WATER SUPPLY AND SEWERAGE

TENDENCIES OF TRAINING IN WATER SUPPLY AND SEWERAGE

by

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1. Introduction

Water supply and sewerage assume an ever greater importance. Available water reserves in this country require a purposeful water management, water and sewage purification activity both from quantity and quality aspects. Water supply of the residents, the industry and the agriculture with the due quantity and quality, at the same time, clearance and disposition of pollutants overcharging and disturbing the biosphere make consciousness, extension and updating of the range of knowledge, close relations with scholars of marginal sciences a must.

2. Main tendencies of the training development

The abrupt development of social conditions in socialist countries affects of course the education in the subject "Water Supply and Sewerage". Further development is needed from several aspects in the mode of viewing, theory and practice of education, so that the subject matter can be composed of objective elements of theoretical and practical knowledge.

Realization of this target is possible from the following mental, theoretical and practical considerations of basic importance:

a) Theoretical bases of the subject matter are to be strengthened. The descriptive, bookish character of treatment has to be replaced by one based on hydraulics, hydromechanics, probability calculus etc., contributing to the evolution of a common vernacular.

b) Along the development of theoretical bases, criticism to the subject matter has to be emphasized based on achievements and experience in research, design and operation. The evolved criticism will help students to recognize value, reliability, usefulness of theoretical correlations, findings, data etc. This physical mode of viewing will vivify the subject, connect it to tasks and point to future trends.

c) Alongside with the worsening water pollution and with the diversification of polluting agents, experience in design, construction and operation must be introduced already at the education stage. Design and operation do

not tolerate schematism, stereotypy so that in-service modifications to ensure optimum service conditions for actual engineering structures and works have to be provided for.

The comprehensiveness of education will be enhanced by applying the scheme in Fig. 1, creating causal correlation and interaction between

— theory and research,
— design,
— construction,
— operation.

Thereby the education activity will become operative, realistic.

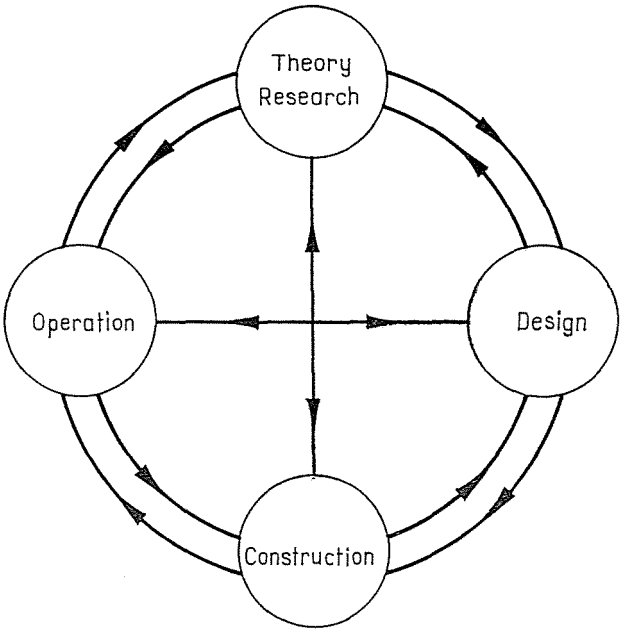

Fig. 1

d) Orientation in the ramified system of our knowledge, process approach gets of importance for the sake of efficiency. In this special field of ours, processes are composed of a variety of factors, some of which belong to marginal fields. Acquisition of knowledge is based on the logical, clear-cut analysis, outlining, understanding of principal and secondary partial processes, micro-phenomena. An extremely careful analysis of the interaction, sequence of physical, chemical, biological partial processes, generally concomitant to purification procedures, is needed for efficiency. The education has to emphasize the importance of exact recognition of processes.

e) Since water supply and sewerage fundamentally affect environmental factors in the biosphere, hence human living and health conditions, especially

as concerns future — *hygienic* aspects are to be stressed. As a matter of fact, our activity consists in the combined application of technical and sanitary knowledge. For instance, health aspects of drinking water are to be specified beyond classification in the actual meaning of the word, involving scientific and practical co-operation between hygienists and technologists.

f) Actually, teaching the subject matter is largely based on technical and hygienic knowledge. No doubt, however, economic aspects of the speciality are to be pointed out in the future. At any level of education, more technical-economical knowledge is to be offered. Thereby the next step — i.e. the development of technical-economical optimization approach — is arrived at almost spontaneously. This objective has to be realized as soon as possible. This kind of knowledge will permit — not to speak but of the most important tasks — to causally co-ordinate

— correlation between local and regional water supply systems;
— water management within an industrial plant;
— industrial water management within a region;
— design of complex water purification technologies;
— relationships between the sewage clearance degree and the spontaneous clearance of outlets;
— methods to fight eutrophization

with exigencies and possibilities of the national economy.

Development of a subject matter of this kind requires high-grade mathematical treatment implying mathematical statistics, probability calculus, digital computers.

These have been the principal considerations on education, more or less valid, of course, to any level and form of training. In what follows, advisable tendencies, theoretical aspects of, and correlations between

— engineering education,
— specialist engineering education, and
— post-graduate engineering education

will be considered.

3. Engineering education

Relevant engineering education is aimed at offering fundamental theoretical and practical knowledge in the field of "Water Supply and Sewerage" to a depth enabling the graduate to undertake *directing activity* in theoretical research, design, construction or operation. In the training-educational work,

— acquisition of fundamentals,
— development of a self-contained engineering way of thinking,
— development of a right engineering consciousness

are emphasized. This objective is to be approached in the actual educational frames, through the training forms shown in Fig. 2.

3.1. Lectures relating to all the curriculum are backbones of education. These are complemented by design in drawing rooms, visits in plants, and laboratory exercises in water chemistry—water biology. This proved system is to be maintained, since it permits to acquire the entity of knowledge needed.

At the same time, however, the number of lecture hours should be increased by about 25 per cent, and that of plant visits by about 100 per cent, to

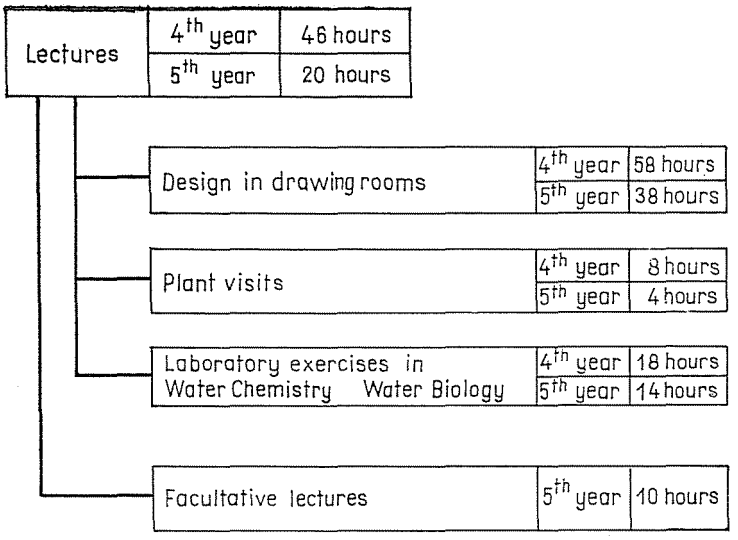

Fig. 2

cope with the continuous growth of knowledge matter. Although obsolete knowledge matter has to be eliminated from education, because of the development peculiarities of our speciality, but several parts of the subject matter, only outlined before (e.g., bases of reaction kinetics in water supply and canalization, slow filtration, eutrophization, dewatering and disposal of sewage sludge, knowledge in hygienics) are to be incorporated for purport of education. More of plant visit hours would be motivated by the stress laid on practical training.

A means has to be found for students to make themselves familiar with major water and sewage purification plants in service, parallelly to the acquisition of the subject matter. In view of the diversity of sewage treatment plants, it is a lucky coincidence that our students themselves are desirous to be familiar with them, to directly gather service-bound experience.

The backbone of the subject matter has been established, but its approach has to be further developed to include e.g. the following aspects:

a) Water supply

— variations of the water demand concomitant to industrialization, agricultural development, living standard increase, and methods of pre-assessment;

— industrial water management, to be treated proportionally to its significance;

— water resources, to be discussed from hydrological, mathematical statistical aspects;

— the complex process of slow filtration, either natural or artificial, and the involved problems;

— water purification technology, involving theoretical and practical problems of a technology of increasing complexity and intensity as required by the diversification of microscopic pollutants, to cover hygienic aspects;

— engineering approach of the water storage and distribution within the water works, taking both hydraulic and chemical-biological processes into consideration. Pertinence of purification technology to water storage and distribution processes has to be enforced in instruction;

— effect of water storage related to river channelling of reservoir storage, of lakes on water quality, complex processes in the reservoir space, relations between oxygen, carbon dioxide and nutrient etc. balance, design, water discharge, feasibility of water purification, involving recent experience in this country.

b) Sewerage

— Perfection of the existing "hydraulic" design of the sewerage system, starting from the objective to establish the actual and the optimum proportions between sewerage system and purification plant; of the approach of design and operation, separating discussion of sewerage system and purification plant;

— endeavour to timely and spatially exact description and control of contamination and condition of the "fluid" entering the canalization;

— relating hydraulic to hydrologic mode of viewing;

— exploitation, if feasible, of advantages arising from artificial storage possibilities within the canalization system;

— incorporation of operation experiences, actual measurement results in conformity with the peculiarities of the process.

c) Sewage purification

— In addition to strengthen evolved theoretical bases, operation experiences have to be involved. First of all, engineering hydraulics — as basis —

are to be lent an applied character. Various processes involved in sedimentation, recirculation, aeration, equipment design and operation require comprehensive hydraulic approach.

— In view of conditions in this country, aspects of arrangement, design and operation of small and medium sewage treatment plants and equipment have to be enhanced. These examples picked out at random are likely to illustrate the nature and diversity of development problems within each subject.

Lectures normal in the 5th year are seen in Fig. 2 to be completed by facultative lectures devoted to subject matters of actuality for our special field, offering comprehensive theoretical knowledge and a deeper insight into design and operation practice. Such announced lectures are, for instance:

— Colloidics in water supply and sewerage.
— Air pollution and its prevention.
— Mathematical statistics in water supply and sewerage.
— Experience with the design and operation of sewage treatment plants.
— The third sewage purification stage.
— Treatment and disposal of sewage sludge.

To our observations, students are pleased to attend lectures on previously announced, duly selected subjects. This method is likely to become an efficient basis of education in the future.

3.2. Drawing-room design lessons helped by lectures and "Design Aids" are intended to offer high-standard design skill and mode of viewing, to cope with designing, constructing and operating practice. It may be advisable to directly involve some specialists with outstanding design practice into this kind of instruction.

We are conscious of the fact that any acquired knowledge is *worth its applicability*. Accordingly, training in practical design has to be made more efficient, for instance by

— elaborating conditions providing for more efficient design exercises;
— actualizing "Design Aids" by incorporating the intensive development in design practice during the last decade;
— demonstration of operation experience in drawing room exercises for the sake of purposeful design, to make it more vivid, realistic, less schematic. This mode of viewing is to be approached by editing notebooks on the experience in sewage treatment plant operation. This is likely to assist diploma designers.

3.3. Water chemistry and water biology exercises are intended to supply students with positive fundamentals through measurements and observations, indispensable for water and sewage classification, for choice of purification technologies, for decisions of hygienic nature (Photos 1 and 2). Such exercises are likely to enhance the value of subjects concerned with water chemistry and

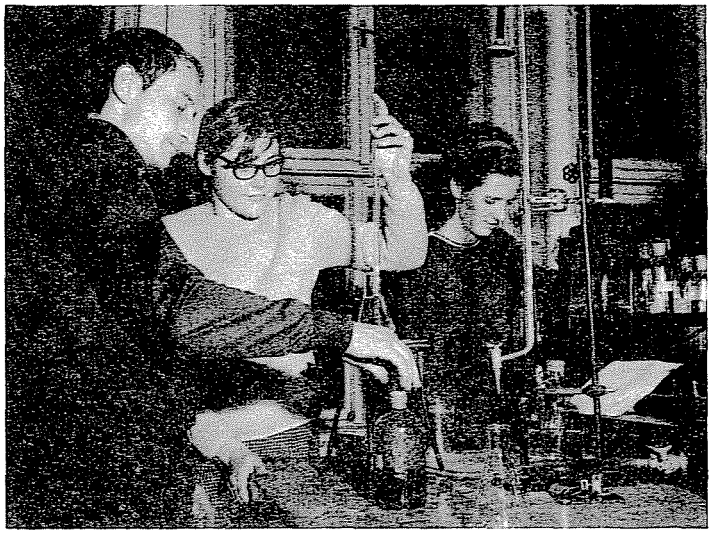

Photo 1

Photo 2

water biology. In the actual stage of education, transfer of knowledge of applied character has to be stressed. The previous "engineering" approach may be developed, updated even by these subject parts, to cope with future tasks, more complex than hitherto. Concrete knowledge in chemistry and biology may deepen relations to specialists in marginal fields.

Since exercises of this kind are to be correlated to all basic processes of water supply and sewerage, exercises may only be held by chemists and biologists with comprehensive knowledge in water supply, sewerage and sewage treatment.

4. Specialist engineering education

This kind of training is intended primarily to deepen — rather fundamental or general — knowledge of university-trained engineers with lesser or greater practice, to complete it with concrete, special, high-standard knowledge matter. At the same time, also transfer of new knowledge still not included in university education is aimed at.

In specialist engineering education,

— acquisition of modern, novel knowledge becoming common property at the instant of training;

— systematization of new findings in designing and operating practice;

— enforcement of hygienic aspects in our speciality;

— for those graduated as specialist engineers, to obtain scientific degrees are emphasized.

Actually, specialist engineering education in water supply — sewerage — hygienics comprises four semesters. Its program is shown in Table 1. Semesters 1 and 2 are mainly priming ones, featured by majors of "applied" character, such as:

— water chemistry, water classification,
— applied hydrology,
— applied hydraulics,
— biology (microbiology),
— water and sewage biology,
— sewage chemistry.

These present details of mostly rather complex phenomena of relevance, their connections and interactions. In the actual stage of development one must be aware that subject matters operatively aiding engineering activity are to be developed — often beginning from the bases.

These majors are to be taught so as the specialist engineer can appreciate a phenomenon in any field of this speciality in an objective and exact manner, aided by nothing but particles of his knowledge.

Remind only how many knowledge particles are needed by the designer or manager to compose the actual processes involved in e.g.

— shore-filtered water supply,
— ground water enrichment,
— water purification by a complex technology,

Table 1

Program for specialist engineers in water supply, sanitary engineering (1971—1972)

Subject	Theory (hrs)	Exercise (hrs)
Ist Semester		
1. Water management and administration	16	—
2. Water chemistry	18	—
3. Applied hydrology	24	10
4. Applied hydraulics	15	10
5. Settlement hygienics I	18	10
6. Biology	14	15
Total	105	45
IInd Semester		
1. Deep bore wells	15	5
2. Water and sewage biology	28	10
3. Sewage chemistry	16	10
4. Settlement hygienics II	15	5
5. Industrial water management	10	—
6. Work hygienics	5	15
7. Sanitary organization and management	16	—
Total	105	45
IIIrd Semester	**Theory (hrs)**	**Exercise (hrs)**
1. Drinking water purification	20	10
2. Industrial water uses and water treatment	16	5
3. Hydraulic machines	15	10
4. Purification of domestic sewage	20	10
5. Epidemiology	16	10
6. Fundamentals of computerization	16	—
7. Professional study	2	—
Total	105	45
IVth Semester		
1. Industrial sewage purification	20	7
2. Application of computers	15	15
3. Management technique	20	8
4. Technologies in plants for settlement hygienics	10	5
5. Concepts of planned economy	10	—
6. Construction, operation and maintenance of water supply and sewage systems	20	10
7. Optimization of water management systems	10	—
Total	105	45

— sewage treatment technology,
— sewage sludge treatment,
— eutrophization,
— water ducts,
— artificial filtering.

Thus, at specialist engineering level, adequately reasoning, well-oriented, operative-minded specialists should be trained.

In possession of these fundamentals, subject matters of semesters 3 and 4 may be acquired, with special stress laid on:

— the essentially dynamic character of purification technologies;
— peculiar, uncommon features of industrial water uses and treatment technologies;
— the systematic transfer of knowledge in hydraulic machines, based essentially on home observations;
— management operations, of prospectively growing importance;
— theoretical and practical bases of overall computerization;
— optimization of water management systems (including water supply and sewerage), a subject matter to be elaborated now. Technical and economical considerations are to be strictly connected, as bases of training in the time to come.

These items must prevail in future education forms of specialist engineers, taking, of course, flexible adaptation of target and form of education to requirements in mind. Some other considerations based on educational observations are:

— Instead (or besides) of educating students in large groups, small groups could be educated more efficiently, more directly, more specialized if needed.
— Theoretical niveau of the education should be raised, involving marginal science results.
— Subject matter "Hydraulic machinery" has to be completed by a wide range of systematic, concrete plant operation experience.
— Purposeful incorporation of sanitary aspects is a requirement.
— Practical features of education (laboratory exercises, plant visits) should prevail also at specialist engineering level, with due consideration of peculiar features.

5. Post-graduate engineering education

This is intended as a specialized, high-niveau presentation of development, achievements in research, design and operation in sectors of the special field.

Observations made to now refer to the necessity of a closer co-ordination between post-graduate and other engineering education forms.

Summary

1. Theoretical and practical subject matter of university education is to be settled in notebooks, based on available home and foreign achievements and experience. Of course, these fundamentals brought to date, emphasized in its essentials, and completed with the latest research results and considerations, will be offered in lectures, too. In view of the abrupt development of our speciality, much stress is laid on lectures, conferences.

2. Laboratory exercises are to be emphasized. Establishment of a self-contained hydrochemical and hydro-biological laboratory is most essential for this speciality, by bringing exercises closer to life. Education has to be based on examples, facts.

Also a self-contained hydraulic, water and sewage treatment laboratory is needed. Direct observation of phenomena, acquaintance with essential equipment, chemical feeders, technologies, carrying out measurements is of much support for the education. Properly organized, carefully selected exercises, demonstrations are accessorial to the up-to-date training in water supply and sewerage.

At the same time, such a technological laboratory would permit research work accessory to education and providing for the professional development of the teaching staff. Research work of adequate extension on a relevant subject is fundamental for the education in our specialities, a link towards the development of theory and ability and also of importance for the preservation and strengthening of our sound relations to designing and operating specialists. Hence, establishment of a research basis is of urgence.

3. In view of the wide expansion of our speciality, relations more purposeful and closer than to now are to be established with designing, constructing and operating specialists, also education offered by specialists in hygienics will be had recourse to.

These relations should be concrete, steady. With respect to purport, they should be developed as soon as possible, taking actual educational principles and exigencies in mind. We are convinced of the positive contribution of these relations to the efficiency of our education work.

Relevant university notebooks

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