THE LOCAL WATER LABORATORY – AN ASSET, OR SOMETHING TO DISPOSE?

DET LOKALA VATTENLABORATORIET – EN TILLGÅNG, ELLER VÄRT ATT AVVECKLA?

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Sammanfattning

Svensk vattenvård kan i vissa avseenden sägas ha startat på allvar under de fyra första decennierna under förra seklet. En manifestation av detta kan sägas ha varit grundandet av Sötvattenslaboratoriet på Lovön under förra hälften av 1930-talet. Detta blev också snart vaggan för statens naturvårdsverk, som först senare flyttade från Lovön in till centrala Storstockholm. Tidigt kom också kravet på analys och kontroll av vattenkvaliteten att bli central för den framväxande vattenvården. En andra stor milstolpe inträffade i slutet av 1960-talet då en ny vattenlag kom att kräva bland annat en avancerad fosforrening av framförallt kommunalt spillvatten. En stor statlig satsning på reningsutbyggnad med investeringsbidrag kom att bidra till en framväxt av vattenlaboratorier, såväl hos kommuner som hos de större konsultbolagen. I det följande diskuteras hur denna satsning kom att förändras, och framför allt hur lokala vattenlaboratorier på de kommunala avloppsreningsverken i stor utsträckning avvecklades, liksom för övrigt också hos konsultbolagen. Stora så kallade ackrediterade laboratorier tog över analysverksamheten. I det följande diskuteras behovet av att återupprätta det lokala vattenlaboratoriet utifrån att strängare krav ställs på behandlingen, samtidigt som allt mer komplexa föroreningar skall behandlas och reduceras vid våra anläggningar.

Abstract

The modern use of water for various needs result in a complex polluted wastewater. The needs to purify the used water will by time deepen into more demanding questions. The needs for an efficient and on-site control will thus become more and more pronounced. This paper focuses on the importance to have an efficient laboratory facility located at the treatment facility. The needed local competence for the pollution control is related to the correct handling and performance of the samples. In the text four “key words” are suggested as paradigms for the successful control: The art of sampling and analysis may be summarized by the following words: “WHY- WHEN – WHERE – HOW?”. Some illustrating examples are given on shortages in the control and understanding of the requirements for and efficient handling of sampling, as well as adequate comparisons of the analyses results

Key words: water laboratory, analysis accuracy, water quality

Background

"To measure is to know", Lord Kelvin

Quite a few of the water laboratories once located and operated at Swedish wastewater treatment plants have been closed or are at stake to be closed. This situation is indeed more than astonishing in many respects. One crucial aspect may be defined as a political ignorance with respect to the needed knowledge of accurate and up-to-date information on water quality issues. This statement may be mirrored in the fact that the local and active water control is deemed to be "too expensive", and thus the evident needs are cut down. In this paper a discussion is presented with reference to the Swedish water environment sector, and especially to deepen the question on adequate on-site water analysis. Now, the question has an international relevance and thus it is deemed interesting to use the actual situation in Sweden as a "mirror" to reveal a problem within the water environment protection.

A short history on water environment concern in Sweden

In this context an 80-year perspective on the water environment development in Sweden may serve as a background. However, the first more systematic concerns on the water quality in the major Swedish water bodies, such as the lake Mälaren were identified during the last part of the 19th century. The understanding of the situation was in the first place an identification that fish life in the lakes and coastal areas was threatened. An extinction of the fish live stocks would threaten parts of the food supply for a growing population. It would however last some 60 years before a water laboratory with special focus on fish life and the water environment protection was implemented on the Lovö Island, outside Stockholm in 1935. Only a few years later, the foregoer to the Swedish EPA (Environmental Protection Agency) was founded at the very same site.

These actions were established in an atmosphere of pioneering. Thus, this soon inspired both large municipalities and consultant companies to establish their own water laboratories. This became for some decades an important and acknowledged part in the technological society.

In the late 1960s and early 1970s an important investment boom took place in Sweden within the wastewater purification sector. These investments were found both within the municipalities as well as for large industries, especially within the pulp and paper sector, as well as for the large steel industries. One driving force related to the municipal sector was the conviction that the phosphorus discharges were major threats for the water bodies in Sweden. Going back to the 90-year perspective on the Swedish water environment work a somewhat simplified pattern may be found. The "sustainability" of the discharge norms lasted for a period of around 20 years. The four first decades in the 20th century focused on the removal of visible pollutants. The 1940s saw a growing insight on the impact of organic pollutants – normally expressed as BOD5. This in turn started investments in biological treatment plants. However, in the early 1960s a stronger focus on the water environment came about, partly thanks to Rachel Carson, and her book "Silent Spring" (Carson, 1962). In Sweden the environmental concern became evident. A proof or this concern may be the foundation of the Swedish EPA in 1967. Simultaneously more stringent effluent requirements on municipal wastewater were stated. These requirements focused on phosphorus (P) as being a major threat to the water bodies. The standard stipulation those years was a >90 % removal of P, or a maximum discharge concentration of < 0.5 ppm P.

Initially, this concern was also reflected in a focus on analysis and correct measurements, thus asking for additional controls of pollutants at an increased frequency. The Swedish EPA even organized a "blind-test" program, when samples were sent especially to the consultant´s laboratories for analysis and reporting. The test program was repeated for some years during the 1970s.

In this perspective it is more than astonishing that the following decade would demonstrate a closing of water laboratories, foremost at the consultant companies, motivated by a too limited profit from the analysis work. Almost simultaneously, a closure started of water laboratories located at medium-sized and smaller wastewater treatment plants. This was accompanied by a disposal of analysis instruments. At the end of the day, this started a pathway towards a reduction of the local competence in water analysis.

The change in the market lead to the occurrence of independent, commercial laboratories. These entities were by-and-by growing to large companies, all focused on a far-reaching automation of the analysis work. These laboratories must get a formal quality certificate for the operation, by contrast to the local laboratory. Today these (often) international laboratories will sometimes distribute parts of the received water samples to many laboratory branches within the company. As an example, the BOD analysis for a northern Swedish treatment plant may be performed in Prague. In other words, the provided results (up to 30 days from the sampling moment) were of use only as a history writing, and in the worst case of no use for a process refinement or adjustment! Finally, the analysis results from these laboratories arrive to the client normally a fortnight to a month after the sample was taken. In other works, the results provide historic results, and may not easily be used for process adjustments.

For further concerns on the sampling and efficient wastewater treatment operation, see my previous papers (Morling, 2014;2016).

A pathway towards more stringent discharge control

In the mid-1980s was an occurrence "explosion" of algae identified in the salt and brackish waters surrounding Sweden. This "new" situation was caused by nitrogen discharges from a number of municipal wastewater treatment plants. The matter called for added knowledge especially in nitrogen removal, and more investment in additional treatment stages. Typically, the knowledge in biological nitrogen removal was found more than necessary especially for major municipal discharges. Consequently, this demanded updated and more accurate knowledge on the nitrogen "behavior" in the wastewater. An example of the lack of adequate knowledge and understanding of the nitrogen complexity is presented in the following section.

Since the last few years of the 1990´s and during early years of the 2000´s focus is more and more concentrating on complex pollutants, and especially on pharmaceutical remains in treated wastewaters. Thus, an evidently "endless" ongoing call for more complex treatment technologies and more refined water environmental control seems to be indispensable. In addition to these concerns, the problem of so called "multi-resistant" antibiotics remaining in the treated sludge from municipal plants has caused a new concern. Will it be safe to re-use the sludge as fertilizers? This matter is another example of the urgent needs for the upgrade of the use of competent laboratory skills! In this perspective it could be seen a paradox that the local laboratories have closed lately, and even at an accelerated rate.

The modern process control at wastewater treatment facilities

The modern process control at a wastewater treatment plant can – somewhat simplified - be defined by two categories:

The formal legal control that is stipulated by the environmental authorities. This control requires formal periodic reports to be presented both on a quarterly basis as well as in annual environmental reports.

The ”operation" control that is a far more specific model, sometimes – you may say unique – system with respect to what it is used, and in which on-line instruments that are installed. The ambition with respect to the internal level of active process knowledge is the key. In this context we may recall Lord Kelvin: "To measure is to know." Throughout the years different on-line instruments have been developed. These are working continuously inside the treatment plant and used as process control facilities. However, an evident risk has been a sometimes "naïve" and unprofessional understanding: A blindfolded belief that these instruments are maintenance-free. This in turn resulted in a reverse reaction: "The results are false; the instrument is useless". Consequently, the instrument was not used at all. The needed knowledge to use and take advantage of on-line instruments calls both for a regular maintenance and the competence to use a local laboratory for calibration of the specific instrument.

Now, an efficient and comprehensive internal process control calls for some crucial and important elements:

The first demand is the regular and competent sampling on water and sludge. This must be performed in a well-planned and competent way. The art of sampling and analysis may be summarized by the following words: WHY- WHEN – WHERE – HOW? To perform a correct sampling program calls for an adequate and up to date process competence. It will be more and more needed that this process knowledge is present at the plant, and this need is growing with the more demanding process performance requirements. Thus, the local laboratory should be adequately equipped and the process engineer (or chemist) must have both the needed skills, but also the authority to execute necessary process alterations.

Discussion

In this section, two examples are given, both in various ways illustrating the absence of the questions pointed out above. They illustrate both the need for an "unbroken chain" of relevant competence, including the following stages:

1. WHY, in this context it represents the selected sampling strategy;
2. WHEN, the chosen times of the sampling;
3. WHERE, or selection of the adequate sampling points;
4. HOW, the method to perform the sampling, the following handling of the sample, the analysis work at the laboratory and finally the critical evaluation of the results.

The first example is old and may be called: "Do not compare bananas with cows!"

Now, the telling is about the control of a municipal plant performance in mid-Sweden. The plant was built in accordance with the at the time modern process configuration. Mechanical, biological as well as post-precipitation based on alum dosage were included. The discharge levels were low, for phosphorus even very low, normally close to 0.1 ppm of total-P to be com-pared with the ruling consent value of <0.5 ppm. In those days the formal demand also included a stipulated percentage removal, in this case >90 %. Now, one day a representative from the regional Environmental Board calls me: "The plant has a lousy performance!" I wondered "How so?" The response was: "The reduction level is even far below 70 %! I responded: "Now, how come, the effluent levels are very low, and substantial amounts of sludge are produced every day at the plant!" Anyhow, according to the representative, this was not good!!

Consequently, I contacted the plant operator, and asked him: "What about the sampling on inlet water?" A rapid answer: "Well, you know, that automatic sampler was lousy, now we take a grab sample in the morning, at 07.00 am!" So, as the fact was: Inlet wastewater, mainly com-posed of the infiltration during the night-hours with very small amounts of municipal wastewater, thus very diluted, was compared with a 24 h, flow-proportional sample at the discharge from the plant. No wonder, the percentage removal efficiency was more than modest. The comparison would be defined as "comparing a banana with a cow".

However, sad to say this warning example is still relevant! At those days, no local laboratory was installed at the plant, thus the samples were sent to a consultant´s laboratory. The observations in this case on the analysis results were scrutinized about 30 days later! A local direct analysis would have been of great help!

You may easily find that one systematic error in this case, the grab sampling in the morning revealed a shortage of versus three of the needed points, as defined above: "WHY" – the sampling strategy; "WHEN" – taking the sample in early morning; and "HOW" the same erratic way to take a grab sample and not a flow proportional sample during 24 h.

The second example shows how the handling of a sample will most likely be the basis for disputable analysis results. The situation described refers to a control of reject water from a test facility. The background is clearly presented in the protocol from the authorized laboratory:

The sampling date is given as the 20th of October, and the water temperature at sampling 20 °C. The arrival date of the sample was the 30th of October, and the sample temperature had sunk to 13.7 °C. No cooling of the sample had taken place during the period, from the time of sampling until the start of analysis took place. So very brief, at least three crucial points should be highlighted:

1. The time elapse from the sampling until the analysis started, almost two weeks puts the question: How trustworthy were the results? The analysis should of course start as soon as possible after the sampling!
2. The matter is even more critical, as the sample should have been put in a cooling box (temperature max + 4 °C). This matter is especially important as organic compounds were to be analyzed.
3. The laboratory would have made a notice to the client concerning these two circumstances, and thus pointed out the risks for erratic results in the analysis.

This again underlines the risks with a "blindfolded" trust in a so-called authorized procedure, where an immediate handling of the sample would most likely have eliminated some fundamental mistakes.

Conclusions

It will of course not be possible to equip and operate a "complete" water laboratory at each water treatment facility. Nevertheless, the local water laboratory, not necessarily a certified one, will contribute to a good local process competence. To demolish the existing local laboratories may in the long run be found a bad act. Now, at the end the day, what are the gains for maintaining and even strengthening the local laboratory?

- To safeguard and develop a local process engineering capacity.
- Improved possibilities to run the plant at stable and high removal levels of the key pollutants.
- To operate the plant in an even lower operating cost by having an active control of the different vital process variables.
- The possibilities to have an onsite regular control and maintenance of the installed on-line probes.

A finally, and in a broader perspective, it is fundamental that the water protection work is acknowledged far better than in the present time. This matter is to a large extent a political question.

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