aspects of pollution arising during operation.

Both EIA and IPPC **examine the effects of site operations to the environment**, emission of contaminants to air, soil, surface- and groundwaters. The human and nature related **risks and the extent** of emissions are determined by model calculations or actual measurement result.

Based on the results, the **necessary preventive measures** including emission monitoring are determined and implemented during the site development and operation to prevent or control pollution to minimize the impact on the environment. Additionally, IPPC evaluates the application of environment related **best available techniques** (BATs) and defines relevant requirements.

Application

EIA and IPPC studies are generally prepared **during permitting procedure of a given site's developments and operations**. Their application is mostly integrated into the relevant legal processes and related authorial decisions (obligations) are basically made according to the findings of these surveys.

Performing these studies during the development and operational phase will help avoid unforeseen future expenditures by minimizing the likelihood of unexpected future pollutions generated by said operations.

EIA and IPPC are typically required in consideration with the following activities: operation of power plants, mining, metallurgy and metal processing, mechanical engineering, large scale chemical processes, paper, textile, leather, animal breeding and food processing, production of building materials, waste treatment and disposal.

Technical details

As applicable to the concerned site, EIA and IPPC examine and concern mostly the following **potential impacts to the environment**:

- water consumption and identify the related sources such as public water network or direct extraction,
- generation, treatment and discharge of wastewaters, particularly contaminated technological effluents, their potential contamination effect primarily to surface waters,
- potential contamination to soil and groundwater particularly by handling, storage and use/treatment of hazardous materials and wastes,
- emission of pollutants to air by operation of heating, cooling and technological exhaust systems, and related external odour effects,
- noise load and vibration effect to sensitive receptors, mostly to residents at neighbourhood areas.

EIA is based on model calculations using expected operation parameters and reference values considering effects and risks more widely to human and natural receptors, while **IPPC mostly investigates actual operations** and their direct impacts.

The application of **available best techniques (BATs)**, as well as the occurrence of **accidental events and related hazard prevention** measures are also assessed.

Experiences

Our environmental experts **carried out several EIA and IPPC** surveys during the last decades. These include EIA for the establishment of logistic and storage centres, production plants of cosmetics and car spare parts (plastic and metal), as well as IPPC for waste incineration plant, chemical and pharmaceutical factories, hazardous waste treatment and deposit sites, beer production plant, cellulose processing and aluminium-metallurgy factories.