Water quality protection in Romania

by

VASILE CHIRIAC

Comité d'état des eaux, Bucarest (Roumanie)

1. General aspects of water resources utilization

Water quality protection in Romania represents an integrating part of the general activity for a rational use of water resources, a problem of peculiar importance for the national economy aspects.

The up-todateness and importance of hydraulic resources utilization derive from the ever increasing water requirements of the population and of the economy in full development, as well as from the specific characteristics of the rivers in this country.

Sufficient to illustrate how ample water resources are and in how impor ant way they are put in value is the fact that the water needs have increased considerably during the past two decades roughly atteining at the present time 6 billion m^3 per year, that is twice the 1960 value, with an average consumption of 300 m^3 per inhabitant. Out of the total water consumption 3.5 billion m^3 are used for industrial purposes, 1.1 billion m^3 for irrigation, 0.8 billion m^3 by population and so forth.

The accelerated rate of the economy growth, the recent industrial works set into operation, the introduction of large-scale irrigation, the hydroelectric power plants planning, the uprising standards of living, all call for ever greater water amounts. In 1970 the overall consumption of water in this country is expected to rise to twice the present consumption and to maintain itself at a high rate of growth in the near future also.

To solve satisfactorily the economy and population water requirements is one of the first objectives of water housekeeping activities in this country.

The complex water management has also other two aspects of equal importance to out national economy : the prevention of destructive effects of water and the water pollution control.

The satisfactory approach of all the water housekeeping problems considered from the three aspects — quantity, quality and destructive effects prevension — meets with serious difficulties first of all owing to the torrential character of our watercourses themselves.

The total amount of water flow of our inland rivers — in a multiannual average — is around 40 billion m^3 per year, except the river Danube which transports to the Black Sea an additional flow of 200 billion m^3 per year.

The inland water courses are characterized by a markedly torrential regime, with short peak periods, when streams transport most of the flow, ranging from 40 to 80 % and long periods of low water level, when flows are greatly reduced and when some streams even dry up. In this instance, on acount of the nonuniform distribution of flows in time — during the course of year and from year to year — only a small percentage of the water volume is utilizable in a regime of natural flow for lack of concordance between the water sources flow and the requirements. A further characteristic of the inland water resources is their non uniform distribution throughout the country.

In order to solve these drawbacks common for most of our streams, ample storage lakes are necessary to store important water volumes in the high water level periods and to distribute them in accordance with the requirements in the drought periods. Moreover, in some basins the water deficit has to be made up for from richer river basins of their vicinity.

In Romania the activity in the water management field, considered in the three already mentioned basic aspects is directed by the State. The basic principles in solving the complex water management problems are as follows :

Rapp. Comm. int. Mer Médit., **19**, 5, pp. 879-884 (1969).

a. rational utilization of water resources co-ordinately to satisfy the social and economic requirements according to their importance by appropriate planning of the water resources utilization both under natural and regulated regime conditions with a view to re-utilizing water to the greatest possible extent as well as to preventing waste of water in every field;

b. development of new potentials of water resources by river basin planning conceived so as to meet the requirements for an economic growth in successive stages according to the future hydrotechnical projects in every hydrographic basin;

c. prevention of damages caused by water in areas subject to floods or excessive moisture to make them utilizable for multiple purposes and especially for agricultural purposes;

d. water resources protection on every specific aspect of water quality, flow regime in the channel as well as erosion prevention of the river basin versants.

The aforesaid principles form a unitary ensemble of objectives which must be attained by separately solving the various water management problems; the best solution can be established only by complex and co-ordinate study of all possibilities for the optimum utilization of every water resource.

The comprehensive studies underlying the activity of rational utilization of water resources in Romania are the multiple purposes and complex water management of the hydrographic basins. They constitute the frame technical material in the water housekeeping activity. They screen the general schemes of watercourses utilization comprising all the hydrotechnical necessary works and steps to take, in order to utilize and control water as well as to protect its quality.

The water programs reflect how important the rational utilization of water is to the planned economy of this country under the up-to-date conditions when water becomes every day more and more necessary to activity and human life. The basic study problems within the framework of water programs are the following :

— surface and sub-surface water potentials, considering the possibilities of hydrotechnical works to regularise flows by storage lakes and canals for a maximum utilization of this potential (irrigation, hydroelectric power plants etc.);

— water uses and present hydrotechnical works for the utilization, control and protection of water quality;

— water uses and prospective hydrotechnical works in accordance with the requirements of economic growth;

— present and long-term balance between water resources and water requirements, determining the critical and excessive areas, including given deficit and surplus;

— river basin planning schemes of maximum social and technico-economic efficiency to satisfy the requirements of every user in successive stages, to harness the utilizable potential (irrigation, hydroelectric power etc.), to prevent the destructive effects of water and to protect the water quality;

— gradation of the hydrotechnical works required by the studied schemes in accordance with economic necessity and rate of growth, as well as with the technico-economic characteristics.

To ensure the necessary flows in the next stages and to control floods, water programs provide the realization of about 150 storages lakes totalling 7 billion m^3 in volume, about 130 microregional drinking water supply systems, numerous industrial water supply systems, about 130 hydroelectric power plants etc.

The planned hydrotechnical works will allow the rising of the total water consumption in the next 10-15 years to above 20 billion m^3 per year, irrigation will be developed over several million hectares, hydroelectric power plants will generate several tens of thousands of GWh per year. The destructive effects of water will be controlled and prevented over areas covering several million hectares, by dams and dikes as well as drainage ditches in the Danube meadow and in the inland river basins.

2. Organization of the water quality protection activity

As pointed out above water quality protection is a problem of particular importance and up-to-dateness in our country as well as all over the world. It is common knowledge that none of the national economy branches and all the less population can use water with its quality characteristics in the watercourses. This is consequential on the fact that the natural qualities of water do not usually satisfy the exigences of users and, more particularly, that these qualities even if naturally good, become greatly pollu-

ted by the economic activity and urban life. Pollution of water resources by the irrational utilization thereof and by discharges of industrial and municipal wastes is known to be highly prejudicial, preventing further use of water resources and endangering human life.

Therefore, it is precisely man and human activities that constitute a dangerous potential for water pollution, though it is man again that needs clean water.

An example will suffice to illustrate that water pollution is a world problem : an annual quantity of about 20 million tons waste oils, about 100 thousand tons radioactive waste and many other wastes of economic and social life is discharged into the watercourses.

An easy inference is, therefore, that in view of this permanent process of water use and water pollution, a reasonable qualitative and quantitative balance has to maintained so as not to interfere with economic programs and impede it. If measures are not taken in time to preserve the quality of water, the use thereof will be hindered so much that it will be lost for economy and the aquatic life will be braked and sometimes even destroyed.

In Romania water quality protection has become an organized activity especially in the last decade. It has become an action of stringent necessity bearing in mind the serious situation created as a consequence of the lag o measures destined to protect-water quality to the extent called for by the permanent increasing of more and more pollution sources.

Nowadays in our country water pollution sources, industrial and municipal effluents are as numerous as 2200, and the annual quantity of sewage and waste water discharged into the watercourses exceeds 3 billion m^3, without taking into account the conventionnaly clean water. As water consumption increases with the passing of time, concomitantly with economic development, there is also a much greater water pollution potential increase.

3. The principles of the water quality protection activity

Protection of water quality is governed by a special legislation, the basic principles of which are the following :

— the obligation of all industries and towns to build appropriate waste water treatment plants according to a planned program;

— prohibition for all novel industrial and economic units to run without suitable waste water treatment plants;

— obligation of ensuring the running and operation of sewage and waste water treatment plants with maximum efficiency;

— development of the study and research activity in the field of waste water treatment;

— training of staff for sewage and waste water treatment plants operation;

— establishment of penalties for transgressing of the legal provisions in the field of disposal and treatment of waste water;

— organization and opération of the State Division in the field of water pollution control and water quality protection.

The principles underlying the whole activity is that of preserving in every section of watercourses an appropriate quality according to the use category required for every section. The water quality categories as a function of characteristic uses are the following :

— Category I : Water to be used for :

— supply with drinking water;

— water supply to food industry and other industrial branches that necessitate water identical in quality to drinking water;

— pisciculture;

— bathing areas, swimming pools;

— Category II : Water to be used for :

— pisciculture (not including salmon culture);

— municipal recreational purposes.

— Category III; Water to be used for :

— water supply to irrigation;

— industrial water supply (not including those of category I);

— other uses than those of category I and II.

In no section of a watercourse is a lower quality than category III admitted. The characteristic quality indicators are distributed into four groups, as follows :

— oxygen regime conditions;
— mineralization conditions;
— physical, organoleptic and bacteriologic conditions;
— special conditions.

The degree of treatment required for every waste water discharging unit is establich taking into account the ensemble of uses and of pollution sources within the whole hydrographic basin with consideration also of the effect of the natural phenomenon of river water self purification.

Before resorting to waste water treatment plant building at the industrial units, all measures other than waste water treatment are exhaustively applied to minimise the quantity and nocivity of waste water, as follows :

— the use of technological procedures and processes necessitating the minimum possible quantity of water (the dry processes list along this line);
— the use of innocuous reagents;
— introduction on a large scale of recirculation and reuse of water within the same unit in the technico-économic admissible limits;
— recovery from waste water, before discharge into the sewer, of any substance valuable to economy but detrimental to the quality of water-courses;
— utilization of waste waters for irrigation.

Thus two important advantages are obtainable :

— the technical as well as financial means required by the treatment of waste waters will be reduced by diminution of the volume of water in the installations and of the number of the necessary treatment stages;
— national economy benefits both by reducing of the water flow required and by utilization of the useful substances recovered from waste water.

Along this line of préalable measures other than waste water treatment, here are some of those achieved or under study at the present time :

— replacement on noxious reagents producing waste phenols such as Tymerol in textile industry, Spumatol in coal flotation, of phenolforamldhyde resins in wood processinf factories etc.;
— massive introduction of recycling in the iron mills, coal industry, sugar facories (beet washing and transport) and so forth;
— modification of some manufacturing procedures, such as generalization of the technologic process of continuous diffusion in sugar factories, adoption of the aerobic fusion in the textile industry etc., which results in substantially minimising the pollution problems;
— injection into depleted oil strata of the waste water discharges from oil extractive and processing industries to prevent the discharge there of into water sources and their pollution;
— recovery from waste waters of the valuable substances such as fodder yeast in paper and cellulose mills, ferrous sulphate from steel pickling, fibres in the paper mills etc., and their economic utilization;
— the action of reducing the use of biologically nondegradable detergents and replacing them with degradable detergents, a problem of particular importance in the present stage in which extending of the industrial and domestic utilization of detergents is wirnessed.

It is considered that such measures taken before proceeding to waste water treatment should be intensified, for they have important technicoeconomic advantages both in the field of water pollution control and for the national economy. Sewage and waste water treatment plants thus constitute an ultimate stage of the ensemble of measures, acting as a final stage in completion of the efforts to bring waste waters discharged into the watercourses to the least admissible degree of pollution in relation to the quality conditions required by existing and future uses.

4. Achievements in the water quality protection activity

The measures and installations provided as necessary to ensure a suitable quality of the country's water sources have been planned in stages according to the national economy development interests, also taking into account the possibilities of displaying the important technical and financial efforts called for by an action such as this. It should be mentioned that concomitantly with solving the problems concer-

ning the existing units, the suitable measures and installations must be ensured at every novel economic and social unit, their number and size are greatly increasing and they pose more and more difficult problems from the water pollution control point of view.

Up to the present the activity displayed in water quality protection in Romania has led to a number of achievements of theoretical interest and effective as far as the positive effects on water quality in a number of hydrographic basins is concerned.

The case of the river Jiu is noteworthy and representative, as an improvement in water quality was necessary to ensure the suitable water quality for the development of the industrial area close to the town of Craiova. Therefore, a number of sewage and waste water treatment plants of importance and of high technical efficiency have been built in this basin, out of which we first mention those at the coal washing installations with a residuum removal capacity of 300 tons per shift obtained by means of 17 filter presses. Waste water treatment plants have been built in the same area at the thermoelectric power plant using coal powder and the groups of enterprises possessing a completely automatical equipment for neutralizing acide waters and a biological treatment process with activated sludge.

Another interesting treatment plant for waste waters, with a predominantly organic load from a synthetical rubber plant discharging around 39,000 m^3 daily. The secondary treatment consists of six perclorating filters of 30.00 $\times$ 60.00/4.00 m each, the fill material being crushed granit stone. To improve the biological treatment process of such waste waters devoid of nutrients as nitrogen and phosphorus feeding devices are provided for these purposes.

Another installation treating an influent of about 7,800 m^3/day was achieved at a novel chemical plant ans is provided with : reception tanks, neutralization basins, aeration basins for activated sludge process and chemical treatment basins for flocculation. The two aeration tanks are sized 60.00 $\times$ 20.00/ 3.00 m and protected inside by epoxy coating in order to resist to the chemical action of waste water. The aeration period is 13 hours. The organic loading of the influent is 0.9 kg BOD_5 par m^3 of aeration tank; the mechanical aerators — Vortair type — provide for the 10,800 kg oxygen/day requirements. Horizontal sedimentation tanks of 40.00 $\times$ 15.00/3.00 m are provided with a 2.5 hr retention time. The final treatment basin, a circular one, has a 19.00 m diameter and 5.00 m depth. Here flocculation is performed by means of aluminium sulphate in a 20 mg/1 dosage.

A frequent problem is the chemical treatment of cyanide waste waters from many industrial units. In this field a number of installations have been realised using the method of CN-ion destruction by chlorine or chlorine compounds such as sodium hypochlorite in high basic medium (pH 10-11). Anoxidation takes place by oxidation of cyanhydric acid into sodium cyanate possible in a very short time and at usual temperature only at pH 10.2-10.8. Using hypochlorite the conclusion was reached that the optimum dosage is 10-11 1. og NaOCl solution and 12 % active chlorine to destroy 1 kg of NaCN.

Among the more particular industrial water treatment pilot plants it is worth mentioning the pilot plant for treating the effluent on an antibiotics factory. Its diagram comprises preaseration tanks, primary sedimentation, high-intensity percloration filters, secondary sedimentation tanks, digestors, sludge. dr ying beds and chlorination. Aeration requirements are satisfied by means of compressed air with pipes lying under the bottom tanks. Perclorating filters are laden with crushed stone of 5-8 cm size and recirculation of water therein is made in 1/1 ratio, the hydraulic loading is 7 m^3/m^2/day and the percloration rate 0.3 mph. Digestors are heated by steam and sludge is recycled by centrifugal pumps. The efficiency of the plant is 78 % for suspended solids removal, 82 % for BOD_5, and 66 % for $KMno_4$. The studies have continued to improve the waste treatment method.

Actualization of the proposed program, mostly in connection with industrial waste water treatment necessitates an appropriate development of research activity in order to improve the methods of solving the major problems in this field Apart from research activity, however, the institutes for investigations in this field have realized experimental pilot plants in various industrial branches. So is, for indtance, the experimental pilot plant for effluents coming from the cellulose and artificial viscose fibres industry. Rhis plant is provided with facilities for conducting separate studies on waste waters from cellulose — cardboard and paper mills and stable fibres, cellophane, as well as on various mixtures of them. The installation comprises small scale sedimentation tanks, clarifiers, sludge thickeners, vacuum filters, compressed air aeration basins for activated sludge, perclorating filters with stone or plastic material etc. The models are of the Froude type at the scale alpha = 5. The pilot plant has various facilities, laboratories, in order to perform physico-chemical and biological analyses and a calculation office for experimental data processing. Experiments carried on at this plant are in progress.

A complex problem has been the ensemble of measures and sewage and waste water treatment plants as well as the hydrotechnical works to control and to prevent the pollution of the Black Sea within

the Romanian littoral area especially in the summer period. The following categories of activities are included : sewage treatment, industrial waste water treatment, collection and disposal of hydrocarbons in the harbour area as well as refuse treatment and disposal. The measures and treatment plants are in process of realization and rest on the principle of complete elimination of any waste matter discharge into the sea during the summer season in order to protect the beaches and Black Sea pollution. This sollutionis organically combined with the use of effluents for irrigation purposes after previous primary treatment.

Within the framework of the water pollution control activity in Romania, waste water treatment plants have been built in great number, at about 1100 industrial and municipal units which discharge waste waters, representing about 50 % of the pollution sources. The results of the undertaken actions within this program are already visible. Systematical and periodical studies follow water quality evolution in the hydrographic basins.

5. The problem of the sewage and waste water treatment plant operation

Practice so far has shown that success in water quality protection is to a great extent a question of how efficienctly treatment plants and their installations are utilized. Along this line systematical training is done to the staff operating the given installations. The comprehensive program of treatment plants construction at the existing units as well as at the novel units which develop as a consequence of economic progress raise to an equal extent the question of prividing the treatment plants with the suitable laboratories for raw, effluent and sludge analyses to assess the efficiency of the installations.

6. Formation of a mass opinion on preservation of water resources quality

Protection of water resources quality is an action which must be understood not only from the aspect of the measures taken by the economic and social units which systematically discharge concentrated waste water, but also as a permanent desideratum of civic behaviour in everyday life. In order to form a general opinion supporting the water quality protection, the State organs which co-ordinate this action have initiated and have made full display of the most varied forms of popularization of the important problems raised by water quality protection. Various facilities are used, such as press, radio, television, the cinema, lectures and so forth.

7. Conclusions

Water quality protection in Romania has been in full development, being organized in the past decade as an integrating part of the general activity of beneficial and reasonable use of water resources for multiple purposes.

The program of measures and works to ensure a suitable quality to water resources and to protect them is graded according to economic development interests and to the State's technical an financial purposes.

Sewage and waste water treatment plants have so far been provided for about 50 % of the water pollution sources. Apart from sewage and waste water treatment plants, special technical measures are taken to minimize the discharge and nocivity of the industrial waste waters.

The results of the above action are assessed by systematical studies of the water quality evolution in various hydrographic basins.

Special stress is laid on hig.-efficiency operation of the sewage and waste water treatment plants as well as on formation of a mass opinion supporting the protection of water quality.

Water quality protection, however, is a world problem and calls for wider and wider international co-operation and collaboration in order to achieve, by exchange of experience, the mutual support necessary to further the solution of this condition essential to technical, social and economic progress.

Along this line our country has taken part in international activities concerning the practical and theoretical aspects of the methodology and research in this field and will further contribute to the extensive application of the most advanced techniques in water pollution control and water treatment.