INTRODUCTION

Water represents a standard civilization norm of the time and society which we manage and in which we live. Following the vision of the 21st century, when water will become the basis of the world’s business and political scene, we have built a modern biological waste water treatment plant in the town of Koprivnica.

A well organized and regulated treatment of waste water implies: collection and drainage of waste water through a drainage system, efficient treatment before discharging into the recipient within the legal quality standard and setting an example of responsible management and comprehensive use of water.

The main purpose of the waste water treatment plant is to treat water until it is safe to be discharged without worsening or endangering the natural state of the environment.

The beginning of the sewage system construction dates back to the early 1960s. In the town of Koprivnica and its suburbs, more than 95% of the system has been constructed to date. Currently, the system is 202 kilometers long. The sewage system is mostly mixed-type, which means that both fecal and rain water is drained through the same system. All accumulated waste water is drained through the main collector heading north-east from the town to the village of Herešin where, after being treated, it is discharged into a natural recipient Moždanski Jarak, until it reaches a stream, the Bistra, and eventually the river Drava. Until 1989 waste water was discharged without being treated. In the same year a pre-treatment plant was built, but its technology and treatment capacity was far from the satisfactory quality of waste water. This quality can only be achieved by using technology which includes preliminary, primary, secondary and tertiary level of treatment.

The Agreement of the construction of the waste water treatment plant of the town of Koprivnica by the international FI-DIC norms was signed on 25 August 2005 with the main contractor Astra International Inc. Zagreb on a turn-key basis. The construction of the plant began in August 2006 and was finished in June 2007. Its capacity is 100 000 Equivalent persons (EP) and it runs on the basis of SBR technology (sequencing batch reactor). SBR represents a discontinued process of the biological treatment of waste water, where different phases of the treatment process alternate within one reactor.

In compliance with the principles of European Water Charter (Strasbourg, 6 May 1968):

“When used water is returned to a common source it must not impair the further uses both public and private”, we will contribute towards sustainable development and protection of the environment of Koprivnica and its surroundings.
Drainage and treatment of waste water represents one the infrastructural bases of modern life. At the end of the sewage system, waste water is treated and discharged into a natural recipient, a waterway which flows into the stream Bistra and further on into the river Drava, within quality standards complying with all applicable national regulations. This can be achieved by using technology which includes preliminary, primary, secondary and tertiary level of treatment.

After initial treatment on a coarse screen, water is primarily treated in a compact chamber consisting of a fine screen, a sand trap and a grease trap. Due to considerate oscillations in the quantity and quality of waste water SBR technology has been chosen for waste water treatment in Koprivnica.

SBR represents a discontinued process of the biological treatment of waste water, where different phases of the treatment process alternate within one reactor. These include filling, aerobic digestion, anoxic, anaerobic digestion, sedimentation and conveyance of treated water.

The final stage of waste water treatment includes sludge treatment by aerobic digestion, dewatering and MID-MIX technology which is founded on a physico-chemical reaction of sludge with reagent based on Calcium (CaO and Ca (OH)₂). This creates a chemically inert powder - solidificate - which can be used in the construction industry or be disposed of in a second category landfill without having a harmful effect on the environment.
INITIAL TREATMENT

Initial treatment of waste water uses a coarse screen in order to remove all large objects that are deposited in the sewer system, such as sticks, rags, leaves, plastic objects. This process is automated.

PRIMARY TREATMENT

Primary, mechanical treatment includes a fine screen, a sand trap and a grease trap.

The fine screen removes smaller, hard objects such as paper, cloths, plastic objects and hygiene products.

After that the water is treated in a cylindrical sand trap along which there are air vents. Air is blown through them causing turbulences which help separate organic from nonorganic matter. Other items such as sand, grit, and stones are removed here.

During ventilation, grease and buoyant matter rise to the surface (oils, mineral oils, petrol, fuel) and these are skimmed off by a pump.
Secondary biological waste water treatment includes the application of aerobic, anoxic and anaerobic processes where microorganisms disintegrate ingredients containing carbon, nitrogen and phosphorus. Secondary treatment is conducted in SB reactors.

Phosphorus treatment

An increased intake of phosphorus into natural water is the main cause of eutrophication. It is therefore important to extract phosphorus from waste waters before discharging it into a recipient.

In order to reach a regulatory prescribed amount of phosphorus, PAC - a decanting agent - is used. It is a highly polymerized polymetal hydroxide-chloride mixture which binds phosphorus from waste water and puts it in a sludge flocculant.

The polymer agent is stored in a 25m³ tank and is dosed into a common pressure line which transports waste water into SB reactors. The quantity is dosed proportionally to the water level increase or according to a weekly regime which takes into account different phosphorus concentrations in incoming waste waters. The dosing product quantity is about 5-7 kilograms per one kilogram of phosphorus exuded.
The fundamental characteristics of SBR technology are:

- Each reactor represents a separate reactor unit with all biological treatment processes. This means that one reactor can be put out of order for servicing purposes without interrupting the functioning of the whole waste water treatment plant.

- SB reactors operate on the principle of active sludge.

- Oxygen aeration is done by distributing compressed air using E-Flex module consisting of 12 aeration tubes placed paralelly in a stainless steel frame at the bottom of each SB reactor. Each tube is perforated, allowing air escape. Simultaneous or alternate stirring of the contents of the reactor is conducted by Hyper-classic floor mixers which allow and ensure central-symmetric mixing, symmetric profile of flow, strong flow at the bottom, economical electricity consumption and extremely easy maintenance. Combining both processes in parallel and alternated sequence achieves the target process of biological treatment which includes a nitrification and denitrification processes.

- The reactor content oscillates between two levels of water. During the filling phase the waste water is transported into the reactor while being stirred continuously in order to achieve the maximum level of water. This is followed by subsequent reaction and sludge sedimentation while achieving ideal hydraulic conditions.

- The result of the sedimentation process is a precise separation of purified water and sludge settled at the bottom. Using a mobile T-shaped device for decantation, the purified water is drained from the reactor without disturbing the sludge. When the minimum level of water is reached, the drainage is stopped and the reactor is ready to be refilled with waste water.
Mixing, aeration and decantation in SB reactors

An optimal sequencing of aeration, mixing and sedimentation phases is essential for an effective operating of SBR processes.

The mixing is conducted by Hyper-classic floor mixers which rapidly and intensively spin the sludge settled after sedimentation and decantation process.

The advantages of Hyper-classic mixers are:

- They produce an intensive and symmetrical flow at the bottom of 0.3 m/s with power density below 3.0 W/m³ which significantly reduces energy consumption.
- High plant endurance is exclusively achieved by downward axial power which affects the plant’s system and at the same time causes a slight mechanical load.
- The mixers are built of plastic and reinforced with glass fibers which results in a low weight and total corrosion resistance.
- All parts susceptible to wearing and requiring maintenance are above the water level which enables easy maintenance and service.
- The mixing technique does not destroy sludge flakes because the mixers have rotor blades which create the strong effect of floating sludge.
Compressed air aeration is done by using the E-Flex modules consisting of 12 aeration tubes placed in parallel into a stainless steel frame. The tube is built of EPDM (ethylene propylene diene M-class rubber) which ensures extremely long duration, permanent flexibility and wear-resistance. It is perforated and creates a big area for the escape of air.

There are 76 large plate modules at the bottom of the pool in each reactor. The air is supplied from two rotational piston blowers whose total performance is 120% of a theoretically needed air quantity. The blowers run simultaneously - one with a constant number of turns while the other is frequency-regulated. In case one of the blowers breaks down, the other one keeps running at 60% of the necessary capacity, enough for the minimum oxygen supply to biological ingredients.

Drainage of purified water is a very important part of the process because, unless the decantation devices are positioned properly, they can stir the sludge and mix it with purified water.

The decantation device, a T-shaped tube decanter, is used and it is connected to the fixed drain pipe. Vertical T-shaped trough consists of an eduction pipe and outlet pipe and it is slowly lowered using a robust electro-davit winch and raised back up after the decantation process.

As soon as the sedimentation phase finishes, a trough is slowly lowered. The eduction shutter is used to stop the floating sludge from entering. The depth of immersion is limited by conductive sensor, located at the top of the decanter, which releases a sound when in contact with the medium. It is slowly lowered until the minimum level of water is achieved. There are three DN 350 decanters in each reactor, each with a 350 l/s capacity.
Sludge surplus is created during a biological treatment process in SB reactors. It is removed and transported by a pressure pipeline to sludge tanks where it is accumulated, solidified, aerobically stabilized and centrifugally dewatered. After that, the sludge containing 25% of dry solids is further treated in a MID-MIX plant, creating a final product: an inert solid matter with more than 85% of dry solids.

**Aerobic stabilization and dewatering**

The surplus sludge with 1% of dry solids is processed in sludge tanks which are alternately filled with surplus sludge. Three 200m³ tanks were built and equipped in order to enable stirring with aeration, stirring without aeration and sedimentation with waste water drainage.

The process is the following:

- The reactor is filled with surplus sludge while being stirred and aerated. This achieves an effective stabilization.
- After the filling, the next phase is sedimentation which lasts 24 hours. During this time, the sludge settles and creates around 3% dry solids. Using the height adjustable decanter, waste water is extracted and brought to a pumping station where it re-enters the treatment process.
- Following the solidification phase is the second stabilization phase which lasts for 2 days.
- After the second stabilization phase comes the sludge dewatering process. Using the eccentric screw pump the solidified surplus sludge is transported to a centrifuge where it is dewatered to >25% dry matter. A mixer runs during this process to achieve as homogeneous sludge consistency as possible.
- After the reactor is emptied, the new filling process begins. At the same time, the second reactor is being emptied, and the sludge is being solidified and stabilized in the third.
MID-MIX technology

MID-MIX is a technological process of sludge treatment and management of the waste water treatment plant in an economical and environmentally friendly way. It allows the use of the final product: the solidificate, which entirely avoids any kind of further devastation or endangering of nature and environment. MID-MIX technological process dewateres, stabilizes, detoxicates and neutralizes sludge, and consists of the following physico-chemical phases:

- Mixing of treatment material in a preparation tank
- Adding reagent based on Calcium CaO and Ca (OH)₂
- Exothermic process reaction
- Dissociation during the treatment process
- Vacuum-gas encapsulation of the material
- Evaporation of steam and filtering of particles
- Solidifying of the material
- Storing solid matter
- Solid matter management (usage)

After preparing the sludge in the preparation tank in order to equalize the content and the quantity of moisture, the planned daily mixture is dosed to the reactor unit. It achieves the working temperature of the exothermic reaction at 80-105°C with the help of reagent based on Calcium CaO and Ca (OH)₂, which are added in appropriate doses. The temperature is needed for the molecular disintegration process, ionic dissociation, stable vacuum-gas encapsulation and complete solidification of surplus sludge.

The steam is filtered in order to collect and recover particles. The final product is a solidificate in the form of a dry, hydrophobic material which is transported to a cooling silo by a line transporter, and packed into so called jumbo bags. The solidificate obtained by sludge treatment is a useful material with more than 85% of dry solids. Owing to its hydro, thermal and acoustic insulating characteristics, it can be used in the construction industry or be disposed of in second category landfill.
Air waste from the pumping station and primary treatment compact machine is transported through vents into a biofilter, a separate unit filled with organic material (chopped tree bark), where the air is biologically purified. The moisture of the organic material needed for operating the biofilter is supplied by dispersing water over the filling of the biofilter.

The biological breakdown process results in residue material in the form of CO$_2$, water and particles which eventually disintegrate within the biofilter.

The purified air is released into the atmosphere.
Town Utility Company Komunalac Ltd. Koprivnica, 15 Mosna Street, is a corporation which has been developing its status and business since the opening of the communal enterprise in 1958. The communal institution offered mostly construction and trading services. Systematic growth of its utility services started during the 1970s and included: the installation of the natural gas system in the town, the taking over of decoration and cleaning, maintenance if green areas, the setting up of carpentry facilities and the merger with the Green market department.

The first natural gas pipeline was built between Jagnjedovec and Koprivnica in 1968. Komunalac became the distributor of natural gas for this part of Podravina. Expanding its services beyond construction and trading services, and after moving to new premises with production facilities in 1978 at 15 Mosna Street, Komunalac intensified the development of trading services and opened a production facility for plastic carpentry, while keeping its utility services on a separate location on 18 Varaždinska Street.

During the 1980s Komunalac increased the number of services, went through the most significant organizational changes and by training and recruiting highly skilled personnel it developed a qualified company structure. On 1st January 1990 the Utility Company Komunalac was divided into two separate companies: Public Company Komunalac, completely owned by the town of Koprivnica and Assembly and Construction company MGP Koprivnica.

In compliance with the Commercial law of 1997, the Public Company has been reorganized into a corporation GKP Komunalac Ltd. Koprivnica and consists of five departments. In 2002 Komunalac became the majority owner of Koming with the aim of acquiring a reliable utility infrastructure contractor.

During the last couple of years, the company has extended its services to this part of Podravina, constructed the Biological waste water treatment plant, improved Piškornica landfill through Koming, constructed the recycling yard, had excellent results of the first research of the potential future water well Lipovac, opened its own certified Laboratory for the testing water quality and intensive expansion of water supply network with 114 added kilometers; changed gas steel network for a polyethylene one and constructed two gas odorization stations, expanded and reorganized the Open Market supplying wooden stands and complete infrastructure, widened the town cemetery and redesigned its premises and surrounding buildings.

Komunalac currently has 244 employees, while Koming employs 182 workers. The utility infrastructure has grown to 407 kilometers of gas pipelines, 344 kilometers of water pipelines and 172.5 kilometers of sewer, due to the economic growth and reorganization of the town of Koprivnica. The number of users is also rising. Komunalac maintains utility infrastructure to keep it functional, it raises service standards and contributes towards the general development and image of Koprivnica and its surroundings.
WORKERS AND PROJECT COMPANIES
OSNOVNE DJELATNOSTI

- opskrba pitkom vodom
- fizikalno, kemijsko i mikrobiološko ispitivanje pitke vode i otpadnih voda
- odvodnja i pročišćavanje otpadnih voda
- opskrba plinom
- građenje, projektiranje i nadzor
- projektiranje priključaka i unutarnjih instalacija za plin, kanalizaciju, vodu, grijanje, ventilaciju i hlađenje
- održavanje čistoće
- odlaganje komunalnog otpada
- održavanje javnih površina
- tržnice na malo
- održavanje groblja te obavljanje pogrebnih poslova
- ugostiteljska djelatnost
- obavljanje geodetskih poslova

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BIOLOGICAL WASTE WATER TREATMENT PLANT
OF THE TOWN OF KOPRIVNICA