European Union Network for the Implementation and Enforcement of Environmental Law

Report on “Industrial Water Management Guidelines: A guidance for IED permit writers” – Addendum

Integrated Water Approach and Urban Water Reuse Project

2017/10

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<tr><td colspan="2">Executive summary:
This Report is the result of the work of the subgroup dedicated to the industrial reuse of the “Integrated Water Approach and Urban Water Reuse” project team. It intends to be an addendum of the first phase report and intends to present the application of the previous results from 2017 to a real case, namely the application of the check-list to a wastewater discharge permit from a pulp installation and how its results were used to define appropriate emission limit values that ensures the protection of the water body.</td></tr>
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Introduction to IMPEL

The European Union Network for the Implementation and Enforcement of Environmental Law (IMPEL) is an international non-profit association of the environmental authorities of the EU Member States, acceding and candidate countries of the European Union and EEA countries. The association is registered in Belgium and its legal seat is in Brussels, Belgium.

IMPEL was set up in 1992 as an informal Network of European regulators and authorities concerned with the implementation and enforcement of environmental law. The Network's objective is to create the necessary impetus in the European Community to make progress on ensuring a more effective application of environmental legislation. The core of the IMPEL activities concerns awareness raising, capacity building and exchange of information and experiences on implementation, enforcement and international enforcement collaboration as well as promoting and supporting the practicability and enforceability of European environmental legislation.

During the previous years, IMPEL has developed into a considerable, widely known organisation, being mentioned in a number of EU legislative and policy documents, e.g. the 7th Environment Action Programme and the Recommendation on Minimum Criteria for Environmental Inspections.

The expertise and experience of the participants within IMPEL make the network uniquely qualified to work on both technical and regulatory aspects of EU environmental legislation. Information on the IMPEL Network is also available through its website at www.impel.eu.

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Introduction

On a climate change scenario the increase for water demand is showing that in a growing number of countries large quantities of high quality water may no longer be available at low cost. Therefore, some alternative water sources are being used with an increased attention to water recycling and reuse.

The possible economic feasibility of reuse and recycling is stimulating the interest in the practice, however, this also increased the complexity of designing water catchment area and delivery system, in terms of possible natural sources of water, treatment processes, reuse and/or discharges.

This project is the follow-up of the previous project “Integrated Water Approach” of 2017, that aimed to deal with the water management and reuse inside Industrial Emissions Directive (IED) industries. As noticed from the first phase report, while the role of the water system designer is to optimize the costs-opportunities scenario, the role of the permit writer turns to be critical in stimulating such a virtuous approach and in regulating.

One of the major outcomes of the first phase from 2017 was that the water management inside industrial sectors, namely pulp and paper and oil refining sectors, should take into account that the water use efficiency must be seen from quantity perspective without jeopardizing the quality of wastewaters and water sources for direct use or reuse.

The exchange of information regarding best practices, safe uses and the permitting process contributed for the development of a check-list to help permit writers, in particular, for wastewater discharges, that allows to verify the needs of going beyond Best Available Technologies (BAT) to not put at risk the receiving water bodies status.

As already mentioned, this project is the follow-up of a first phase from 2017, extended to the sector of Urban Wastewaters Reuse, i.e., the use of treated urban wastewaters for agriculture irrigation.

The project is carried out by two working groups, related with the urban treated wastewaters reuse and the industrial water management, respectively. The aim of the second working group is to enhancing best practices included in the guidelines on industrial water management with respect to water reuse inside industry (already developed on first year of the project) and test the application of these guidelines to a real case study, taking into account the complexity of balances needed in terms of quantity and quality of water in the industrial water cycle use.

Why this addendum

The check-list developed in the previous phase of the project (2017) is applied to a real case study from a certain sector, a pulp and paper industry, to access the needs of definition of dedicated emission limit values to apply to a wastewater discharge, combined with water reuse practices, to ensure the maintenance or recovery of the water body status.

Case study description

The case study is a pulp mill for the production of bleached kraft located near a river bank. Few kilometres upstream there is a border with a different country and downstream there is a dam, for electric energy production.

The pulp mill produces pulp from pine and eucalyptus wood. The annual average production is around 262800 t per year and discharges a flow of treated wastewaters around 15000 m^3 per day.

The water body status is less than good, namely due to problems linked with organic matter and nutrients (phosphorous), and some influence on the concentration of these parameters is seen near the border, upstream to the pulp mill discharge, but a water quality decrease was also noticed after the discharging point.

Between the border and the dam there are several wastewater discharges, but the pulp mill discharges more than 95% of the total organic load in this catchment area.

In 2017, a severe drought decreased significantly the water flow in the river and the effects of the treated wastewater discharges negatively affected the receiving water body quality. Downstream, in the dam, was observed that the levels of dissolved oxygen, near surface, reached 0 mg L^{-1} O_2 in a certain period.

The pulp mill is an IED installation and the respective environmental permit had attached a wastewater discharge permit with Emission Limit Values (ELV) supported exclusively on the BAT reference documents, namely on the emission levels associated with the use of BAT (BAT-AEL).

The wastewater treatment plant was a conventional biological treatment without additional nutrients removal. The Emission Limit Values (ELV) expressed as emission factors, in 2017, for the installation were:

pH – 6 to 9 Sørensen scale

Total Suspend Solids (TSS) – 1,05 kg/ADt[1]

Chemical Oxygen Demand (COD) – 14,5 kg/ADt

Biochemical Oxygen Demand (BOD_5) – 2,5 kg/ADt

Total nitrogen (N_t) – 0,175 kg/ADt

Total phosphorous (P_t) – 0,02 kg/ADt

The compliance of these values was accessed as yearly average, according the respective BREF.

Emission levels associated with the use of BAT

The BAT-AELs are focused on the environmental performance of the techniques of the specific industrial sector, without any relationship with the reception capacity of the water body. I.e., these values reflect the capacity of techniques to reduce pollutant loads discharged into the water to prevent pollution.

[1] ADt - Air Dry tonnes (of pulp) expressed as 90 % dryness.

Usually, the BAT-AELs are defined as yearly averages. To access representative emissions for short-term reference periods, such as daily average emissions, an assessment of the data set is often needed to allow the removal of misleading and non-representative data. In some cases, extreme peak values may not be considered to avoid misleading emissions ranges that would not representatively reflect the real environmental performance of a mill, like low or high emission values would be overestimated, since these usually only occurs during short time intervals. Therefore, for reporting representative daily average values, the BREF document accepts that certain exceptional operating conditions and unusual peak values of a very limited number of operation days may be dismissed. Different methods can be used, e.g. statistical approaches (e.g. 95th percentile) or analysing the causes of unusual peak emissions in order to individually assess the representativeness of the data.

For instance, for the determination of the daily average values, namely for the COD, the days with a production considerably below the annual average (<70 % of the annual average) can be dismissed in order to reduce the possibly misleading mathematical effect of dividing similar daily COD emission loads by a relatively lower denominator (decreased net production).

As noticed, the possibility of dismissing peaks does not reflect any relation with the risk of negative impacts over the waterbodies, e.g., high peak loads that can produce an acute depletion of oxygen in the receiving waters.

However, according the IED, on its article 18: "*where an environmental quality standard requires stricter conditions than those achievable by the use of the best available techniques, additional measures shall be included in the permit, without prejudice to other measures which may be taken to comply with environmental quality standards*", which means that ELV more restrict than the BAT-AELs can be applied to avoid peak loads.

To find in which cases a discharge permit need to go beyond BAT, a check-list for permit writers was developed on the first phase of the project.

Application of Check-List

To ensure that discharge of treated wastewaters included in the IED environmental permitting process complies with the WFD requirements, some aspects need to be checked to guarantee that the permitting process is both IED and WFD proof. Hence, to ensure the definition of ELV that avoids degradation of the water status a list of tasks, defined as check-list, was developed in the first phase of this project (2017). The check-list can be found at pg. 35 in the project guideline, downloadable at this link: https://www.impel.eu/wp-content/uploads/2018/06/FR-2017-10-Integrated-Water-Approach-Guidance.pdf.

Table 1: Check-List for water discharge permit writers – Case study: Pulp Mill

A. Wastewater discharge assessment:	
1. Is the water status of the receiving water body less than good?	Yes
2. Define which are the critical parameters for water body status achievement	Dissolved oxygen
3. Do the wastewaters of the installation contribute to the enrichment of the content of this (these) critical parameter(s)?	Yes
4. Was (were) defined a BAT–associated emission levels (BAT-AEL) for this (these) parameters on the respective BREF document?	Yes
4.a Is(are) this(these) value(s) sufficient to contribute for the achievement of the good status?	No
6. Can an appropriate Emission Limit Value(s) (ELV) adjusted to the local conditions be defined, according the need of achievement/maintaining the water good status?	Yes

7. Is the appropriate ELV, adjusted to the local conditions, achievable and/or affordable?	**Yes**
7.b Is a mixing zone advisable?	Yes
7.a Can a mixing zone be applied ?	Yes
8. Was a monitoring program, upstream and downstream (outside the exterior limit of the mixing zone, when applicable) defined? (This program will allow to see that the discharge is not contributing to the deterioration of the quality of the water body).	Yes

B. Freshwater consumption assessment:	
12. Regarding the freshwater consumption, is its abstraction contributing for endanger of ecological flows (surface water) or the quantitative status (groundwater)?	Yes (surface water)
12.a Define additional measures are needed to reduce water consumption	Several measures, including internal reuse of specific wastewater streams, are already in place to reduce water consumption per ton of dry pulp produced
5. Is the reducing of the water consumption and/or promotion of water reuse an obstacle for the ELV (or BAT-AEL) compliance?	Yes (Return to question 6)

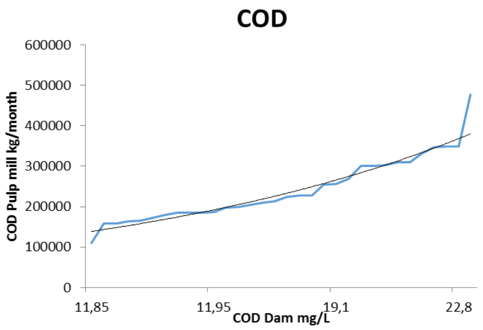
Result:
Deliver wastewater discharge permit and assess water body quality evolution through the monitoring results.

The application of the check-list revealed the need of the definition of adjusted ELV based on a combined approach as defined on the Water Framework Directive, i.e., maximum discharge values that can be absorbed by river without compromising the improvement of the water quality and the water body status. Then, a new permit was delivered with appropriate ELV, specific compliance rules and an adjusted monitoring program for the water body. This program intends to access the real impact of the discharge of the treated wastewaters.

It was also noticed that the wastewater treatment system needed to be improved to allow the increase of efficiency desirable to achieve the new ELV. Therefore, the system was upgraded from a conventional biological treatment to a membrane bioreactor (MBR) system with ultra-filtration.

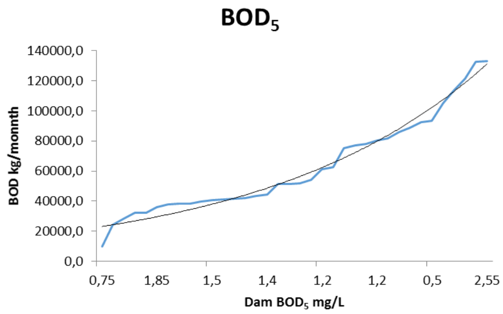
Methodology used to define appropriate ELV

To understand the real impact of the wastewater discharge an assessment was made based on the self-monitoring data from the installation and on the data from the water body from a monitoring program performed at the dam. The time period evaluated was from 2012 to 2017. A nonlinear regression model, expressed as exponential function, was applied and for the parameters COD, BOD_5, N_t and P_t a strong correlation (correlation coefficient, R superior to 0,70) was found, when data from discharges and from the water body was ordered by its magnitude, as seen in figures 1 to 4.



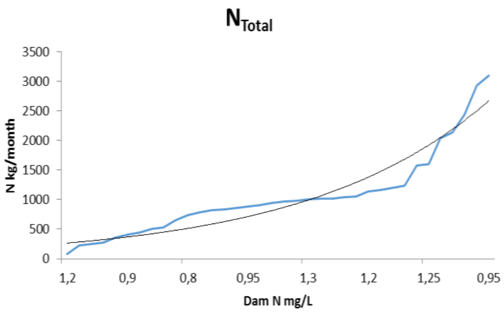
R^2=0,9446

Fig. 1: COD Relationship



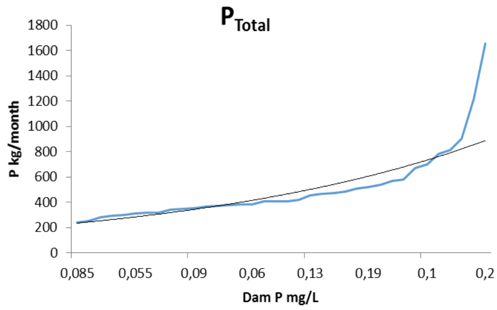
R^2=0,9029

Fig. 2: BOD_5 Relationship



R^2=0,8613

Fig. 3: N_t Relationship



R^2=0,8719

Fig. 4: P_t Relationship

Final ELV were derived by the direct use of the mathematical expression of the respective regression model and refined according results from a surface water quality modelling exercise using the model QUAL2.

To ensure an adequate level of protection of the water body all over the year, due to the seasoning changes, three levels of ELV were defined:

- Wet season (from 1st October to 30th of April)
- Dry season (from 1st of May to 30th of September)
- Unusual conditions (e.g., severe droughts, low level of dissolved oxygen in the surface water. Determined by the water authority depending on climate conditions and quantity or quality of surface water conditions. The permit establishes the terms in which this exceptional period can be determined).

For each of these periods, three types of ELV with specific goals were also defined. Each type of ELV has a specific compliance rule to guarantee the achievement of the respective goals:

Table 2: Types of ELV and compliance rules – Case study: Pulp Mill

Type of ELV	Goal	Compliance Rule
Punctual concentrations in mg L^{-1}	Protection against acute effects over the water body (e.g. quick depletion of oxygen)	No grab sample can exceed this ELV
Daily mass loads in kg/d	Protection against chronic effects (increasing of nutrients in water body)	In 52 composite samples/year is allowed a maximum of five above this ELV, but not in samples collected during the same season
Yearly averages in kg/ADt	Compliance of BAT-AEL	Yearly average cannot exceed this ELV

In dry season the flow allowed to be discharged should decrease from 15000 m^3 per day to 10000 m^3 per day. Depending on the real climatic conditions, the dry and wet period can be diminished or extended through a requirement from the operator to the water authority.

Monitoring and mixing zone

A mixing zone was defined to choose the location of the monitoring points in the receiving water body. For this, the results of the river modelling (model QUAL2) were used and an area around the 500 m downstream from the discharging point was proposed.

The permit defines the establishment of several monitoring programs:

- Raw wastewaters: pH, BOD_5, COD, TSS, N_t and P_t. The aim of this monitoring is to allow the determination of the treatment efficiency. The defined frequency of monitoring is weekly;
- Treated wastewaters:
    - Online monitoring to allow a rapid perception of possible system failures. The parameters with online monitoring requirements are: pH, temperature, conductivity, total organic carbon (TOC) and dissolved oxygen;
    - Discrete monitoring: sampling for pH, temperature, colour, TOC, conductivity, BOD_5, N_t and P_t. The programme includes the assessment of grab and composite samples and the frequency is also weekly;
- Water body:
    - Upstream:
        - Online monitoring: pH, temperature, conductivity, total organic carbon (TOC) and dissolved oxygen;
        - Weekly monitoring (grab sampling): pH, temperature, conductivity, colour, dissolved oxygen, TOC, BOD_5, N_t, P_t, sulphates and chlorophylla;
        - Each three months: TOC on sediments;
    - Downstream
        - Weekly monitoring (grab sampling): pH, temperature, conductivity, colour, dissolved oxygen, TOC, BOD_5, N_t, P_t, sulphates and chlorophylla;
        - Each three months: TOC on sediments.

The complex monitoring program of the water body aims to ensure that the discharge is not negatively affecting the surface water and at the same time rapidly detect any change on the pattern of the discharge. The upstream and downstream monitoring is crucial to understand if any changes on the surface water quality can or cannot be derived from the industrial installation.

Another important aspect on this water management approach and displayed on the permit is that whenever is verified a decrease of the water quality downstream, the discharge conditions can be immediately turn into the more restrict ones. E.g., in wet season the water authority can indicate the need of the compliance of the dry season conditions or even the unusual conditions.

Water abstraction and water reuse

The installation had already implemented measures to reduce water abstraction from river, namely due to the BREF requirements in terms of water efficiency use, i.e., reduction of freshwater consumption and due to energetic costs. Although, these measures also contributed to the increase of loads in the effluents and consequently on the discharged wastewaters.

The changes of the new ELV on the new permit allowed the linkage between quality and quantity for an efficient water use. Nevertheless, the installation is searching new possibilities to promote water reuse taking into account those cannot increase the load on the discharge.

Conclusions

The outcomes of the first phase of the project (2017) were very useful to understand the current case study in terms of water management inside the installation. From the application of the check-list it became clear that the use of the BAT-AEL would not allow the recovery of the water body, since this installation represents more than 95% of the total discharged load between the border and the dam, where in 2017 were observed very low values of dissolved oxygen.

The use of a combined approach between the data from the receiving water body and self-monitoring data from the installation allowed the definition of new ELV that includes the real protection of the surface water. However, the real protection can only be achieved by the management of several types of ELV and its variations according the seasons along the year, including severe climatic conditions.

This case study allows to validate the importance of definition of discharge permits that are simultaneously WFD and IED proof.

Another important aspect to consider is the importance of maintenance of ecological flows. Therefore, in situations where the river flow is very low, the abstracted water need to be balanced. In this case, the discharge of treated wastewaters should be seen as a reuse to support the river and its ecosystems. However, this can only be achieved by an integrated water management inside installations to ensure the possible lowest abstraction and the highest discharge level quality.

In particular, action should be taken on two fronts. The first intervening identifying all the wastewater streams and intercepting the less polluted ones to be recycled. At the same time action should be taken on plant engineering by adapting wastewater treatment plants to reduce nutrients (especially phosphorus). This approach would allow a lower consumption of water resources and a greater abatement of pollutants with a positive feedback on the quality of the water body.

The several wastewater streams intra and inter installation should be properly assessed to find matching uses that not compromise the quality of the discharged waters. This could present an opportunity to a better closure of the loop of the water use.

A comprehensive understand how water use can be integrated and managed inside and outside industries, taking into account several descriptors, such as reduction of water consumption, energy balance, CO_2 emissions, quality of discharged treated wastewaters and quality and status of the present water bodies, i.e., surface and ground waters, will support a better transition to the circular economy.

Finally, according the current developments of water reuse in Europe, this project and its outcomes could be useful for some of the European Commission current works in this field.

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