C2 4A Sodium Hypochlorite Solution - Disposal Options BAT Appraisal

November 29

2016

IQE Europe's non-technical summary & BAT options appraisal in relation to the disposal of waste sodium hypochlorite solution.

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Scope

An assessment of the available options for the disposal of waste sodium hypochlorite solution in order to determine if on-site discharge to foul sewer is a valid BPEO and satisfies BAT requirements.

Purpose

To provide a non-technical summary of IQE's proposed activity of discharge to foul sewer and evaluate the existing sodium hypochlorite disposal method in comparison to IQE's proposed disposal method for this material.

Non-technical Summary

IQE uses a wet abatement system to neutralise process gases prior to discharge to atmosphere which currently generates on average 25,000 litres of liquid waste per month.

The primary treatment chemicals used in the scrubbing process are sodium hypochlorite, sodium hydroxide and ortho-phosphoric acid which are mixed to form a bleach solution which strips the residual process exhaust of any remaining arsine or phosphine gas prior to discharge to atmosphere via the main site stack (Emission point A3).

Once the oxygen reduction potential in the solution has been depleted the hypochlorite solution is automatically transferred to 1000 litre ($1m^3$) intermediate bulk containers (IBC's) located in a bunded compound. These IBC's are collected every 21 - 28 days and transported via road to the disposal endpoint.

It is important to note that this is a dilute waste solution and is not the same strength as the concentrated raw materials.

It is known that this solution has a typical PH of 7.4 - 7.5 ± 0.8 and is disposed of at ambient temperature by means of discharge to receiving waters. IQE is seeking a permit variation to discharge this waste to foul sewer at source.

Under the Dangerous Substances Directive 2006 sodium hypochlorite is a list II substance of the biocide family and classified as a non- hazardous pollutant.

Samples of hypochlorite solution (appendix 1) have been provided by IQE for analysis by Dwr Cymru's Trade Effluent Team. As a result of this analysis IQE has obtained written authorisation from Dwr Cymru for the discharge to foul sewer of this waste stream (appendix 2).

H1 Assessment

The H1 modelling tool has been designed for the assessment of very high flow volumes (tens of thousands of litres per hour) and could not be used to assess the environmental impact of the low discharge volume proposed by IQE ($3m^{3/}$24 hours).

Following discussion with Mr. Toby Griffiths, Compliance Officer, Natural Resources Wales (NRW)) it was agreed that calculations based on the total volume discharged and the concentration of each compound would be deemed acceptable.

Hypochlorite Solution Analysis Results (Dwr Cymru)

Determinand name	Result	Unit
Chemical oxygen demand	1050	mg/l
Chemical oxygen demand	1240	mg/l
Suspended solids	329	mg/l
Phosphorus (as P)	3110	mg/l
Arsenic	0.0008	mg/l
Field pH	7.5	pH units

Discharge concentrations at IQE Europe of $1m^3$ (without dilution)

Determinand name	Result	Unit
Chemical oxygen demand	1050	mg/l
Chemical oxygen demand	1240	mg/l
Suspended solids	329	mg/l
Phosphorus (as P)	3110	mg/l
Arsenic	0.0008	mg/l
Field pH	7.5	pH units

Dilution could potentially reduce concentrations by 50% or greater prior to discharge to foul sewer at the IQE facility.

Approximate discharge concentrations of 3m^3 at 1/1 dilution

Determinand name	Result	Unit
Suspended solids	164.5	mg/l
Phosphorus (as P)	1555	mg/l
Arsenic	0.0004	mg/l
Field pH	7.5	pH units

Calculated discharge concentrations at sewage treatment works (without dilution at IQE or at the STW)

N.B. the following sewage treatment reduction factors (STRF) taken from guidance document H1 Annex D – Basic Surface water discharges.

Applied STRF's are as follows:

- Phosphorus – 0.80, i.e a 20% reduction in total phosphorus content
- Arsenic – 0.89, i.e a 11% reduction in total arsenic content

Determinand name	Result	Unit
Chemical oxygen demand	0*	mg/l
Phosphorus (as P)	2488	mg/l
Arsenic	0.00712	mg/l
Field pH	7	pH units

*Communication from NRW advised that the sewage treatment works would effectively neutralise COD and pH prior to discharge.

Further dilution and mixing would take place at the Cardiff Waste Water Treatment Works (WWTW). Dwr Cymru has provided the flow rate data shown below for the destination facility.

Dry Weather Flow	Full Flow
309,960m^3/day	523,584m^3/day
12,915m^3/hour	21,816m^3/day
215.25m^3/minute (3.58m$^{3\text{-}s}$)	363.6m^3/minute (6.06m$^{3\text{-}s}$)

Identified control options

Activity	Option 1 - (Base Case)	Option2
Disposal of Sodium Hypochlorite solution	Collection and removal from site; transfer to disposal endpoint for mixing and discharge to foul sewer.	On site discharge to foul sewer.

Option 1

A collection vehicle travels from Worcester to Cardiff (135Km) containing empty IBC's.

This vehicle is unloaded and reloaded with full IBC's and then returns to Worcester.

Upon arrival in Worcester the IBC contents are pumped into a road tanker, mixed with similar wastes and transported to a second facility (109 Km) for final disposal by means of mixing with acid wastes and subsequent discharge to foul sewer.

Tanker then returns empty to Worcester.

Total distance travelled by both vehicles 488km. 20 collections per annum, total travel distance is 9760Kms.

Total CO_2 produced by both vehicles per collection (assuming 1kg CO2/Km (DEFRA) is 0.488 tonnes. 20 collections per annum, Total off site CO^2 produced is 9.76 Tonnes.

Current disposal cost based on 2015 figures is £54K per annum excluding transport and administration charges. Total cost exceeds £60K. Following installation of 3 new G4 machines as part of the site upgrade it is expected that the discharges volumes will increase, and consequently total cost is likely to increase proportionally.

Option 2

The installation of a discharge point connected to foul sewer and associated monitoring and holding facilities.

The dilute solution will be further diluted 1:1 with freshwater makeup. The maximum discharge rate to foul sewer per 24 hour period would be $1.5m^3$ of Hypochlorite solution diluted at a ratio of 1:1 giving a maximum discharge volume in any 24 hour period of $3m^3$.

Estimated installation cost £35 -£40K - payback in 12 months with ongoing savings of >£50K per annum in subsequent years (excluding maintenance costs).

Monitoring Arrangements

Dwr-Cymru has not imposed any monitoring requirements in the authorisation reproduced in appendix two. However, IQE has noted that from the sample analysis report (appendix 1) that there are upper and lower pH limits of 11 & 6 respectively and therefore we propose to monitor the pH of the discharge solution to ensure that it remains within acceptable limits.

In addition to the above IQE proposes to monitor the flow rate of the effluent to ensure that the discharge is released at the lowest possible flow rate and does not exceed the 3000 litre discharge limit (including dilution) required in the Dwr-Cymru authorisation.

Non-routine Activities

Option two described above is the preferred method of disposal for normal process waste.

However, during planned preventative maintenance (PPM) activities such as the bi-annual deep clean and inspection of the scrubbing systems waste may be generated which contains higher levels of contaminants than those typically produced under normal process operating conditions.

IQE proposes to retain the existing transfer and storage system in addition to the proposed discharge system so that exceptional waste may be transferred to IBC and sent for appropriate treatment prior to disposal.

The existing disposal system will also be utilised at times when the proposed disposal infrastructure is taken out of service for planned preventative maintenance or inspection.

Identification of Risk – Option 1

Risk	Environmental Impact	Severity			Control Measure	Comment
		L	M	H		
Vehicle fire whilst empty	Release to air - short term impact		M		Collection vehicle carries fire fighting equipment.	Emission of dark smoke and harmful fumes.
	Release to air - Long term impact	L				Initial release diluted.
	Release to controlled waters short term impact		M			Fire water run off to surface waters - no chemicals released.
	Release to controlled waters long term impact	L				Initial release diluted.
On- site waste transfer - vehicle loading	Release to controlled waters - short term impact			H	Drain blocking mats and documented procedure. All collections supervised. Use of competent personnel for loading.	Dropped IBC leading to containment failure and release of 1000 litres to surface waters. Assumes no control measures in place.
	Release to controlled waters - long term impact	L				Initial release diluted. Estimated as short term recovery. Assumes no control measures in place
On Site Storage Fire in waste compound	Release to air		M			Emission of dark smoke and harmful fumes.
	Release to controlled waters			H	Individual 1000 litre containers and bunded storage	Total loss of all containment (HSE Research Report 564 - Fire performance of composite IBC's), 20,000 litre spillage and fire water run off.
Off site transport - vehicle fire whilst loaded	Release to air - short term impact		M		Collection vehicle carries fire fighting equipment.	Emission of dark smoke and harmful fumes.
	Release to air - Long term impact	L				Initial release diluted.
	Release to controlled waters - short term impact			H	Collection vehicle carries fire fighting equipment.	Fire water run off contaminated with up to 18,000 litres of sodium hypochlorite solution released to surface waters.
	Release to controlled waters - long term impact		M			Unknown recovery time following total loss of vehicle load
Transport movements - production of CO^2	Release to air - short term impact	L				No immediate effect.
	Release to air - Long term impact		M			May contribute to global warming.

Identification of risk -Option 2

Risk	Environmental Impact	Severity			Proposed Control Measure	Comment
		L	M	H		
PH deviation from accepted norms.	Release to foul sewer	L			Continuous PH monitoring and audible alarm should deviation occur.	PH could be adjusted by addition of neutralising agents (phosphoric acid or sodium hydroxide) prior to discharge or alternatively the waste would be diverted to an IBC for disposal via option 1.
PH probe failure - deviation from accepted norm.	Release to foul sewer	L			Daily checks and weekly calibration of PH probe. Spares held on site to effect immediate repair.	
Discharge pump failure	None	L			Pump serviced annually. Spare pump held on site as a stock item.	Aqueous waste would be diverted to an IBC for disposal via option 1 until repair is made or retained within the dilution tank.
Storage tank overflow	None – contained	L			Level sensor fitted to dilution tank and secondary containment will be provided.	
Storage tank failure	None - contained		M		Secondary containment will be provided	Aqueous waste would be diverted to an IBC for disposal via option 1 until repair is made.
Excessive discharge rate	Release to foul sewer	L			Flow controller.	Aqueous waste would be diverted to an IBC for disposal via option 1 until system repaired or retained within the dilution tank.
Transport movements - production of CO^2	Release to air - short term impact	L				Reduced frequency for collection of other waster streams by smaller vehicle.
Transport movements - production of CO^2	Release to air - Long term impact		M			May contribute to global warming.

Selection of preferred option

It is evident from the risk analysis that option 2 (onsite discharge to foul sewer) would be the BPEO for disposal of this waste stream.

Offsite environmental benefits

- Eliminates the risk of accidental release to surface waters during transportation.
- Reduction in offsite CO_2 emissions by using less vehicle movements for remaining waste streams.

Onsite environmental benefits

- Eliminates the risk of accidental release to surface waters during waste transfer operations (2013- 300 individual full IBC movements - potentially 300 opportunities for an uncontrolled release to surface waters, due to site upgrades the number of opportunities is likely to increase from 2016 onward).
- Eliminates storage of large quantities of waste awaiting collection.
- Reduction in size of fire / spillage hazard.
- Reduction of on site CO2 emissions from collection vehicle and fork lift truck.
- Reduction in traffic movement in local environment by reducing frequency of residual waste collections.
- Reduction in noise pollution from delivery vehicle.
- Eliminates one of IQE's identified major accident hazards under the COMAH regime.

Offsite socio-economic impact

IQE's current waste disposal contractor is part of a large national service provider. It is estimated that the partial removal of this waste stream would not have a significant detrimental effect on the business operation.

Cost Benefit to IQE

As previously discussed the cost of disposal via option one during 2015 was £54K. This is likely to increase due to the increased manufacturing capacity, and therefore disposal volume provided following refurbishment of FAB1.

The estimated cost for the installation of necessary plant and equipment for option 2 is approximately £40K. Payback period would be within 12 months of installation with continued savings thereafter. Ongoing preventative maintenance for the life of the system will be initially budgeted at £500 / month (£6K per annum) and reviewed after 12 months.

Comparison over a five year period

Option 1 - Assuming that production output continues at the same level for the next five years using today's disposal price it would cost IQE somewhere in the region of £300K to dispose of this waste. This is a conservative estimate and does not make allowance for the increased capacity resulting from the refurbishment of FAB1.

Option 2 - Installation and ongoing maintenance costs for the next five years projected as £70K spend. Total cost saving over option 1 - £230K.

Conclusions

IQE believes that the proposed volume-limited discharge of sodium hypochlorite waste to foul sewer in line with the authorisation granted by Dwr Cymru would be the BPEO and is in line with current BAT for the management of this type of aqueous waste as evidenced above.

It is hoped that given the massive dilution factors at the WWTW and the low discharge rate of $3m^3$ in line with the Dwr Cymru permission that Natural Resources Wales will be agreeable to IQE monitoring the flow and pH of the proposed discharge without imposing additional monitoring requirements.

Appendix 1. Hypochlorite Information

DŴR CYMRU
WELSH WATER

Sample Analysis Report

FAO STEVE MORGAN
IQE EUROPE LIMITED
PASCAL CLOSE
ST MELLONS
CARDIFF
CF3 0EG

Sampling Point No -	302070	**Location -**	EPITAXIAL PRODUCTS LTD
Date Sampled -	28-Oct-10	**Time Taken -**	11:20
Originator -	TREATMENT	**Purpose -**	SPECIAL INVESTIGATION
Laboratory -	BRIDGEND	**Lab Ref No -**	T 3302006
Sampler -	ESA8	**No Results -**	8
Type -	COMMERCIALLY		

Sample Results

Code	Determinand Name	Units		Result	Limit	
91	CHEMICAL OXYGEN DEMA	MG/L		1050		
92	CHEMICAL OXYGEN DEMA	MG/L		1240		
135	SUSPENDED SOLIDS 105	MG/L		329	400	
192	PHOSPHORUS AS P	MG/L		3110		
356	ARSENIC	MG/L	LT	0.0008		
407	FREE CHLORINE (OSM)	MG/L	N			
9406	FIELD PH	PH UNITS		7.5	11	
9406	FIELD PH	PH UNITS		7.5	6	GT

Appendix 2. Dwr Cymru Authorisation

Dŵr Cymru
Welsh Water

Pentwyn Road
Nelson
Treharris
Mid Glamorgan
CF46 6LY

Tel: +44 (0)1443 452 300
Fax: +44 (0)1443 452 323
Web site: www.dwrcymru.com

Heol Pentwyn
Nelson
Treharris
Morgannwg Ganol
CF46 6LY

Ffôn: +44 (0)1443 452 300
Ffacs: +44 (0)1443 452 323
Safle gwe: www.dwrcymru.com

Mr Shane Alder
HSE Manager
IQE Europe Limited
Pascal Close
St Mellons
CARDIFF
CF3 0LW

Date 26th February 2016

Dear Mr Alder,

Ref:-Disposal of Sodium Hypochlorite Waste Stream to the Public Foul Sewer

Further to your request for an authorisation to dispose of the above wastewater to the public foul sewer.

Based on the information provided, I can confirm that authorisation is given to discharge this wastewater to the public foul sewer, subject to the following conditions and not otherwise:

1. The premises from which the trade effluent may be discharged is: IQE Europe Limited, Pascal Close, St Mellons, Cardiff CF3 0LW.

2. The maximum volume of trade effluent that may be discharged shall not exceed 1500 litres per day.

3. The trade effluent to be discharged is derived from wastewater containing sodium hypochlorite (10%). Please ensure that the waste is diluted 1:1 with clean water (preferably recycled roof water, if not available mains water) prior to disposal to the foul drain.

4. Please ensure that the diluted waste is discharged to the foul drain at the lowest possible flow rate. Flows must be introduced into the public sewer in such a way that will not affect the free flow of its contents, for example, settlement of suspended solids or surcharging upstream.

5. Please ensure that the wastewater is discharged to the foul sewer only and there is no risk of the contamination of any surface water drainage.

6. There will be no attempt to identify the volumes of domestic sewage and this trade effluent for charging purposes. Both volumes will be discharged at the current domestic rate with no minimum charge for trade effluent.

7. This permission is given on the understanding that:
   a) it may be reviewed from time to time in accordance with the frequency applying in respect of a trade effluent consent issued under the Water Industry Act 1991, section 124.
   b) Dwr Cymru-Welsh Water may review its Trade Effluent Policy and require a review of this permission subject to the restrictions in a) above.
   c) If the nature of the discharge is changed then Dwr Cymru-Welsh Water must be informed of this and shall be entitled to review the permission.

8. The trade effluent consent application fee has already been paid in respect of this authorisation.

In the meantime, if you have any queries or should the operation change in any way so as to affect the nature and volume of wastewater for disposal, please contact Heather Pepper, Trade Effluent Officer on (02920) 478822 or at heather.pepper@dwrcymru.com.

Yours sincerely

Richard M Ingles
Process Scientist