New refinery effluent survey

Additional data requirement under the REACH risk assessments

Within the REACH registration process, registrants of a substance must submit a Chemicals Safety Report that includes a Chemical Safety Assessment (CSA). If the CSA indicates that the substance should be classified as 'hazardous' then the Report must include a Risk Characterisation[1].

Many products that are manufactured and handled by the refining industry fall under this rule. Therefore, the category reports that CONCAWE is developing to assist with the registration of these products under REACH must include a REACH Risk Assessment.

To enable this assessment the PETRORISK software has been developed, incorporating the mathematical models prescribed by the European Chemicals Agency (ECHA). These models require input on the different life stages of a product and several input parameters covering the production phase.

Some relevant data were already available in CONCAWE, having been collected to provide input into the Best Availability Techniques Reference Document (BREF) for refineries under the IPPC Directive. The information was, however, incomplete in both refinery population coverage and time period.

In order to quickly obtain the missing data up to and including 2008, a questionnaire was developed and sent to all CONCAWE member companies. The response was excellent and all data were collected within five weeks. This is a clear indication that the CONCAWE membership are well aware of their responsibility to gather the essential data regarding their environmental performance.

The initial data received was of very high quality. A limited number of additional requests for clarification further increased the quality and consistency of the dataset which covers 119 refineries representing 124 unique locations with a total of 203 independent discharges into the environment.

Survey results

As shown in Table 1, the total crude capacity reported for 2008 is 838,660 kt with 88.9% total refinery utilisation, including non-crude feedstock.

In accordance with the REACH Risk Assessment Guidelines, only the worst case effluent scenario for each location was evaluated. The rationale behind this is that if this effluent is demonstrated to be free of risks to the environment or to human health, so will be effluents under other, less extreme scenarios.

Table 1 Capacity and throughput statistics for 2008

	Crude capacity (kt)	Crude throughput (kt)	0ther feeds (kt)	Total throughput (kt)	Total utilisation (% crude)
Total	838,660	686,860	58,720	745,580	88.9%
Average	6,763	5,871	734	6,013	86.8%
Median	5,543	5,204	376	5,309	89.7%
25th percentile	3,538	3,320	120	2,904	–
75th percentile	9,700	8,204	943	8,638	–

[1] *Details may be found in the ECHA 'nutshell guidance' on* Registration data and dossier handling: *http://guidance.echa.europa.eu/docs/guidance_document/nutshell_guidance.pdf*

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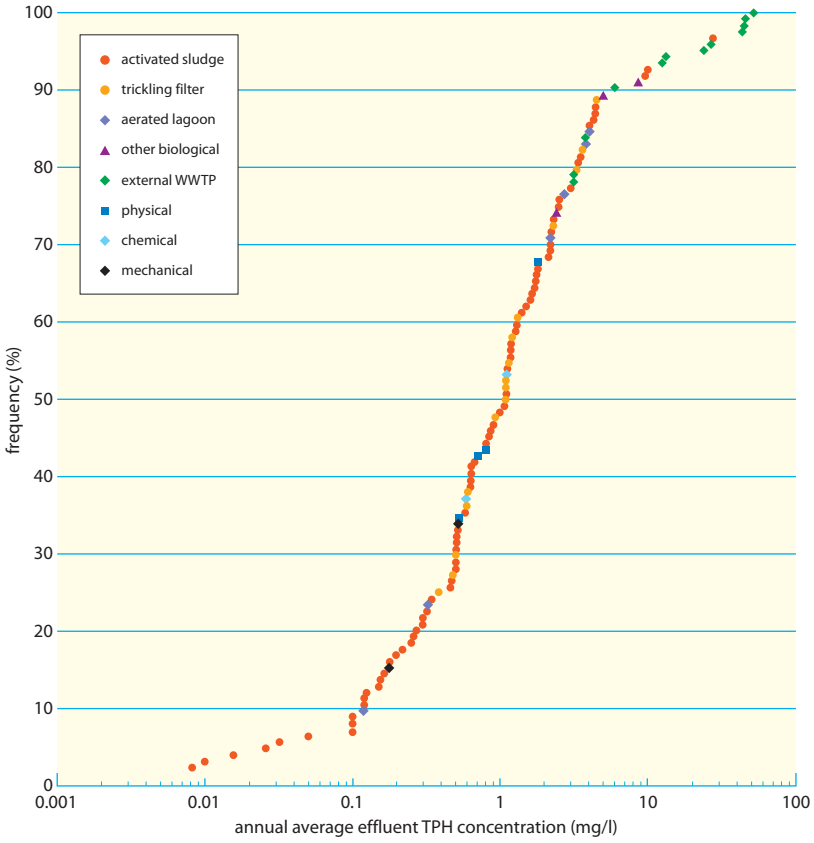
Table 2 Effluent treatment and receiving environment for the worst case discharge per location

Final effluent treatment		Type of biological treatment		Receiving environment	
3-stage biological	103	Activated sludge	77	River	50
External WWTP	13	Trickling filter	17	Canal	9
Physical	4	Aerated lagoon	5	Estuary	18
Chemical	2	Non-aerated lagoon	1	Marine	40
Mechanical	2	Fixed bed bio-film reactor	1	Harbour standing water	2
None	0	Aerated tank	1	Lagoon marine	5
		Other biological	1		
Total	124	Total	103	Total	124

Figure 1
62% of the refineries emit effluents with TPH within the BAT range of 0.05–1.5 mg/l irrespective of the treatment technique applied.

Table 2 provides an overview of the final treatment technique, the number of effluents to which this is applied, the type of biological treatment employed and the different receiving environments for these discharges. These receiving environments include those that are subject to external treatment.

Figure 1 Cumulative frequency plot of the reported TPH concentrations in effluents and final treatment technique applied



A total of 13 of the 124 locations discharge their on-site, pre-treated effluents into an external biological waste water treatment plant (WWTP) where they are subject to further biological treatment.

From the other 111 locations, 57 discharge their treated effluents into the marine environment, either directly or through an estuary. The remaining 54 locations discharge treated effluents into fresh water rivers, canals or harbours.

In Figure 1, the Total Petroleum Hydrocarbon (TPH) concentrations reported are presented in a cumulative frequency plot with an indication of the final treatment method applied. About 62% of the refineries emit effluents that are within the Best Available Techniques (BAT) range of 0.05–1.5 mg/l TPH reported in section 5.0 of the Refinery BREF[2]. Moreover, this appears to be achieveable irrespective of the treatment technique applied.

The statistical analysis of the data that will be used for the REACH Risk Assessments is provided in Table 3.

The reported TPH in the receiving environment is the ratio of the reported effluent concentration over a dilution factor estimated from the discharge volume and the flow characteristics of the receiving water. Where the latter information is not provided, a dilution factor of 10 is applied to fresh waters and of 100 for the marine environment. The discharges into external WWTPs will be subject to waste water treatment modelling as prescribed, and will therefore be reduced by approximately 90%.

In Table 4 the effluent discharge and TPH-load statistical analyses are presented. The total reported TPH load for all refineries is 1,333 tonnes in 2008 for the effluent streams that contribute to the worst-case discharge points considered for the REACH Risk Assessment. These discharge points emit 83.1% of the total reported effluent volume of 1,112.5 Mm^3 for the same period.

[2] *EIPPC-Bureau, 2003. Reference Document on* Best Available Techniques for Mineral Oil and Gas Refineries. *http://eippcb.jrc.es/reference/_download.cfm?twg=ref&file=ref_bref_0203.pdf*

Table 3 TPH load and concentrations discharged into the receiving environments

Receiving environment	Freshwater		Marine		External WWTP	
	TPH load (t/a)	[TPH] in receiving environment (µg/l)	TPH load (t/a)	[TPH] in receiving environment (µg/l)	TPH load (t/a)	[TPH] to WWTP (mg/l)
Total	221	-	524	-	588	-
Average	4.09	21.74	9.19	17.28	49.01	23.28
Median	1.27	1.02	3.80	9.00	16.45	18.65
25th percentile	0.45	0.11	1.50	3.20	4.92	5.45
75th percentile	5.65	8.22	11.90	22.71	90.44	43.90
Min	0.01	0.001	0.01	0.01	1.01	3.17
Max	33.35	378.57	72.10	100.00	166.00	52.00
Locations	54	54	57	57	121[1]	12

[1] One of the discharges into an external WWTP is sent to a treatment unit from another refinery, therefore the load and concentration of this is not included in the analysis, to avoid double counting.

A total additional TPH load of 90 tonnes is reported for other effluents (totalling 188,333 Mm^3), which are not taken into account for the REACH Risk Assessment. This is relatively low compared with the one reported above, as these concern separate cooling water, domestic sewage and storm water discharges.

These effluent discharges and the total TPH or oil-in-water loads can be compared with the previously reported values[3] covering the year 2000:

- Firstly a reduction of the total effluent volume from 2,543 to 1,112.5 Mm^3 is observed.
- Secondly, the TPH load discharged after treatment is stable at 750 compared to the previous figure of 745 tonnes. It must be noted, however, that the 2000 dataset only included 84 refineries compared to 119 in 2008. The remaining TPH releases to external WWTPs (more than 600 tonnes reported in 2008) are subject to additional treatment and are therefore reduced by a further 90 to 95% before discharge into the receiving environment. Therefore, it is estimated that the total environmental burden regarding TPH in 2008 was 850 tonnes for the CONCAWE membership refinery activities.

[3] Trends in Oil Discharges with Aqueous Effluents from Oil Refineries in Europe—2000 Survey. *CONCAWE Report 4/04.*

Table 4 Discharge and TPH load statistics of the REACH effluents

	Total effluent ($1000m^3/a$)	Treated effluent ($1000m^3/a$)	0ther effluents ($1000m^3/a$)	Outfall TPH load (t/a)
Total	1,112,545	611,650	312,562	1,333
Average	8,972	4,933	10,083	11
Median	2,843	2,102	1,207	3.0
25th percentile	1,399	1,029	428	0.8
75th percentile	6,693	4,775	3,967	8.3

The statistical evaluation of the TPH loads and effluent emissions, including cooling water, as a function of the crude capacity and total throughput is presented in Table 5. The numbers between brackets are the values that include the TPH discharges into external WWTP before treatment.

The average water use presented in Table 5 may appear on the high side. However, it has to be noted that these figures include process, cooling and storm water data and, when looking to the median and percentiles reported, it becomes evident that the average is skewed by some high reported values. Furthermore, the average values are higher than in earlier surveys, despite the fact that the number of participating refineries has increased from 73 in 1969 to 119 in 2008. Somewhat unexpectedly, the average TPH load of 1.96 g/t of throughput is higher than the BAT range of 0.01–0.75 g/t

Table 5 TPH load and effluent per tonne of crude capacity and total throughput

	TPH load (g/t crude)	Average load TPH (g/t throughput)	Water use (m^3/t crude)	Water use (m^3/t throughput)
Average	1.91 (3.01)[1]	1.96 (2.94)	2.23	2.53
Median	0.61 (0.71)	059 (0.66)	0.59	0.55
25th percentile	0.198(0.22)	0.18 (0.19)	0.33	0.33
75th percentile	1.55 (2.28)	1.55 (2.23)	1.37	1.45

[1] The numbers in brackets are the values that include the TPH discharges into external WWTP before treatment

indicated in section 5.0 of the Refinery BREF[2], with 55% of refineries reporting values within this range.

A further analysis will have to address this and will certainly provide more meaningful indicators enabling a distinction to be made between these different effluent streams and reported outliers.

Next steps

Further analysis of this unique dataset will be carried out and published in a CONCAWE report. This will support several other CONCAWE activities, in particular the work on the implementation measures of other EU-legislation such as the Water Framework Directive (WFD), the Marine Strategy Framework Directive, the European Pollution Release and Transfer Register Regulation (E-PRTR) and IPPC BREF revisions.

The successful collection of this dataset is a testimony to the petroleum industry's commitment to the development of sound, fact-based legislation. The results of this effluent survey, which demonstrate the ongoing positive trends in discharge reductions, can be further enhanced by gathering similar data for other relevant contaminants. This could include analytical monitoring data on WFD Priority Substances and Priority Hazardous Substances and the typical effluent markers for the refining Industry that are mentioned in the E-PRTR Regulation and its associated guidelines.

CONCAWE intends to explore the possibilities for extending effluent data gathering activities in 2010 and beyond, in order to bring further factual data from our industry into the European water quality debate.