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SOME ASPECTS OF FLOW PHENOMENA IN SWIMMING POOLS

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Abstract

In water-recycling swimmingpools the phase of the disinfection which takes part in the pool is essential. In this phase the appropriate hydraulic conditions are ensured by the full-mix tankreactor-like flow. In pools with several inlets the investigation of the flow-conditions, taking place inside the pool units belonging to each inletplace, are essential.

Keywords: swimming-pool, disinfection, streams in pools, public health risks, hydraulic investigation.

During the last decade the Department of Water Supply and Sewerage of the Technical University of Budapest has been requested to make hydraulic investigation on swimming pools, bathing pools, their water supply systems and to solve public health problems of some institutions.

We dealt with the design of new pools, operational checking and reconstruction problems of existing pools as well (MÉSZÁROS, 1984).

Pools in Hungary are seasonally overcharged, the experienced public health anomalies were shown by checking of the operational management, official investigations and unfortunately sometimes by unambiguously identifiable epidemics as well (MÉSZÁROS, 1984).

The first laboratory investigation was carried out in 1974. The aim was to get to know whether there will be any stagnation zone supposing certain inlet and outlet solution. After solving several technical problems of modelling, we could visualize the flow pattern. During the evaluation it became obvious that the knowledge of the flow pattern is not enough to judge public health conditions.

Certainly, flow conditions in the pool must satisfy the requirements of public health and operation. So the requirement of a stagnation free flow pattern can be only the first approach of the problem (MI–10–204–85, DIN–NORM 19643).

It became clear that the requirements must be derived from the changes of water quality in the sense of public health. This must be start-

ed with a detailed study of the processes taking place in the recycling and treatment system. The investigation of the hydraulic conditions can be simplified only on rare occasions in order to achieve or to control a predetermined flow pattern.

We have come to our today's attitude gradually. The public health risk, as one of the most important factors, cannot be measured directly and, fortunately, epidemics are not frequent enough to use a statistical method. Thus it was an important step to realise that the connection of the hydraulic and public health conditions can be studied mainly in a speculative way.

The pollution including septic micro-organisms is getting directly into the water of the pools. At usual water recycling intensities the nominal recycling time can be measured in hours but the dwelling period in the treatment system is only some minutes. Consequently, besides the quality of the input water, the processes in the pool are also very important for public health safety (MÉSZÁROS, 1984).

The processes in the pools can be considered as processes of concentration changes. According to this, the experiences of the chemical reactors can be applied. Considering the chemical and suspended pollution this comparison is obviously true, moreover, it is valid, probably, for the septic organisms, as well. The connection between virulence concentration and activity of septic organisms as a fact, can be taken even if the quantitative recognition of these connections requires further research work.

There are two main processes taking place in pools:

- the dilution of the input pollution, the gradual decrease of its concentration,
- the reaction of the pollution with the water, the process of becoming inactive; this process can be considered as a conversion in the pool.

The dilution and the conversion are typically reactor processes. Accordingly, swimmingpools can be regarded as reactors. Nevertheless, these are special reactors and their description and approach are more complicated than those generally applied for the reactors in the industry. The most important special features which set limits to the direct application of quantitative methods used in the reactor technic are the following:

- All guests, even the cleanest persons bring a certain pollution load. This contamination can be taken as uniformly distributed load only in a first approach, because the virulent contamination which is the most dangerous is brought only by some guests and this means punctual load in the pool.
- Most types and amount of the virulent contamination are more or less connected to secretion (mucus) or other suspensions. This fact has effect on their transport and reaction.

- The specific energy of the flow in pools is definitely low even if the input is carried out by jet pipes. Therefore the temperature differences and the energy produced by the movements of the guests have significant effect on the developing conditions.
- On the surface of the water there is a definite pollution accumulation and the contamination of this layer is very dangerous concerning public health regulations.

The main processes described above demand absolutely mixing, a so called tankreactor-like flow. This can cause the most rapid decrease of local pollution concentration and — if the input water has an antiseptic character — it causes the inactivation of the pollution independent of the place of the input. It should be mentioned that these points are valid only if the following conditions are satisfied:

- the rapid mixing takes place in the entire pool, not only in a smaller confinable volume or part,
- the dilution and rapid change of the surface layer can be ensured.

These statements are in conformity with the recent design directives (MI–10–204–85, DIN–NORM 19643). However, we also have to deal with the realization of these conditions.

First of all, there is a contradiction between the opposing requirements of the dilution and the rapid changing of the surface layer. Namely, the concentration decrease supposes an intensive mixing while the rapid changing can be achieved by a definite directional, consequent, moderate mixing flow (MÉSZÁROS, 1987).

We think it is worth to look for the optimum in this problem.

In most solutions of jet pipe water inlet the mixing process has two stages. Each jet has its active zone and inside this zone a perfect distribution of the antiseptic can be achieved. The truly dangerous, virulent pollution is mixed in no time inside this zone, but only here. The complete mixing in the entire pool takes place very slowly or it is not carried out at all.

Consequently, pools practically behave like intensive mixing, element tankreactors connected parallel. The mixing process between the element reactors is insignificant in comparison with those in the inside zone. This causes no problem if the element tankreactor is perfect as an individual public pool.

This effect must also be taken into account in shallow pools where the volume of the individual parts is some m^3 and in cases when the process of inactivation takes longer, i.e. some minutes. Our attention was called to this shallow pool phenomenon by infectious diseases of children under 10. The knowledge of the real proceedings of pools which are shallow or irregu-

lar shaped, or operated with hardly disinfectable water gives arrangement for design work and operation.

Summary

During the hydraulic investigation and experiments on public health problems it was proved that pools can be considered as reactors from the point of view of flow and water quality processes happen.

This is specially valid for the absolutely essential disinfection process. Pools are special reactors where dilution and elimination — conversion — of the pollution processes. From the point of view of hydraulics both the energy of the input water and the temperature differences can be significant. The input of pollution and the parallel operation of the more or less independent element reactors are special features.

In appropriate pools flow approaches the ideal tankreactor-flow. A part of the public health problems caused by shallow pools (so-called childrenpools) can be attributed to the theoretic problems of hydraulic design.

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