The future of water quality management for the refining industry

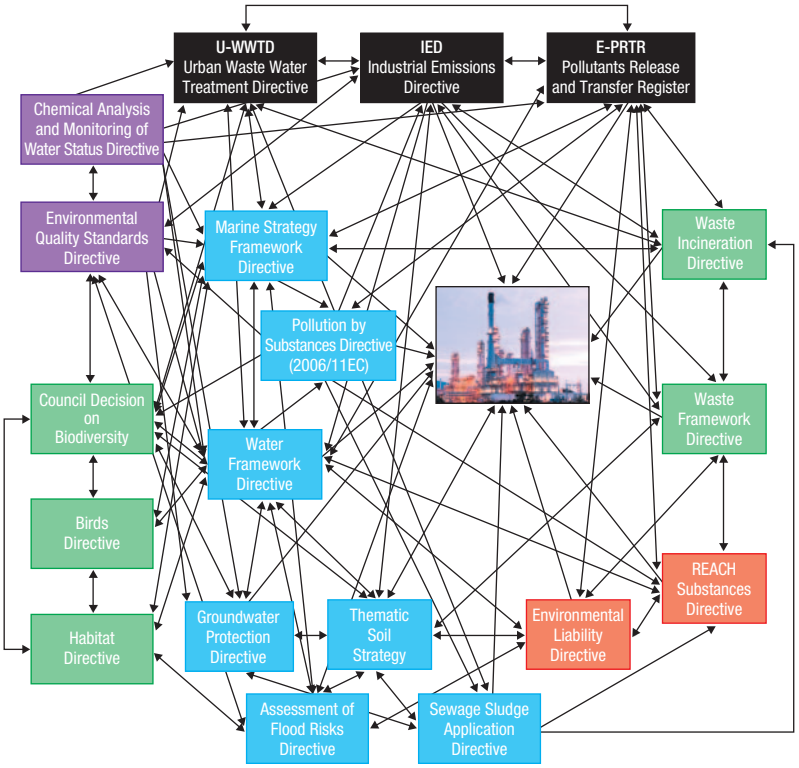
The refining industry has continued to respond to water-related environmental issues in a responsible manner and remains committed to doing so.

Introduction

It is often assumed that the environment is deteriorating due to continuous emissions from industry and that new adverse effects can be attributed to chemical mixtures and unknown substances in these emissions. This dogmatic thinking was probably correct in the late 1960s and early 1970s but, due to the reduction in those emissions and a better understanding of what is emitted by industry, it is unlikely to be the case today.

Europe's environment is probably better today than at any time since 1900, thanks to the enhanced environmental control measures taken by industry, both voluntarily and in response to the legislation developed in the EU. This is substantiated by the European Environment Agency in their 2010 report on the state of the European Environment[1] which states that, 'Considerable success has been achieved in reducing the discharge of pollutants to fresh and coastal waters, leading to considerable freshwater water quality improvements'. In turn this has contributed to the still increasing life expectancy in Europe[2].

Figure 1 Main EU-Legislative frame controlling releases into the aquatic environment



The European Commission review (2012)[3] of the River Basin Management Plans (RBMP), that were required from Member States (MS) under the Water Framework Directive (WFD, 2000/60/EC)[4], recognised that Good Ecological Status (GES) and Good Chemical Status (GCS) have been achieved or maintained for many European water bodies. This demonstrates that the WFD has delivered several of its objectives before the specified final deadline of 2027. Consistent execution of the 2nd and 3rd RBMP cycles are expected to deliver further improvements.

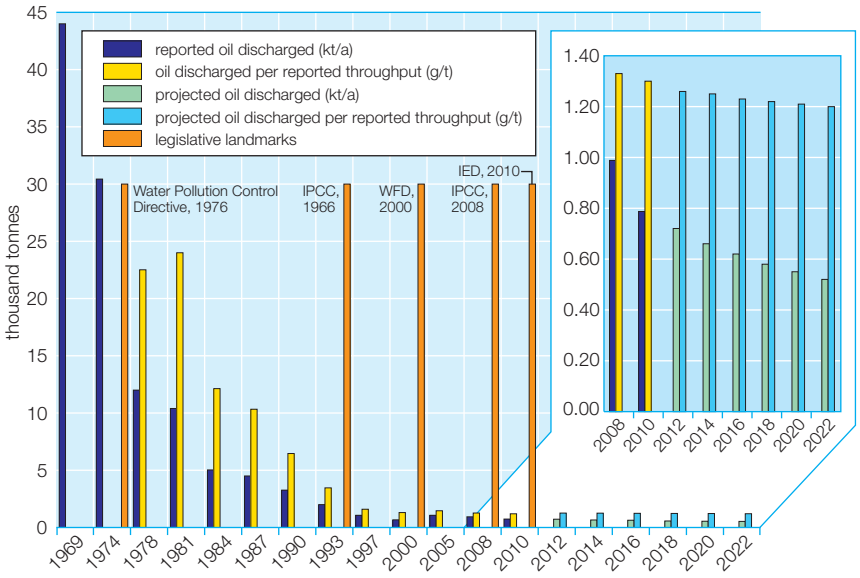
This article looks at emerging contaminants under the WFD from the perspective of the European refining industry, starting with a short description of the relevant legislative framework that covers discharges into the aquatic and soil environment, ultimately demonstrating that the potential for these discharges to cause environmental effects has declined significantly. An analysis of the impact of the sector on the GES and GCS is also provided for those RBMPs that have been completed.

The four main key environmental issues in the field of water that the downstream oil industry is facing in the near future are discussed and put into context on the basis of existing factual information.

The EU refining industry and water

In 2008, the 43 Concawe members operated 125 refinery locations with a total processing capacity of 840 million tonnes of crude oil throughput, equivalent to a ~90% utilisation rate. These refineries produce almost 40% of the total production of the EU petrochemical and chemical industry[5,6]. The water use in the refining industry is considerable. In 2010, the water discharges amounted to a total of 1,583 Mm^3 containing a total of 798 tonnes of total petroleum hydrocarbons (TPH) or 1.3 gTPH/tonne of crude processed[7]. These discharges are all subject to treatment before release and most (at 113 locations) are receiving a final biological treatment, whereas the remaining locations apply a final treatment with equivalent results, compliant with their permit requirements.

Figure 2 Trend in TPH discharges from the refining industry in Europe



There are several legislative and regulatory requirements which need to be met in order for industry to both produce within the EU and place their products on the EU-market. The requirements which are relevant to the protection of the aquatic environment are presented in Figure 1.

This total regulatory framework has all the required elements to adequately manage and control the desired environmental improvement to create a sustainable and diverse ecosystem that can provide the natural resources required to maintain and improve today's and tomorrow's living standards. The Commission concluded the consistent implementation of this framework by the MS is all that is needed to achieve this[8].

The two directives that have had the most impact on water quality are the WFD and the new Industrial Emissions Directive (IED)[9]. The IED aims at reducing emissions into the environment through the application of Best Available Techniques (BAT), an approach that has been embedded into EU legislation, since 1996 (Council Directive 96/61/EC).

Figure 2 shows the reduction in TPH emissions from 82 Western European refineries in 1969[7] to 116 refineries in the whole EU in 2010. These data show that the TPH emissions have been reduced from 45,000 tonnes in 1969 to only 798 tonnes in 2010. In 2010 all EU crude oil processing facilities reported their emissions. When looking at the growth in throughput over the past 40 years, the relative reduction of TPH emissions is well over 99%[7]. Whilst there is no hard data available before 1969, reports on the installation of emission reducing measures since 1955[10] are available and allow us to conclude that, even before the EU was founded and their regulations were introduced, the refining Industry took significant steps reducing its emissions to water.

Figure 2 also includes a projection of future reductions in TPH emissions, indicating that the relative emissions in grammes per tonne is not likely to reduce further. The projected total mass reduction is therefore most likely to result from the sector's response to the economic situation, leading to a sector rationalisation including changing refinery activities at current locations to distribution only[11].

Returning to the WFD and the published RBMPs, Concawe has evaluated the status of the River Basin Districts (RBDs) where the refineries are located. RBMPs have been published covering 88 refinery locations. Of these, 38 are located in RBDs that fail GES, and 53 fail GCS for surface water. A further in-depth analysis of the RBMPs associated with those RBDs, revealed that only 5 RBD failures could possibly be linked with past refinery emissions.

For groundwater the equivalent numbers are 44 failures related to GCS and 18 related to Good Quantitative Status (GQS). Again, the analysis of causatives that lead to these status failures revealed that potentially 5 refineries may have had an impact on two groundwater bodies, as 4 are located on the same groundwater body. From this analysis we would conclude that the refining industry can best improve the status of failing water bodies by focusing on these few whilst maintaining the good performance of the remaining refineries.

The above demonstrates that the refining industry has taken significant strides to improve the quantity and quality of their discharges and that the contaminant levels obtained by current water treatment do not give significant cause for concern. Therefore, Concawe trusts that the Competent Authorities will focus on the real

causes that have to be managed today, to obtain the desired WFD water quality objectives. However, as in the past, Concawe will continue to support its members in their endeavours to improve their environmental performance.

Current environmental issues faced by the refining industry

As explained above, the refining industry has continued to respond to water-related environmental issues in a responsible manner and will remain committed to doing so. However, the focus is shifting, with today's priorities, being:

- resource efficiency;
- mixture effects;
- emerging contaminants; and
- enhanced monitoring efforts.

These are discussed further below.

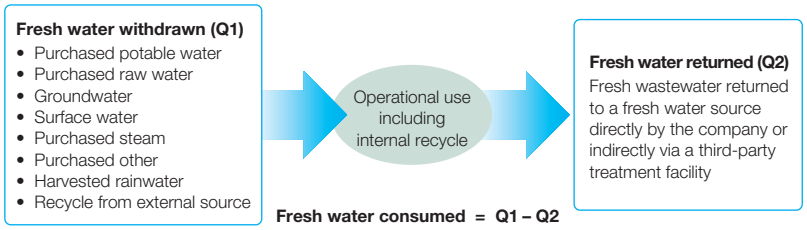
Resource efficiency

In the refining industry several resources are constantly evaluated to optimise their use and to minimise the potential environmental and health impacts. Today's focus is on feedstock and production optimisation, with minimal losses and waste generation, minimal energy use and balanced water consumption.

As energy efficiency and water consumption are already incorporated into the IED, new legislative instruments (under the WFD) aimed at reducing water consumption may be superfluous for industrial resource management.

In the context of this paper the water use and discharges are of most interest, in regions where fresh water is a scarce commodity. In this respect the refining industry questions whether total water use is the correct parameter to manage. In line with the IPIECA guidance on sustainability reporting[12], Concawe is of the opinion that this should concern only the fresh water that is actually consumed. Figure 3 takes into account the difference between fresh water intakes that are utilised in the production processes and the amount discharged into freshwater bodies. The rationale behind this way of defining fresh water consumption is found in the fact that fresh water returned to fresh water bodies remains available for other users.

Figure 3 Fresh water consumption accounting (Source: IPIECA, OGP & API, 2010)



This water accounting method was applied to the refining industry for the first time in the refinery effluent survey of 2010, the results of which revealed that, of the total fresh water intake of 1,140 million m^3, approximately 225 million m^3 was consumed (data from 101 refineries). Minimising the consumption of fresh water has several advantages for both cost and environment. Concawe is working with its members to establish the trend in water consumption over time and produce an inventory of the consequences.

Mixture effects

The substances that are produced by the refining industry are hydrocarbons of variable, and complex composition. The hydrocarbons in refinery discharges differ in composition. Within Concawe there is ample understanding of the impacts of these discharges, which are either measured or estimated using Quantitative Structure-Activity Relationships (QSARs).

Hydrocarbons found in the environment emanate from product spills and/or refinery discharges as well as from natural sources (oil seeps, vegetable oils and decaying organic matter). The anthropogenic sources have been around for more than a century but, as mentioned previously, the discharge reductions (Figure 2) and environmental improvements indicate that these hydrocarbon mixtures will not lead to any new environmental effects.

Emerging contaminants

Emerging contaminants are defined as 'pollutants that are new or present in the environment but whose presence and significance are only now being elucidated' (US EPA).

As the refining industry is a mature industry, the issue of emerging contaminants should not exist, because the products and unintended by-products that are dis-

charged have been in the environment for a long time and any adverse effects will have surfaced and will already be understood. Our understanding of the effect of specific contaminants present in refinery discharges will develop due to progress in scientific understanding or identification of the causative components due to better analytical techniques. Concawe will follow these developments and advise its members if relevant developments occur.

Any new substances or materials introduced into refinery products and processes that may end up in the environment must be registered and hence evaluated under the current legislation (REACH[13]) which includes an assessment of potential human health and environmental risks. This should ensure that these substances or materials will not end up in the environment at levels that can cause harm to human health or the environment.

Enhanced monitoring efforts

The refining and other Industries will continue their effluent quality monitoring efforts, demonstrating that the achievements reported above are at least maintained. The obligation to assess and monitor the water quality under the WFD and associated legislation rests with the Member States, who are therefore responsible for organising and resourcing this activity where it concerns the surface and groundwater bodies that they are responsible for. Involving a refiner in monitoring outside the refinery boundaries should only occur when a causal relation between an observed environmental stressor or impact and the activities of an Industrial site is proven by the Competent Authority.

Concawe will follow these developments and, where required, update its existing guidance for the membership.

Conclusions

Europe's waters are constantly improving and will continue to do so when the WFD and other key environmental regulations are applied in a consistent manner by all EU Member States. The refining industry has been and is delivering actively; their contributions to these environmental improvements are reflected in the factual decrease of relative and absolute emissions and discharges over time.

Emerging issues from mixture or 'chemical cocktail' effects associated with refinery discharges are unlikely to trigger scientifically well-understood environmental or human health impacts that have not already been observed, as the contaminant loads were already present in the environment long before their reported reductions. The exceptions may be new effects, or new products and materials that can only be introduced to the market when registered and authorised after an assessment of potential risks.

Concawe will continue to assist its membership in maintaining past achievements, responding to new scientific and regulatory developments and enabling the management of the further environmental improvements that are required for sustainable water management in cost efficient way.

References

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11 Concawe Report 1/13.

12 IPIECA, OGP & API (2010). *Oil and Gas Industry Guidance on Voluntary Sustainability Reporting*.

13 Regulation (EC) No 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH).