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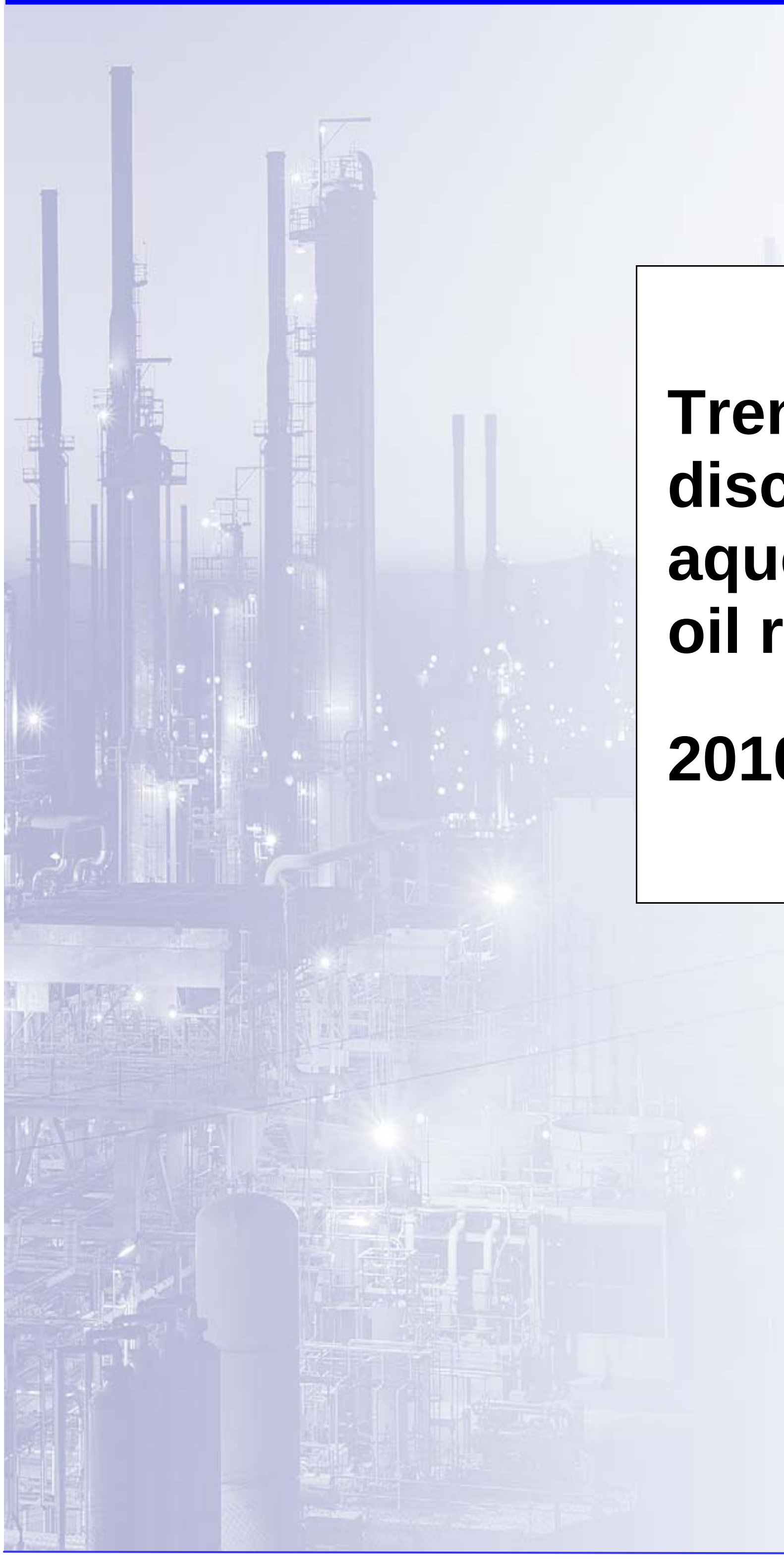

Trends in oil discharged with aqueous effluents from oil refineries in Europe

2010 survey data

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2010 survey data

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ABSTRACT

This report summarises data gathered by CONCAWE in a 2010 survey of effluent water quantity, oil content and treatment processes for refinery installations situated in the EU-27 countries and those in Croatia Norway and Switzerland. Data obtained in previous surveys are included for comparison.

Operators of 100 installations completed questionnaires, of which two of these only reported data for water intake and discharge.

The number of 100 reporting locations is lower than the 125 locations that reported in 2008. There are several reasons for this. Since the last data gathering exercise several refinery installations have been closed or moth-balled, turning these into fuels depots without any production. Another four sites that are still operating today informed CONCAWE that these would not be in a position to complete the questionnaire for 2010. Finally, the ownership of some installations changed since 2008, leading to CONCAWE being unable to identify an appropriate contact person for timely completion of the questionnaire.

The data provided through the completion of the questionnaire have been extracted into an MS-ACCESS Database. This enabled sorting, extraction, analyses and presentation of the information in a range of formats. The information presented in this report relates to a selected range of parameters that have been covered by previous surveys carried out since 1969. Two further reports will cover the results of the complete survey in more detail; one concerning final discharge quality parameters and the other focussing on water use and consumption.

The results reported herein show that the volume of process water that was being discharged from EU-27+3 (Norway, Croatia and Switzerland) - located refineries decreased between 2008 and 2010 while the overall volume of aqueous discharges remained about the same or slightly increased over the same period. When expressed relative to refinery capacities and throughputs there is a slight increase in 2010 in the amount of effluent discharged from all sources per tonne of capacity and throughput compared with 2008.

The amount of oil discharged in effluents from reporting installations continued to decrease both in terms of the absolute amount discharged and the amount expressed relative to the volume of feedstock processed (throughput) and the refining capacity of the installations.

The amounts of ammonia, total nitrogen (TN) and phenols also appear to have continued to decrease but the figures are more difficult to interpret because the number of refineries that reported data was, particularly in the case of ammonia, lower. However, when expressed relative to feedstock throughput, the decrease is still evident. Similar trends are evident in the data for Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Total Organic Carbon (TOC) content. It should be noted, however, that the 2010 figure also includes data for non-process related effluent streams if reported.

The majority of the reporting installations have on-site waste water treatment plant (WWTP) and the total emission loads for ammonia, total nitrogen, phenols, BOD, COD and TOC are reported as associated with their discharges. For installations that transfer their effluents to an off-site WWTP for treatment prior to discharge, these are reported separately.

The distribution of the 2010 Nelson Complexity Index (NCI) scores is very similar to that derived for 2005 and 2008. It shows a slightly increasing trend of operation complexity of the refinery installations operated by CONCAWE members.

The trend series available in CONCAWE demonstrate that the refining sector has reduced its oil and TPH releases into the aquatic environment significantly over the past 40 years. Overall a reduction of more than 99.5%-mass is demonstrated.

KEYWORDS

Ammonia, BOD, COD, TOC, effluent oil in water, phenols, refinery, treatment, waste water

INTERNET

This report is available as an Adobe pdf file on the CONCAWE website (www.concawe.org).

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SUMMARY

This report summarises information on the quantity, quality and treatment of effluents from European oil refinery installations obtained in a survey for the year 2010. The survey area was the EU-27 countries and those in Croatia, Norway and Switzerland (EU27+3).

The data provided through the completion of the questionnaire has been extracted into an MS-ACCESS Database that enabled sorting, analysis and presentation of the information. The data presented in this report relates to a selected range of parameters that have been covered by previous surveys carried out since 1969. The data have been compared with those obtained in the two most recent surveys conducted in 2005 and 2008.

The main conclusions drawn from the survey results are as follows:

- A total of **100** installations responded to the survey. Of these **89** are direct dischargers after on-site treatment and **9** transfer their effluent to external treatment facilities. The remaining 2 installations only reported water use and discharge data. The figure of 100 is down on the previous 125 that reported in 2008. The reasons for this reduction are not completely clear for most of the non-reporting locations, as only four sites informed CONCAWE that they would not be in a position to complete the questionnaire. However, since the last data gathering exercise several refinery installations have been closed or moth-balled, turning these into fuel depots. Four of the refineries reporting in 2008 were no longer in operation at the end of 2010. Several announced that they would be ceasing production and, as a consequence, they would no longer be in a position to complete the questionnaire. Finally, the ownership of some installations changed since 2008, leading to CONCAWE being unable to identify an appropriate contact person for timely completion of the questionnaire.
- The approximate throughput of the 100 reporting refinery installations was **698** million tonnes in 2010 compared to the **748** million tonnes that was reported by 125 installations in 2008.
- The types of refinery installations operated by EU27+3 CONCAWE members have been characterised using Nelson Complexity Index (NCI) scores. The distribution of the 2010 scores for the reporting installations is very similar to that derived for 2005 and 2008. It again shows a slightly increasing trend of operation complexity of the refinery installations operated by the members.
- The results reported herein show that the volume of process water that was being discharged from EU-27+3 based refineries decreased between 2008 and 2010 while the overall volume of aqueous discharges remained about the same or slightly increased over the same period. When expressed relative to refinery capacities and throughputs there is a slight increase in 2010 in the amount of effluent discharged from all sources per tonne of capacity and throughput compared with 2008.
- The amount of oil discharged in effluents from reporting installations continued to decrease both in terms of the absolute amount discharged and the amount expressed relative to the volume of feedstock processed (throughput) and the refining capacity of the installations.

- The amounts of ammonia, total nitrogen (TN) and phenols also appear to have continued to decrease but the figures are more difficult to interpret because the proportion of refineries that reported data was, particularly in the case of ammonia, lower. However, when expressed relative to feedstock throughput, the decrease is still evident. Similar trends are evident in the data for Biochemical Oxygen Demand (BOD) Total Organic Carbon (TOC) content. However for Chemical Oxygen Demand (COD) there appears to have been a significant increase compared with the 2005 and 2008 figures for installations discharging directly after onsite treatment. The reason for this may be that the 2010 survey also includes refinery effluent streams that are not associated with refinery processes.
- The majority of the reporting installations have on-site waste water treatment plant (WWTP) and the total emission loads for ammonia, total nitrogen, phenols, BOD, COD and TOC are reported as associated with these discharges. For installations that transfer their effluents to an off-site WWTP for treatment prior to discharge, these are reported separately.

In the final chapter an overview of over 40 years of the discharge trend reports is provided together with the achievement of a more than 99 %-mass reduction of these discharges by the Refining Industry sector. In addition, work is in hand to further analyse the data of the complete 2010 survey that may lead to further reporting on discharge quality parameters and the water use and consumption of the refining sector.

1. INTRODUCTION

CONCAWE has obtained data for 2010 on oil refinery effluent water quantity, quality and treatment processes from a survey of its members in the EU-27 member states and those in Croatia, Norway, and Switzerland, hereafter, referred to as the “EU-27+3”. The survey questionnaire was returned by 100 refinery installations representing more than 86.5% of the refining capacity located in the survey area in 2010. The data provided have been extracted into an MS-ACCESS Database that has enabled sorting, analysis and presentation of the information.

This report is based on data for a selected number of effluent quality parameters. It illustrates the continued development of the refining industry’s environmental performance in the EU-27+3 in terms of refinery type, waste water treatment systems, and the amounts of wastewater and associated oil and the other selected effluent quality parameters (Ammonia, Total Nitrogen (TN), Phenols, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Total Organic Carbon (TOC)). The data have been compared with those obtained from previous CONCAWE surveys; most recently those conducted in 2005 and 2008 [11].

Throughout the report the number of refinery installations mentioned are those with crude oil refining activities, including speciality, lubricant and bitumen plants, that have independent discharges into a receiving environment via an on-site Waste Water Treatment Plant (WWTP) or that transfer their discharges to an external and often commercially operated WWTP for final treatment.

The number of refinery installations reporting on any specific effluent quality parameter varies. Throughout this report calculations of discharges of quality parameters relative to throughput have therefore been based only on the actual throughputs of those refineries reporting the relevant data. Consequently, the throughputs used in the calculations may differ from the total industry throughput data given in **Table 1** below.

CONCAWE plans to continue to conduct, and where appropriate, expand and adapt this series of surveys in the years to come in order to provide their membership with robust data for benchmarking the performance of their installations. The data will also serve as evidence for the scientific advocacy when participating to regulatory initiatives that are designed to place further controls and monitoring requirements on pollution arising from refinery operations.

2. REFINERIES REPORTING

A total of 100 installations responded to the survey for the year 2010. Of these 89 are direct dischargers after on-site waste water treatment and 9 transfer their effluent to external treatment facilities. The remaining 2 installations only reported water use and discharge data.

The 2010 figure represents a slight increase compared with the figure of 96 that responded for 2005 and a decrease in the figure of 125[1] responded for 2008. The difference in the numbers reflects the way the industry had been reorganised following a number of mergers and refinery closures and the inclusion of additional refineries as a result of new countries joining the EU. The 100 reporting refineries represent approximately 86.7% of the total EU-27+3 refining capacity in 2010.

2.1. CRUDE OIL REFINING CAPACITY AND THROUGHPUT

The numbers of refineries which have reported refining capacity and throughput data in each year of the survey are given in **Table 1**.

Table 1 Crude oil refining capacity / throughput

Year of survey	Number of refineries reporting in each survey	Reported capacity (million tonne/yr)	Reported throughput (million tonne/yr)
1969	82	400	Not requested
1974	112	730	Not requested
1978	111	754	540
1981	105	710	440
1984	85	607	422
1987	89	587	449
1990	95	570	511
1993	95	618	557
1997	105	670	627
2000	84	566	524
2005	94/96 (capacity/throughput)	730	670
2008	125	840	748
2010	100*	720 (830)*	605 (698)*

*Figures relate to 100 installations; the values between parentheses represent the corresponding total capacity and throughput for the same installations that reported in 2008 but excluding the five that had ceased refining operations since then.

For the 100 installations that reported capacity data for 2010 the total figure was 720 million tonnes. The total reported 2010 throughput for crude and other feed intakes, for the same refineries was 605 million tonnes. However, when the 2008 figures for

[1] The number of sites differs from the EUROPIA 2010 White Paper on EU Refining that reported the number of 98 mainstream refineries in the EU-27+, which excludes bitumen and speciality plants and reports refineries as management units, even when these comprise of more than one independently operating installations.

the non-reporting installations that are still in operation are added to the totals for 2010 for the 100 the corresponding totals are 830 million tonnes for capacity and 698 million tonnes for throughput. These capacity totals are very similar to those for 2008. The reporting refineries represent approximately 86.7% of the total refining capacity of the mainstream and speciality refineries of EU-27+3 CONCAWE Members as calculated from the BP Statistical Review of World Energy [14].

2.2. REFINERY COMPLEXITY

The Nelson Complexity Index (NCI) [15] provides a standard measure of the complexity of a refinery. The NCI assigns a complexity factor to each major piece of refinery equipment based on its complexity and replacement cost in comparison to crude distillation, which is assigned a complexity factor of 1.0, being the Equivalent Distillation Capacity (EDC). The complexity of each piece of refinery equipment is then calculated by multiplying its complexity factor by its throughput ratio as a percentage of crude distillation capacity. A refinery's NCI is obtained by summing the complexity values for each piece of equipment, including crude distillation.

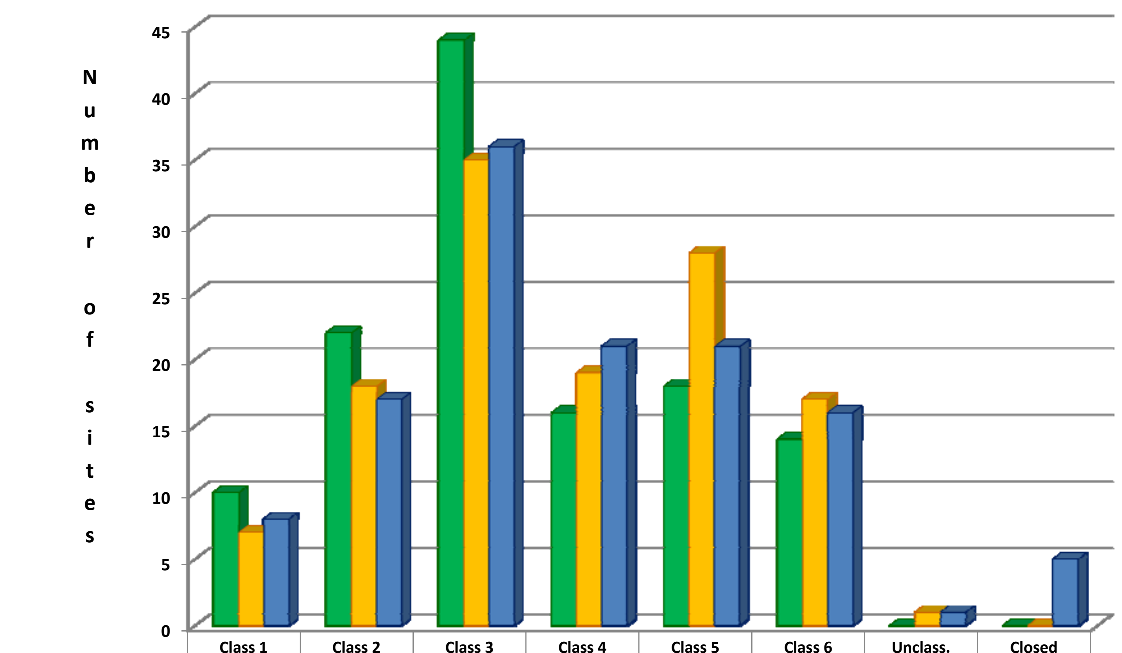
For the analysis of the refineries covered by the 2010 survey the NCI values were derived from the Oil and Gas Journal refining capacity and layout listing of December 2004 (Data as of 1, 2005 [15]). A similar analysis is presented for the refineries surveyed in 2005 and 2008 based on the Oil and Gas Journal refining capacity and layout listing of January 2005 [16], December 2009 [17] and December 2011 [18] No attempt has been made to verify these NCI values with the CONCAWE Member due to changes in ownership and because today's lay-out may have altered due to emerging safety standards, changing strategies and major investments that have taken place.

CONCAWE has derived the following six classes of refinery based on NCI:

- Class 1: NCI < 4
- Class 2: 4 < NCI ≤ 6
- Class 3: 6 < NCI ≤ 8
- Class 4: 8 < NCI ≤ 10
- Class 5: NCI >10
- Class 6: Refineries for speciality lubricants and bitumen production.

The 2005, 2008 and 2010 NCI classifications for all EU-27+3 based CONCAWE Membership refinery locations are shown in **Figure 1**.

Figure 1 Nelson Complexity Index (NCI) classes for all EU-27+3 based Refineries in 2005, 2008 and 2010



	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Unclass.	Closed
31 December 2005	10	22	44	16	18	14	0	0
31 December 2008	7	18	35	19	28	17	1	0
31 December 2010	8	17	36	21	21	16	1	5

The NCI scores show that the EU-27+3 refinery installations differ with respect to the complexity of their operations and the type of equipment and installations that are present on-site. These differences will influence the composition of the waste water streams that end up in the treatment facilities and, hence, the composition and properties of the final effluent. The distribution pattern has been altered only slightly over the period between 2005 and 2010; there is a slight trend towards an increase in the proportion of more complex installations, indicated by classes 4, 5 and 6 and an associated reduction in the numbers of those in classes 1, 2 and 3 that are less complex.

3. WASTE WATER TREATMENT SYSTEMS

In 2008, 14 of the 125 refinery locations reported that their effluents were subjected to biological treatment in external multi-user WWTP facilities, most commonly after partial on-site treatment. The other 111 refineries perform an on-site final treatment before discharging their process effluents, for which 103 sites apply a three-stage biological system. The majority (78) have an aerated activated sludge reactor as the biological unit (**Table 2**). Hence, of the 120 reporting refineries, 113 (94.2 %) subject their process effluents to biological treatment before discharge.

In 2010, the only change appears to be that one of the installations that used mechanical treatment is now transferring its discharge to external WWTP and five installations (2 Activated Sludge, 2 Trickling filters and 1 transfer) have closed. For the non-reporting installations it is not known if there have been any changes to the type of WWTP in operation and so it is assumed that they are unchanged.

Table 2 Final effluent treatment as reported for 2010 discharges*

Treatment	Number of installations	Type of biological treatment	Number of installations with specific treatment
3 Stage biological	99	Activated sludge	76
Mechanical	1	Trickling filter	14
Chemical	2	Aerated lagoon	5
Physical	4	Non aerated lagoon	1
API separator[2]	0	Fixed-bed bio-film reactor	1
External WWTP	14	Aerated tank	1
None	0	Other not specified	1
		External not specified	14
Total	120	Total	113

* For the non-reporting installations, the 2008 responses are included.

[2] An API oil-water separator is a device designed to separate gross amounts of oil and suspended solids from the wastewater effluents of oil refineries, petrochemical plants, chemical plants, natural gas processing plants and other industrial sources. The name is derived from the fact that such separators are designed according to standards published by the American Petroleum Institute (API) [21].

4. AQUEOUS EFFLUENTS DISCHARGED FROM REFINERIES

Aqueous effluent discharge data for the survey years between 1969 and 2010 are summarised in **Table 3.**

Table 3 Aqueous effluent discharge data

Year of survey	Number of reporting refineries	Total aqueous effluent[1] (million tonne/yr)	Aqueous effluent (tonne/tonne capacity)	Aqueous effluent (tonne/tonne oil throughput)
1969	80	3,119	8.0	n.d.
1974	108	3,460	4.9	n.d.
1978	111	2,938	3.9	5.4
1981	104	2,395	3.4	5.4
1984	85	1,934	3.2	4.6
1987	89	1,750	3.0	3.9
1990	95	1,782	3.0	3.5
1993	95	2,670	4.3	4.8
1997	105	2,942	4.4	4.7
2000	84	2,543	4.5	4.9
2005	96	790	1.1	1.2
2008	125	612 (1,112)	0.73 (1.3)	0.82 (1.5)
2010	100	405[2] (1,583)	0.48 (1.9)	0.55 (2.2)

Notes: 1. Until 2000 the total aqueous effluent in the table refers to the sum of process effluents, cooling water and other flows such as lightly contaminated rain water. For the 2008 and 2010 surveys, there is the distinction between treated process water and other streams that are discharged at the same or separate emission points. The values between brackets are based upon the sum of all reported discharges, excluding once-through cooling water.

2. In the effluent database there are reports that only consider treated process water (241 Mm^3) and reports on other water (328 Mm^3) that is treated before discharge or transfer. From the notes provided by the rapporteurs it is evident that these other waters are mixes of process, cooling and storm water. For this report is has been assumed that 50 % of these effluent comprise of process water.

The total reported discharge of effluents increased from 1,112 million tonnes in 2008 to 1,583 million tonnes in 2010. However, over the same period, the volume of treated process water reduced significantly from 612 million tonnes in 2008 to 405 million tonnes, in 2010.

A potentially more meaningful indicator is the volume of effluent per tonne of capacity or throughput. For 2010 the values were 0.48 and 0.55 m^3/tonne for the treated process water streams and 1.88 and 2.16 m^3/tonne for all reported discharges, excluding once through cooling water. In comparison the values for 2008 were 0.73 and 0.82 m^3/tonne for the treated process water streams and 1.33 and 1.49 m^3/tonne for all reported discharges.

These data suggest that the volume of treated process water that was being discharged from EU-27+3-based refineries decreased between 2008 and 2010 while the overall volume of all aqueous discharges remained about the same or slightly increased over the same period. When expressed relative to refinery capacities and throughputs there is a slight increase in 2010 in the amount of effluent discharged from all sources per tonne of capacity and throughput compared with 2008. This appears mainly to be caused by the inclusion of non-process effluents like domestic and cooling water.

5. OIL DISCHARGED WITH AQUEOUS EFFLUENTS

The most frequently used measure of refinery effluent quality is hydrocarbon content (oil in water).

In the years between 1969 and 2000, there was a continuous reduction in the amount of total oil discharged with refinery aqueous effluents from about 44000 tonnes from 73 refineries in 1969 to 750 tonnes from 84 refineries in 2000 (**Table 4**, **Figure 2**). This figure rose in 2005 to 1050 tonnes from 96 refineries; the increase being associated with a corresponding increase in the number of refineries that reported data. Since 2005 the total amount of oil discharged has decreased to 798 tonnes from the 98 reporting refineries in 2010.

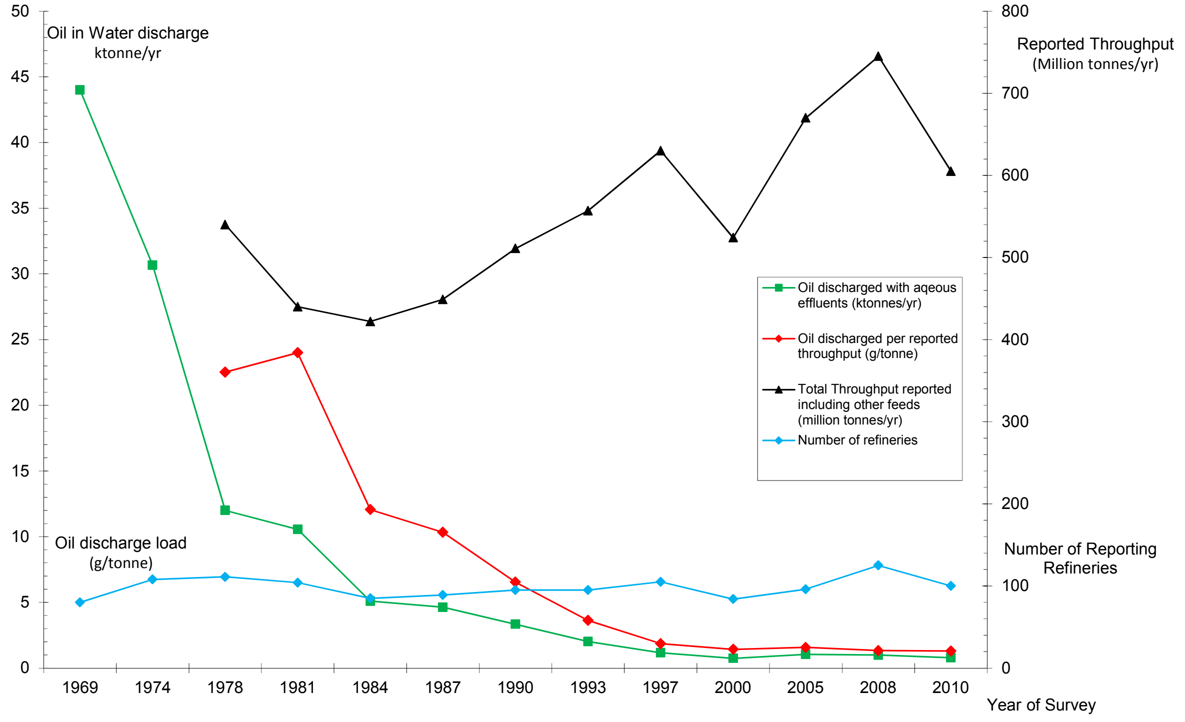
The ratio of oil discharged relative to the refining capacity and throughput has continued to reduce over the whole period covered by the surveys; the values now stand at 1.07 g per tonne capacity and 1.28 g per tonne throughput. These decreasing values continue to be below the OSPAR Recommendation 89/5 figure of 3 g/tonne of processed oil [20] that was set in 1997.

Table 4 Comparative data on oil discharged

Year	Number of refineries reporting these data	Total oil discharged (tonne/year)	Oil discharged (g per tonne capacity)	Oil discharged (g per tonne throughput)
1969	73	44,000	127	n.a.
1974	101	30,700	44.8	n.a.
1978	109	12,000	15.9	22.5
1981	105	10,600	14.9	24.0
1984	85	5,090	8.39	12.1
1987	89	4,640	7.90	10.3
1990	95	3,340	5.86	6.54
1993	95	2,020	3.30	3.62
1997	105	1,170	1.74	1.86
2000	84	750	1.32	1.42
2005	96	1,050	1.44	1.57
2008	125	993	1.18	1.33
2010*	98	798	1.10	1.30

* Figures relate to 98 installations; they exclude the two installations that only reported data for water use.

Figure 2 Trends in oil discharged against refinery throughput 1969-2010



6. DISCHARGE OF OTHER COMPOUNDS

CONCAWE has previously collected information on other compounds in refinery effluents, i.e. Ammonia, Total Nitrogen (TN), Phenols, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Total Organic Carbon (TOC)). This information was reported for the first time in 1997. Refinery installations were again asked to provide this information for the 2010 survey.

The reported discharges of Ammonia, TN and Phenols for 2010 are given in **Table 5** along with those for the earlier surveys. The data for 2010 have been split so that the contributions from direct discharges from installations and those discharges after transfer to, and treatment by, offsite WWTP. For effluents transferred to offsite WWTP it has been assumed when analysing the 2010 data that a 95% removal of ammonia and phenols can be achieved prior to final discharge. For TN this is only achievable when the receiving WWTP operates a polishing step that incorporates denitrification.

Table 5 Discharge of ammonia, total nitrogen & phenols

Year	Ammonia[1]	Total Nitrogen	Phenols
	tonne/year (Number of Refineries reporting)		
1993	5,202 (82)	n.a.	179 (77)
1997	3,210 (82)	n.a.	161 (73)
2000	1,715 (46)	1,884 (46)	61 (55)
2005	1,959 (64)	4,778 (80)	180 (84)
2010	454[2] (26) 22[3] (3)	2,307[2] (66) 56[3] (8)	31[2] (76) 5.2[3] (8)
	g/tonne throughput		
1993	10.4	n.a.	0.41
1997	8.0	n.a.	0.32
2000	5.7	7.4	0.16
2005	5.5	10.0	0.35
2010	0.82[2] 8.15[3]	4.2[2] 21[3]	0.058[2] 1.9[3]

[1]Ammonia may also be included in the figures for total nitrogen since many refineries measure this rather than ammonia. Although related, the two measurements are required for different reasons; ammonia can cause acute aquatic toxicity depending upon the pH and temperature, whereas TN is a measure of the potential for eutrophication of the aquatic environment.
[2]Figures for direct discharges from installations
[3]Figures for discharges after transfer to, and treatment by, offsite WWTP

The data suggest that the decrease in the amounts of these parameters that are being discharged that was evident in previous survey data continues, even allowing for the variation in the number of reporting installations. Splitting the 2010 data into direct contributions from refinery installations and those discharged after treatment in offsite WWTP suggests that the offsite WWTP is less effective in removal of the compounds. However, the assumption that the offsite WWTP removes 95% of each compound may be an underestimate.

The results for BOD, COD, TOC and TSS for 2010 are presented in **Table 6** along with those for the earlier surveys. All told 96 refineries reported at least one of these measurements, and in most cases several. For BOD, COD and TOC, the results are expressed in terms of oxygen taken up during the test. This reflects the oxygen demanded of the receiving water body rather than the mass of material in the effluent. The ratio between these will vary with the chemical composition of the effluent involved.

The 2010 data for BOD and TOC show a decrease in the amounts discharged relative to 2000 and 2005 and this is also apparent when the amounts are expressed relative to throughput. However, for Chemical Oxygen Demand (COD) there appears no significant change in the COD -load compared with the 2005 figure for installations discharging directly after on-site treatment. The reason for this may be that water use efficiency measures lead to higher concentrations of moieties that may be more recalcitrant to the final biological degradation. It should be noted, however, that the 2010 figure also includes data for non-process related effluent streams if reported.

Table 6 Discharges of BOD, COD and TOC

Year	BOD	COD	TOC
	tonne/year (Number refineries reporting)		
2000	3,129 (47)	19,002 (61)	3,094 (21)
2005	6,242 (84)	33,156 (90)	3,559 (45)
2010	3,450[1] (68) 75.9[2] (7)	31,765[1] (81) 1,770[2] (9)	2680[1] (41) 195[2] (6)
	g/tonne throughput		
2000	10.4	50.9	17.9
2005	13.5	58.0	12.7
2010	6.3[1] 2.0[2]	57.7[1] 35.0[2]	4.9[1] 4.8[2]

[1] Figures for direct discharges from installations

[2] Figures for discharges after transfer to and treatment by offsite WWTP, assuming 95 % removal.

7. CONCLUSION AND FUTURE EFFLUENT REPORTING

This report is the last in a series that dates back to 1970. In 1970, the results for the 1969 Refining Industry in Western Europe were reported [1]. That report covered 82 refineries in 17 Countries of which 21 were located in West-Germany, 16 in France, 12 in the United Kingdom, 5 in The Netherlands and 3 in Belgium and Spain. For the other Countries, 3 reports on 2 refineries are present whereas for the remaining 8 countries only a single refinery reported its results. Then, the reported quantity of crude oil processed was 400 million tonnes for 1969, which was assumed to represent ~80% of the refining capacity in the reporting Western European Countries.

In 1969, the Oil in water of TPH emissions was reported by 73 of the responding locations that registered a total mass emission of 44,000 tonnes. The effluent treatment at the reporting refineries was different from today. Then, only 19 had the three stage WWTP set-up that is considered today as Best Available Technique (BAT) in the Refinery BREF. It is noteworthy that 14 of these reporting refineries were constructed after 1960.

Today, as described in this report, the situation is completely different. The expansion of the EU over the past 40 years has led to the situation where in the 2010 Refinery Effluent Survey data has been obtained from 20 of the 27 EU Member States and the 3 other Countries. Taking into account that Cyprus, Estonia, Latvia, Luxembourg, Malta and Slovenia do not host any crude-oil refinery, this means that for only one EU-Member State there is no data included in this report.

As mentioned in this report and shown in **Figure 2**, since 1969 the TPH emissions have been reduced by 98.2 %m to less than 800 tonnes of the 1969 reported value, which is a remarkable achievement taking into account the inclusion of the currently active Eastern European Refineries and the fact that the total refining Capacity in the EU-27+ has increased to ~830 Million tonnes, more than double the amount reported in 1970, when the first report in this series was issued. Therefore, the TPH-emission reduction is more likely to be in the order of 99 %mass or higher compared with emissions reported in the late 1960s.

Figure 2 also shows that the reduction in TPH emissions is reaching a plateau that can be explained by the fact that, of the still active refineries, >95 % are treating their effluents by applying BAT, whereas the other 5 reporting refineries, although not using the 3-stage WWTP set-up, also match the levels of emissions that can be obtained by the application of BAT, thus demonstrating that their treatments are at least equivalent to BAT.

This series of trends reports has therefore demonstrated that the Refining Industry has delivered its aim to achieve a significant reduction in its aqueous emissions and a significant improvement in their effluent quality, to the extent that further improvements will only achieve marginal environmental and social benefits. However, where possible and economically justifiable, this process of improvement will be continued.

For the 2010 and future Effluent Quality Surveys the analyses of trends in effluent quality and quantity parameters will be described in additional reports. One will address the effluent quality in line with today's regulatory requirements aligned with the WFD, the IED and the E-PRTR Regulation. This report will also include the continuation of the trend analysis of the effluent quality reported in this report and is likely to be published upon the completion of the full data analysis.

The other report will focus on intakes, discharges and consumption of water by the Refining Industry in response on resource efficiency. This report will incorporate the discharge quantity trends.

8. LIST OF ABBREVIATIONS

API	American Petroleum Institute
BAT	Best available Technique
BOD	Biochemical Oxygen Demand
BREF	BAT Reference document
CFC	Chloro-Fluoro-Carbon
COD	Chemical Oxygen Demand
E-PRTR	European Pollutant Release and Transfer Register
EU	European Union
G	Gravity separation
GA	Gravity separation and advanced treatment
GAB	Gravity separation and biological treatment
GABP	Gravity separation and biological treatment followed by polishing treatment
GC	Gas Chromatography
IED	Industrial Emissions Directive
IR	Infra-Red
FID	Flame Ionisation detector
LoD	Limit of Detection
NCI	Nelson Complexity Index
n.d.	Not determined
OiW	Oil in Water
OSPAR	Oslo Paris Convention on the protection of the marine environment of the North-East Atlantic
QA/QC	Quality Assurance / Quality Control
REACH	Registration, Evaluation, Authorisation and restriction of CHemicals
THC	Total Hydrocarbon Content
TOC	Total Organic Carbon

TOD	Total Oil Discharged
TPH	Total Petroleum Hydrocarbons
TN	Total Nitrogen
TSS	Total Suspended Solids
WFD	Water Framework Directive
WWTP	Waste Water Treatment Plant

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