WASTEWATER TREATMENT FOR POLLUTION ABATEMENT IN POLISH RIVERS

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SUMMARY

Problem description and addressing

The threat to the water quality in the Baltic Sea is focused on nutrients heavy metals and persistent organic substances transported by the rivers as well as by air. The two largest rivers in Poland, the Vistula and the Oder, discharge almost 90 % of Poland's pollutant load to the Baltic Sea. One of the studies for priority areas "The Pre-Feasibility Study for the Vistula River Basin and Baltic Coast of Poland" (1) includes the adoption of measures in the region to reduce the 1987 emission levels by 50 percent by the year 1995. Also the effect on the local environment was regarded. The deterioration of the river water is caused by the discharge of improperly treated wastewater from domestic and industrial sources.

The domestic wastewater treatment is reviewed with special emphasis to the new regulatory effluent limits (November 1991), based on Helsinki Commission requirements. The municipal wastewater treatment plants under construction in 1993 will reduce the amount of untreated wastewater by 8.5 million m^3/day. The new plant in Gdansk with biological phosphorus and nitrogen removal, now under construction, is exemplified.

A specific pollutant problem is the discharge of saline water from coal and sulphur mining. Development of a very deep coal mining, preferred in Poland some years ago due to political and social reasons rather than economical reasons, has created very serious saline water problems. The drainage water from these mines has a daily contribution of, in order of magnitude, 6,500 tons of chlorides and 0.5 ton of sulphates to the rivers Vistula and Oder. The largest amounts of these salts, about 78 %, derive from 18 mines located mainly in the Katowice mine district.

The high salt content in the water from the Vistula causes tremendous economic losses due to corrosion attacks on pipes, machines, etc., within the industry and intensifies the deficit of irrigation water in agriculture and drinking water as well. The classification of water quality in Poland is based on Ministry of Environmental Protection regulations (November 1991). The water quality is defined according to specific physical-chemical and biological criteria in three purity classes. The river water salinity has a crucial impact on this classification. This paper refers mainly to the salinity problem.

Pilot project to abate the salinity problem

At the Debiensko mine a modern Desalination Plant has been erected for zero discharge of the drainage wastewater from two adjacent coal mines Debiensko and Budryck in the Katowice district (2-4). The three main sections for treatment of about 14,000 m^3/day of mine salty drainage with TDS of 8,000 - 115,000 mg/l are the following:

- Pretreatment before reverse osmosis (RO), consisting of disinfection, flocculation/ sedimentation and dual media filtration followed by activated carbon filtration. A detention pond for mixing of the two wastewater streams and algicide treatment during summer time, if necessary, is used for equalization of salt concentrations and flows (av. flow about 12,400 m^3/day with a salinity of around 16,000 mg/l TDS on the average).

- RO-plant, including microfiltration (5μm) and post-treatment of the RO permeate for drinking water production. The RO feed is desalinated at 6-7 MPa through spiral wound membranes, inserted in more than 500 pressure vessels.

- Thermal plant, including stages for concentration of RO reject (about 2,700 m^3/day containing up to 70,000 mg/l TDS) and an admixed brine flow (about 1,870 m^3/day containing up to 115,000 mg/l TDS) from the Budryck mine, followed by crystallization and drying of sodium chloride (NaCl) as well as treatment of the purge from the crystallization process for recovery of additional products in a pilot plant.

  There are two Brine Concentrators operating in parallel according to the RCC principle in falling film evaporators with vapor recompression and a calcium sulphate "seed" recycle system. The single crystallizer is a forced circulation submerged tube evaporator, equipped with a mechanical vapor compressor. The dryer for NaCl-production is a fluidized bed dryer-cooler.

Operation results and technical - economical evaluation

Different problems during the construction period caused delays and additional costs. The thermal plant was started up in August 1993 with the aim to test different stages. The continuos operation of this plant started in September 1994 because of problems with crystallizer recirculation pumps and compressor. The pre-treatment plant and the RO plant were started up during the summer 1995. The purge treatment will be completed up to the end of 1997.

A great number of problems causing operation interruptions have been identified and solved. Special problems can be referred to the composition of the wastewater flows, which have been changed very much compared to the design. It has been favourable to mix the flows from Debiensko and Budryck to a desired degree in order to optimize the RO section and to

increase the operation flexibility. It was also found that the problem with blockage of distributors in the brine concentrators was due to a change in feed chemistry compared to the original specification. The difficulties encountered from the point of view of both process and equipment seem to be overcome now. The operation results from different treatment stages are in accordance with the design data.

The total investment cost for the entire plant is about USD 60 million. Economical effectiveness of the plants is relatively high (as for an environment project). The valuable main products are drinking water (9,700 m^3/d), distillate (4,400 m^3/d) and sodium chloride (276 ton/d) for household and industrial use without any sale problem. Other chemicals, e.g. iodine and bromine, can be recovered by the purge treatment. It has been estimated that the maintenance and operation costs are recovered by selling the salt and the drinking water. A factor also taken into consideration is the fines for salt dumping into the river. The income of the products for sale, taking into account also the savings of penalty fines and environmental fees (ca. USD 3 million per year), implies that the estimated investment cost recovery time would be about 10 years.

Although it may take several more years to completely finish this pilot project, the conclusion is that promising results have been obtained from a technical-economical point of view serving as a model for future desalination plants at other mines along the Polish rivers. The large project under progress at Piast/Czeczott coal mines supports this conclusion.

References

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