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PROGRESS IN SEWAGE TREATMENT TECHNOLOGY ACCOMPLISHED BY THE REGIONAL WATER MANAGEMENT AUTHORITY (RWMA) IN WROCŁAW

Between 1993 and 2001, the Regional Water Management Authority in Wrocław was asked for the opinions on the purposefulness of constructing 60 sewage treatment plants of the throughput higher than 600 m^3/24 h. These opinions included not only technical and process characteristics of sewage treatment plants, but also ecological effects to be achieved after their opening.

The materials on which these opinions are based indicate a significant progress in modern technologies and technical solutions both in construction of new sewage treatment plants and in modernisation of existing plants.

The projects developed in order to improve sewage treatment according to the standards defined in the Regulation of the Minister of Environmental Protection, Natural Resources and Forestry of November the 5th, result in favourable changes in the sewage management in Poland. The improvement obtained in surface water purity, especially with respect to physical and chemical indicators, is a measure of these changes.

1. INTRODUCTION. SEWAGE MANAGEMENT IN POLAND

From the whole area of Poland as much as 9,492.2 million m^3 of sewage effluents were discharged into surface waters in 1999. Most sewage, i.e. 83.3%, came from industrial plants (including 71% of cooling water) and the remaining part consisted of municipal sewage. In figure 1, the percentage share of municipal sewage and industrial sewage, which require treatment, are presented for 1992 and 1999, according to the data collected by the Chief Statistical Office (CSO). This figure presents the share of various kinds of sewage, i.e., sewage treated mechanically, biologically and chemically as well as with increased removal of biogenic compounds for the whole Poland and for the area of the activity of the RWMA in Wrocław.

Of the total volume of 2,664.8 million m^3 of municipal sewage and industrial sewage, which should have been treated in Poland in 1999, 14.1% was discharged into

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receiving waters in the form of crude sewage (mainly from municipal sewers) and in 1992 this figure was as high as 28.7%.

In 1999, in Poland as much as 34.5% of sewage necessitating treatment was treated biologically, 31.9% mechanically and 14.4% in the processes with increased removal of biogenic substances. The remaining quantity of sewage was treated chemically. In 1992, the largest part of sewage, i.e. 33.9%, necessitating treatment was treated mechanically, 32.5% of sewage was treated biologically and 4.8% of sewage was treated chemically. In 1992, no separate figure for a sewage treated in the processes with increased removal of biogenic compounds was reported.

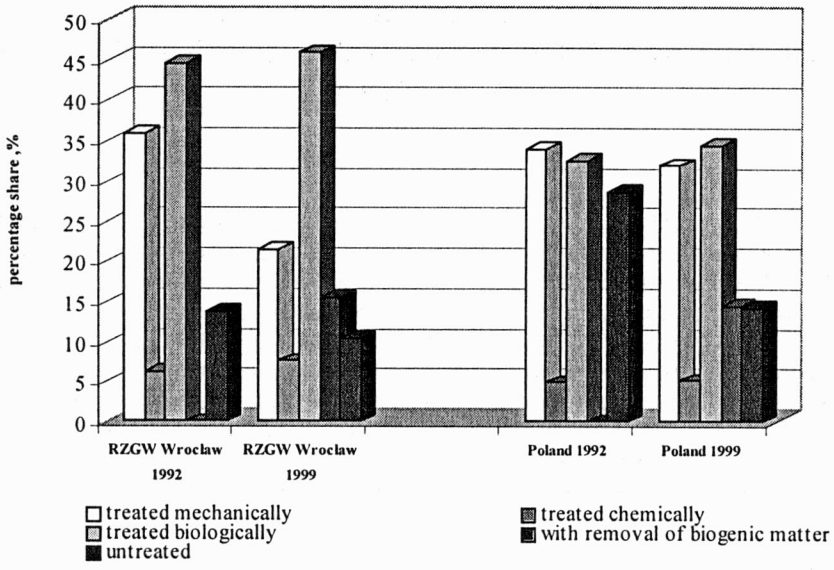

Fig. 1. Municipal and industrial sewage necessitating treatment in 1992 and 1999 according to Chief Statistical Office

Both for the whole Poland and for the area of activity of RWMA in Wrocław, the trend towards the decrease in the quantity of sewage discharged into surface water without prior treatment is observed, as well as towards the increase in the sewage treated biologically and with increased removal of biogenic compounds.

In table 1, the quantities of municipal sewage in Poland are compared in terms of the degree of pollutant reduction, taking into account BOD_5, COD and total suspended matter. These data proved that between 1992 and 1999 municipal sewage treatment was significantly improved. The quantity of sewage characterized by the highest (exceeding 90%) reduction of BOD_5, COD and total suspended matter increased and at the same time the quantity of sewage treated using less efficient processes decreased. Of the total quantity of municipal sewage, amounting to 1,292.7 million m^3 in 1999, 65.6% were subjected to processes, in which BOD_5 was reduced by

more than 90%, and in 1992 this figure was only 23%. The per cent shares of sewage, from which these pollutants were removed in the degree approaching 70%, were as small as 5% and close to 10% in 1999 and in 1992, respectively.

Table 1

Municipal sewage treated in Poland according to the Chief Statistical Office

Pollutant reduction, %	Quantities of sewage in million m^3 treated					
	BOD_5		COD		Total suspended matter	
	1992	1999	1992	1999	1992	1999
≤ 30	122.6	65.1	232.9	78.9	73.3	59.7
30.1–60.0	340.3	176.4	425.5	185.4	343.3	111.5
60.1–90.0	562.6	203.2	570.0	446.1	745.9	358.2
≥ 90.1	304.4	848	101.5	582.3	167.4	763.3
Total	1329.9	1292.7	1329.9	1292.7	1329.9	1292.7

Favourable changes in sewage management result from investment activities undertaken in order to obtain a better degree of sewage treatment according to provisions of the stringent regulation of the Minister of Environmental Protection, Natural Resources and Forestry of November the 5th, 1991.

2. INVESTMENT PROJECTS IN THE FIELD OF WATER PROTECTION IN THE RIVER BASIN OF THE UPPER AND THE MIDDLE ODRA

In connection with applications made by investors for financial support of the National Fund of Environmental Protection and Water Resources, the Regional Water Management Authority in Wrocław issued expert opinions about 60 municipal projects with throughput of a plant larger than 600 m^3 per 24 hours. The breakdown of these projects with respect to the size of a treatment plant is presented in table 2. Most projects, as much as 58.3%, were carried out in the group Q = 2001–20000 m^3/24 hours. These projects were developed in order to implement the construction of new mechanical and biological sewage treatment plants (33 plants) or biological sewage treatment plants (where mechanical sections were completed in the 1st stage) (5 plants). The other projects analysed (22 plants) were designed with the aim of extending or modernizing the existing plants. In towns with insufficient sewerage or having no sewerage, further comprehensive improvement of sewage management was performed (construction of sewage treatment plants with sewage disposal systems) (11 plants).

The sewage treatment plants, which were given the opinion of the Regional Water Management Authority in Wrocław, had an official and legal status with the up-to-date sewage effluent disposal consent and the consent to construct sewage treatment plant and equipment. The ranges of permissible concentrations of pollutants in treated

sewage being discharged into water for each group of sewage treatment plants are given in table 2.

For most sewage treatment plants, some requirements consistent with the appendix no. 2 to the above-mentioned regulation were determined. Stringent conditions should be applied to 7 projects in the catchment areas of the rivers being protected (river intakes, border and international rivers and rivers of significant natural values), in 2 plants from which sewage will be discharged into standing waters and in 6 plants due to slow flow of receiving water. Strict requirements are imposed not only on sewage disposal from sewage treatment plants with throughputs $Q > 2000$ m^3/24 hours (12 plants), but also on 3 plants with throughputs $Q \leq 2000$ m^3/24 hours.

Table 2

Collective breakdown of water protection standards for selected municipal projects carried out 1993–2001

Size of sewage treatment plant, m^3/24 hours	Number of projects	Throughput mech./biolog., '000 m^3/24 h	Parameters of treated sewage acc. to the consent, mg·dm^{-3} Gradual removal of pollutants acc. to a project, %				
			BOD_5	COD	Total suspension	Total nitrogen	Total phosphorus
Small	11	12.0	24-30	50-150	30-50	15-30	1.5-5
$Q \leq 2000$			87-96	65-95	76-95	23-83	42-90
Medium	35	271.1/251.8	12-15	40-150	20-50	10-30	1-1.5
$Q = 2001$–20000			91-98	70-94	67-98	27-86	50-96
Large	14	701.8/553.8	15	100-150	20-50	20-30	1-1.5
$Q > 20000$			91-97	69-90	80-96	32-69	80-94

In the table, the ranges of pollutant reduction in municipal sewage are also given. They are in accordance with technical documentation. Removal of the pollutants of such concentrations and actual composition of sewage supplied to a treatment plant will guarantee in most cases that the quality of discharged effluent will be higher than that of standard. This was confirmed by the effects achieved after a sewage treatment plant had been completed and commissioned (table 3).

In all plants, modern sewage treatment technologies were put into practice. The solutions were based on low-rate activated sludge with the following zones being separated: anoxic zone, insufficient oxygen zone and oxygenic zone (in one or a few tanks), in which the processes of dephosphatation, denitrification and nitrification proceed. The methods with three-stage activated sludge predominated (30 projects). In a few plants, sequencing batch reactors (SBR) were used, in which the effect of biogenic elements' removal is produced due to sequential operation (successive biological processes proceed in one tank).

Table 3

Effects of sewage treatment in new selected municipal sewage treatment plants in the area of RWMA in Wroclaw

No.	Sewage treatment plant throughput, m^3/24 h	Sewage treatment technology [1]	Year of putting into operation	Pollution index	Quality of treated sewage, mg/dm^3		Pollution reduction, %
					Acc. to consents	Actual	
1	1000 400	no preliminary settling tank, retarding reservoir, SBR reactor, additional treatment ponds	December 1998	BOD_5	30	31	98
				COD	150	30	94
				total suspended matter	50	19.1	92
				N_{total}	30	20.3	65
				P_{total}	5	3.3	62
2	3700 2900	preliminary sedimentation, two-stage treatment: I – biofilter, II – low-rate three-stage activated sludge with N and P removal, chemical precipitation of P	January 1998	BOD_5	30/15	6.7	99
				COD	150	46	95
				total suspended matter	50	11.7	97
				N_{total}	30	11.6	84
				P_{total}	5/1.5	3 [2]	78
3	51250 36200	no preliminary settling tank, three-stage biological treatment of sewage with biological dephosphatation, denitrification and nitrification, sedimentation and clarification	December 1998	BOD_5	15	6.3	97.9
				COD	110	54.0	92.0
				total suspended matter	20	14.0	95.3
				N_{total}	30	17.5	75.2
				P_{total}	1.5	1.4	95.3

[1] In all plants the separation of screenings and sand was performed.
[2] Concentration of P_{total} only after the process of biological dephosphatation.

In 41 sewage treatment plants, the possibility of the complementary chemical phosphorus precipitation (mainly simultaneous) was provided for. In 45 out of 60 plants, the single-stage biological treatment of sewage was offered. The second stage of biological treatment was designed as additional treatment ponds (4 plants), gravel-plant filters (1 plant), activated sludge chambers (4 plants) or as the application of the existing biofilters (6 plants).

In table 3, the data describing the quality of sewage treated in 3 new sewage treatment plants according to requirements specified in sewage effluent disposal consents are compared. Sewage treatment in such plants results in satisfactory removal of organic matter, total suspended matter, total nitrogen and total phosphorus. All plants described were underloaded after their commissioning.

3. CHANGE IN SURFACE WATER PURITY IN THE RIVER BASIN OF THE ODRA

The improvement of surface water purity is the measure of transformation the sewage management underwent in the nineties. Of 7,005.6 km of Polish rivers examined in 1992 within the framework of the basic monitoring, the rivers, which did not conform to standards according to the reliable water pollution assessment and the physicochemical criterion, constituted as much as 60% of this length, the rivers of the 3rd purity class – 24.8%, the rivers of the 2nd purity class – 12.8% and the rivers of the 1st purity class only 2.4% (according to CSO data). In 1999, the length of over-polluted rivers decreased to 34.5% of the total length examined (6723.6 km of rivers were examined). The shares of the rivers conforming to the 3rd, the 2nd, and the 1st purity classes increased to 37.9%, 23.5% and 4.1%, respectively.

The purity of the Odra and of selected rivers in the area managed by RWMA in Wrocław is presented in figure 2.

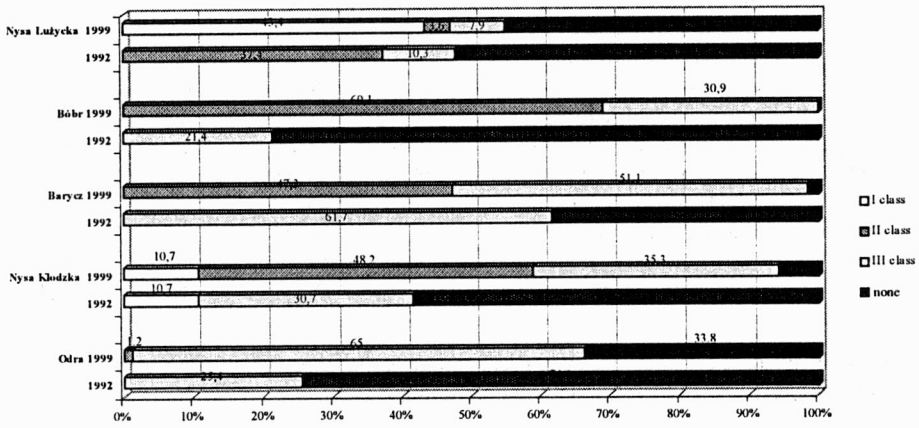

Fig. 2. Changes in the purity of selected rivers belonging to the Odra basin and covered by the basic monitoring in terms of the physicochemical criterion in 1992 and 1999 according to CSO (reliable method)

The quality of water in the rivers examined using reliable method according to physicochemical criterion was improved. In 1992, most rivers being examined carried classless water in the sections ranging from 30 to 79% of the length examined. In 1999, the percentage share of river sections with water, which did not conform to any standards, significantly decreased and in the case of particular rivers was as follows: the Odra – 33.8%, the Nysa Kłodzka – 5.8%, the Nysa Łużycka – 45.1% and the Barycz – 1.6%, whereas in case of the Bóbr the over-polluted water was completely eliminated. In spite of a serious decrease in the share of classless water in all rivers

examined in 1999, a significant increase in the share of waters of the 1st purity class was observed only in the case of the Nysa Łużycka.

For this reason, it is necessary to improve steadily the sewage management and to encourage investments in the field of water protection in order to achieve a satisfactory state of river water purity. Furthermore, not only point sources should be eliminated, but also the influence of spatial pollutants resulting from soil fertilisation, application of herbicides as well as linear pollutants associated with the development of transport.

4. SUMMARY

1. Both in the whole country and in the river basin of the upper and the middle Odra (the area managed by RWMA, Wrocław) positive changes in water management have been observed.

2. Advantageous changes in sewage management result from investment activities undertaken in order to achieve better sewage treatment according to provisions of the stringent regulation of the Minister of Environmental Protection, Natural Resources and Forestry of November the 5th, 1991.

3. Performance characteristics of newly constructed sewage treatment plants prove that the treatment effects, i.e. removal of organic matter, total suspended matter, total nitrogen and total phosphorus, are outstanding. Often the concentrations of pollutants in effluents discharged from the sewage treatment plants are lower than their permissible concentrations.

4. Most new sewage treatment plants are underloaded during the initial period after their commissioning. This offers the possibility of improving sewage management and connecting the sewers from new areas to such sewage treatment plants.

5. A considerable improvement of the purity of surface waters in Poland, especially with respect to physicochemical indicators, is the measure of transformation the sewage management underwent in 1992–1999.

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POSTĘP W TECHNOLOGII OCZYSZCZANIA ŚCIEKÓW NA OBSZARZE DZIAŁANIA REGIONALNEGO ZARZĄDU GOSPODARKI WODNEJ WE WROCŁAWIU

Ponieważ w latach 1993–2001 inwestorzy ubiegali się o pomoc finansową z NFOŚiGW w Warszawie, Regionalny Zarząd Gospodarki Wodnej opracował opinie na temat celowości budowy 60 oczyszczalni ścieków o przepustowości powyżej 600 m^3/d. W opiniach oprócz charakterystyki techniczno-technologicznej i ekonomicznej przedstawiono efekty ekologiczne, jakie przyniesie taka inwestycja.

Analizowane w toku pracy materiały wskazują na znaczny postęp w wykorzystaniu nowoczesnych technologii i rozwiązań technicznych zarówno w budowie nowych oczyszczalni, jak i w modernizacji i rozbudowie już istniejących.

Inwestycyjne realizowane, aby uzyskać lepsze oczyszczanie ścieków zgodne z warunkami obowiązującego rozporządzenia MOŚZNiL z dnia 5.11.1991 r. w sprawie klasyfikacji wód oraz warunków, jakim powinny odpowiadać ścieki wprowadzane do wód lub ziemi, powodują korzystne zmiany w gospodarce ściekowej w Polsce. Miarą tych przemian jest poprawa stanu czystości wód powierzchniowych, szczególnie w zakresie wskaźników fizykochemicznych.

Reviewed by Krzysztof Bartoszewski