Building 18, Tremorfa
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Tel: 029 2035 1800

9th January 2015

Dr Gareth Richards
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Our Ref: W:\Environmental\IPPC\Permit TP3639BH\Polymer Injection\TP3639BH_Polymer Injection Notification Letter 07012015.doc

Dear Gareth,

RE: Tremorfa Melt Shop Environmental Permit TP3639BH Formal Notification of Proposed Changes

In accordance with CELSA Manufacturing (UK) Ltd. Tremorfa Melt Shop Environmental Permit (EPR) TP3639BH, please find below our formal notification of the proposed process changes for the injection of a polymer blend to use as a slag foaming agent during the EAF process at the Tremorfa site.

1.0 Introduction

CELSA Manufacturing (UK) Ltd is regulated under section 12 of the Environmental Permitting Regulations 20010 (as amended) to operate an installation which carries out activities as defined within section 2.1 A(1)(b) *'Producing, melting or refining iron or steel or any ferrous alloy, including continuous casting'*. As such the company is permitted in accordance to the terms and conditions of EPR Permit TP3639BH.

Section 4.3.5 of EPR TP3639BH states:

'Where the operator proposes to make a change in the nature or functioning, or an extension to the activities, which may have consequences for the environment and the change is not otherwise the subject of an application for approval under the Regulations or this permit:

a) *The Environment Agency shall be notified at least 14 days before making the change; and*
b) *The notification shall contain a description of the proposed change in operation.'*

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2.0 Proposed Changes

2.1 Polymer Injection

2.1.1 General

Polymer Injection Technology is an environmentally sustainable method of using recycled polymers in the EAF steelmaking process. Polymer material will be used as a carbon injectant to promote slag foaming within the furnace. The four phases of the polymer injection implementation have been completed, including two trials in July and October 2014. Following analysis of the trial results, a reduction in electricity consumption, reduced raw material usage and decreased dioxin emissions have been observed.

CELSA intend to permanently implement Polymer Injection Technology in collaboration with OneSteel, the premier manufacturer of steel long products in Australia and New Zealand who have successfully implemented this technology at Laverton Steel Mill and Sydney Steel Mill. During carbon injection in the EAF process, coke will be substituted with 40% rubber crumb to create a coke/rubber blend. The rubber crumb will be purchased as a product with a quantity of 250kg injected per heat. During the trials, the polymer increased the slag foaming index by 9.35%.

Following the numerous benefits observed during the two trials, CELSA wish to permanently implement Polymer Injection Technology. In doing so, CELSA UK will be the first in the CELSA Group and also the first steel manufacturer in Europe to implement Polymer Injection Technology. As this is a new and innovative application of the polymer material, the end use is not contained within the Quality Protocol. However, as stated in PAS 107-2012-88:
"In order to facilitate the growth of, and to strengthen the end markets for sustainable recovery options for used tyres, WRAP and industry introduced a range of initiatives to encourage expansion of existing processes and investment in new applications." CELSA is committed to implementing innovative techniques, such as Polymer Injection Technology, in order to continually improve our environmental performance.

The main benefits observed during the trials were as follows:

- Electrical consumption reduction of 1.65% (exceeded the target of 1.5%)
- Carbon injectant consumption reduction of 8.4%
- Oxygen consumption reduction of 5.5%
- Yield improvement (0.15%) and improvements in slag FeO (1.5%)
- Improved productivity through reduced power on time of 45.6 seconds per heat
- Reduced dioxin levels (0.0015 ng/m^3 and 0.11 ng/m^3)

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2.1.2 *Polymer Injection Process Description*

Oxygen and carbon are injected into the slag layer once it has formed to induce foaming of the slag. Injection is facilitated via a lance that enters the furnace via the slag door. A number of different carbon sources can be utilised for this process, such as coke (anthracite) and natural and synthetic graphite.

The injection of oxygen and carbon results in an oxidation reaction that forms bubbles of carbon monoxide. These bubbles become entrained in the slag layer that forms on the surface of the molten metal, forming a foaming slag. The goal is to increase foaming slag volume to reduce the electrical energy required per heat of steel as the heat loss to the furnace walls and roof is minimised. This has been demonstrated during both trials undertaken at CELSA in July and October. It has also been proven by research trials at the University of New South Wales and full scale trials at Sydney Steel Mill. Alternate carbon injectants, such as rubber crumb, have been found to produce a more effective foaming slag, increasing the slag bed depth on the surface of the molten metal.

<u>Summary of implementation process which has been completed</u>:

1. Review steelmaking KPI's
2. Perform volume and chemical analysis of coke and rubber options
3. Rubber sourcing and accreditation
4. Gain regulatory approval
5. Implement Material Handling System (MHS)
6. Training and development of employees
7. Management of controlled trial
8. Co-ordination of environmental testing through specialised consultants.

<u>Trial implementation occurred in four phases</u>:

Phase 1: Training in Polymer Injection Technology of CELSA staff and cold commissioning.

Phase 2: Cold commissioning of the polymer material handling system.

Phase 3: Hot commissioning and stack emissions testing will be undertaken.

Phase 4: Implementation of the polymer injectant and assessing key process variables.

3.0 Environmental Impact

CELSA has assessed the environmental impacts in accordance with the requirements of EP TP3639BH, and these are listed below.

3.1 Raw Materials

CELSA wish to use polymer as an alternative carbon furnace injectant. This will involve substituting coke used in the carbon injection with 40% polymer, reducing CELSA's use of fossil fuels. The polymer will be purchased as a product from World Rubber, a tyre recycling company based in Northampton. The product is 4mm Styrene butadiene rubber (SBR) crumb and has a defined technical specification which has been agreed by CELSA, OneSteel and World Rubber. This satisfies the specification outlined in the WRAP Quality Protocol 'Tyre derived rubber material' in Table 2 of 2.4.3.

The carbon content of the rubber crumb shall exceed 75% by weight and the sulphur content will not exceed 2.5% by weight. There will be no radioactive contamination of the rubber crumb. Additionally, density and sizing criteria must be met. The rubber shall be free of metallic and nylon/textile contamination. Where possible the crumb shall be manufactured from radial truck tyres.

The maximum chemical composition, density and sizing of the rubber crumb is provided in Appendix 1. Appendix 2 contains the analysis report of heavy metals and fluoride results for the rubber crumb which is to be used. All results are below the set limits.

3.2 Water Use

There are no anticipated changes to water use.

3.3 Emissions to Water

There are no anticipated changes to emissions to water.

There are no anticipated fugitive emissions to surface water, sewer or groundwater.

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3.4 Emissions to Air

Periodic monitoring results for implementation trials were as follows:

Substance Monitored	Current Limit (& IED)	Periodic Monitoring Results (coke only)			Periodic Monitoring Results (coke and rubber blend)	
		2013	Trial 1 (2014)	Trial 2 (2014)	Trial 1 (2014)	Trial 2 (2014)
Dioxins (ng/m^3)	0.5 (0.1)	0.17	1.04	0.038	0.0016	0.11
CO (mg/m^3)	100	15	68.37	78.09	82.77	95.92
VOCs (mg/m^3)	20	1.9	3.55	4.3	6.56	12.55
SOx (mg/m^3)	25	18	6.61	2.23	12.36	8.54
NOx (mg/m^3)	25	2.4	18.7	21.95	15.98	22.09
Particulates (mg/m^3)	10 (5)	1	5.5	2.1	4.52	1.1

Table 1: Comparison of periodic monitoring results using coke only and coke and rubber blend during the trials.

It can be observed from the periodic monitoring results that all emission limits were met during both trials using the coke and rubber blend. Furthermore, a significant reduction in dioxin emissions was observed using the Polymer Injection Technology in July. Using the result of 0.0016 ng/m^3, CELSA also meet the revised requirements of BAT under the Industrial Emissions Directive (IED) achieving the lower dioxin emission limit of 0.1 ng/m^3.

Rubber, unlike coke, lacks the required carbon morphology for dioxin formation, with the molecular structure mainly being vulcanised long hydrocarbon chains. Additionally, the reduction in the weight of coke injection has led to the reduction in the supply of chlorines due to the signficantly lower level of chlorines trapped in rubber. These combined effects result in the reduction of dioxin formation.

Slight increases in other emission parameters have been observed. However, all results were within our permit limits. These increases were as a result of issues within the dedusting plant. Filter sleeves coming adrift may have resulted in higher emissions during the trials. Significant investment in dedusting maintenance and improvement is planned for 2015.

CELSA has evaluated the changes to emissions to air following the trial implementation of the polymer injectant. It has been concluded that the numerous benefits, such as the reduction in energy consumption, reduced raw material usage and the decreased emissions of dioxins far outweigh the slight negative environmental impact of a small increase in other emission parameters. CELSA is confident that the implementation of the Polymer Injection Technology will not cause a permit exceedance.

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3.5 Odour

The polymer injection trials are not deemed odorous.

3.6 Waste

No additional waste will be produced as all materials will be consumed within the process.

3.7 Energy

The principal driver behind the implementation of Polymer Injection Technology is the reduction in energy consumption. An electrical energy reduction of 5.9 kWh per billet tonne was observed. This is a reduction of 1.64%, exceeding the 1.5% target.

The formula used to calculate the electrical reduction is presented below:

Difference in total EAF MWh/Billet tonnes x 1000.

Electrical consumption will be significantly reduced as improved slag foaming will result in superior insulation of molten bath, improved shrouding of the electrodes and a longer arc. Subsequently, reduced power on time of 1.84% and improved active power were observed.

As a secondary consequence to a decrease in electrical consumption, CELSA's carbon footprint will be reduced. This is due to a reduced need for the generation of electricity in powerstations and therefore, indirect CO_2 emissions will be reduced.

3.8 Noise and Vibration

CELSA do not anticipate that the polymer injection trials will give rise to any additional noise or vibration sources.

4.0 Timescales

CELSA hope to permanently implement the Polymer Injection Technology, in collaboration with OneSteel, following approval from Natural Resources Wales.

5.0 Conclusions

The proposal to implement Polymer Injection Technology at CELSA is part of the company wide initiative to operate in a sustainable manner in order to abide by legislation compliance and achieve continual improvement, thus minimising the environmental impact and increasing resource efficiency. CELSA UK would be the first in the CELSA Group to implement Polymer

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Injection Technology. As this is a new application of rubber crumb which is not widely used, it is not contained within the Quality Protocol. However, the 4mm SBR crumb which will be used at CELSA meets the specification outlined in 2.4.3. of the WRAP Quality Protocol 'Tyre derived rubber material'. Moreover, this technology displaces fossil fuel and significantly reduces energy consumption during the EAF process.

As part of CELSA's formal response to notice issued under regulation 60(1) of the Environmental Permitting (England and Wales) Regulation 2010 (EPR) to demonstrate how CELSA aim to meet all revised BAT standards, the proposed use of Polymer Injection Technology at CELSA was outlined within Chapter 1.7 – 'BAT conclusions for electric arc furnace steelmaking'. Therefore, this notification supports the planned strategy to reduce dioxin levels in order to meet the revised requirements of BAT.

In summary, introducing the use of polymer as a carbon injectant within the EAF process will result in a number of environmental improvements, such as reducing energy consumption, reduced raw materials usage and lower dioxin emissions to air. This is supported by the results observed during the two trials undertaken in July and October at CELSA, as well as research studies undertaken at Laverton Steel Mill. CELSA do not anticipate any significant adverse environmental impacts from the implementation of this technology.

We hope that the above text provides enough information for your needs. As detailed above, due to the fact that the environmental impact is minimal we believe that this process change is small enough to warrant a formal notification rather than a 'variation' to our process as essentially all of the process operations and authorised release points will remain unchanged.

Should you require any further information regarding these works, please do not hesitate to contact me.

Yours sincerely

Richard Lewis
Environment Manager

APPENDIX 1: POLYMER SPECIFICATION

OneSteel has developed a specification for suitable rubber crumb which will be used as an alternate carbon injectant at CELSA. The chemical composition specification of the polymer is provided in Table 2.

Element	Maximum Concentration (mg/kg)
Cd	10
Cl	1000
Cr	200
F	1000
Pb	400
Hg	1
Ni	30
Zn	20000

Table 2: Chemical composition of alternate carbon injectant

Density

Minimum density of 500kg/m^3

Sizing

Normal size of the rubber crumb particles shall be 1-4 mm with no particles exceeding 5mm in any one dimension. Less than 5% of the crumb particles to be less than 0.5 mm in all dimensions.

APPENDIX 2: HEAVY METALS AND FLUORIDE ANALYSIS RESULTS FOR RUBBER CRUMB