Technical note:
Review of Hydrogen Chloride emissions from Knauf Insulation, Queensferry

1. Purpose

This technical note summaries the progress that Knauf Insulation Queensferry (Knauf) have made towards addressing the improvement condition IC39 in the Environmental Permit (BR9383ID). The permit has a number of emission limit values for stack A, cupola stack after the thermal oxidiser. One of these is a 10 mg/Nm^3 limit for hydrogen chloride (HCl). Since 2014, the routine emission tests have shown that emissions of HCl have exceeded the emission limit value, thus resulting in the improvement condition requested by Natural Resources Wales (NRW) within the permit.

The improvement condition states:

Reference	Requirement	Date
IC39	The operator shall take measures to reduce HCl emissions by either the selection of raw materials with lower chlorine content or to introduce improved abatement. A report shall be sent to NRW for approval	3 months of variation issue.

2. Background

Knauf Insulation Queensferry produces high density mineral (rock) insulation slabs for use as thermal insulation material in the building industry. The process produces mineral wool (stone wool) product in a multi-stage process. The first stage involves melting raw materials, coke, basalt, dolomite, anorthosite in a cupola furnace and then processing the molten mineral into fibres. A binder is applied to the fibres prior to a forming process which gives a stone mineral wool mat of the appropriate thickness. The fibres are collected on a moving grate under suction to allow a thin fibre blanket to be formed. This thin blanket is then folded back on itself multiple times to achieve the required weight, density and thickness for the final product specification. The blanket it is heated in a curing oven which sets the binder and fibre mat to the required thickness and density. After curing, the product is cooled and then trimmed to the final dimensions. Various facings can be applied as required and the products are then packed ready for dispatch. Scrap material is recycled back into the process.

Emissions to atmosphere may arise during each stage of the process. Emissions from the melting stage result from combustion products and particulates generated in the furnace. Waste gas flows from the furnace are passed through a bag house filter system and a thermal oxidiser prior to being emitted to atmosphere via a 41 m stack (release point A) along with the downstream forming emissions.

Emissions from the downstream, curing and cooling stages consist of particulates and volatile organic materials used in the binder. These gas streams are passed through appropriate multi stage abatement systems before being emitted to atmosphere. These are discharged to atmosphere via separate downstream stacks (13 m and 29 m respectively).

3. Raw Materials

The stone, slag and coke are the critical raw materials for producing the type of fibre required to manufacture the mineral wool slabs. Knauf have a specification for these raw materials that is required from the suppliers, which included the composition that can result in emissions to air, e.g. sulphur. Knauf undertake routine testing to ensure compliance with the specification.

The proportions of stone, slag and coke are blended to correct specification for the final product and fed into the cupola via overhead conveyors.

The HCl emission is a direct function of the chlorine content of the raw materials. Knauf's mineralogist has reviewed the specification of the various stone, slag and coke that are used in the product runs and has adjusted the batch formulations to reduce the HCl content in the exhaust. However, there has been no repeatable reduction in the emission of HCl from these changes.

Knauf have concluded that changes to the raw materials and batch formulations will not achieve the reduction in HCl emissions to ensure compliance with the emission limit values within the permit.

4. Secondary Abatement Options

Knauf reviewed various secondary abatement options for the reduction of acid gases, based on the Technical Guidance Note A3[1] and the Best Available Techniques Reference Document[2]. The appropriate secondary abatement techniques are dry or semi dry scrubbing combined with a filtration system. The exhaust from the cupola has a fabric filter system installed presently, therefore, the injection of dry lime powder was considered to be the appropriate abatement option for this installation.

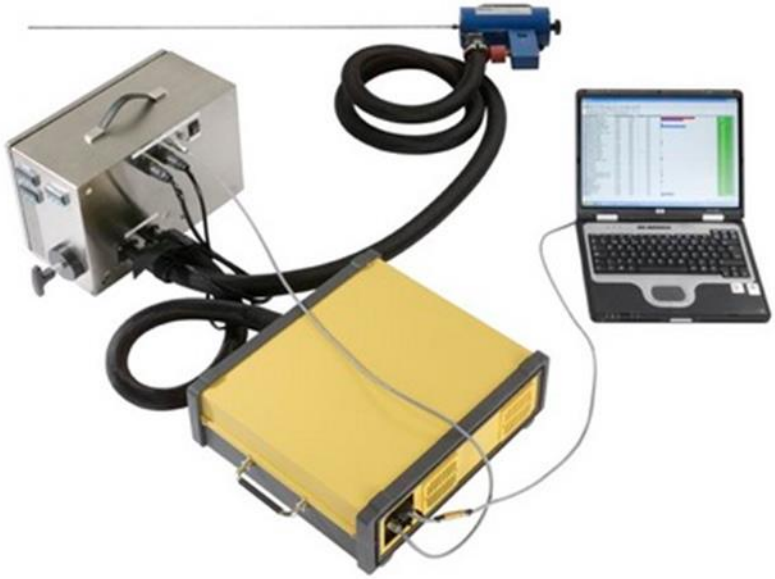
Knauf arranged an initial trail of the lime injection system from Lhoist UK Ltd. This injection rig injected hydrated lime into the duct work between the Enetex W10 preheater outlet and bag filter. A one tonne big bag of hydrated lime was fitted to the injection rig to allow the injection rate of 20 kg/hour for the test periods. The injection rig is shown in Figure 4.1 below. The emissions of HCl were continuously monitored by Northumbrian Water Group Scientific Services (NWGSS), an MCERT accredited test team, using a Fourier Transform Infrared (FTIR) system a Gasmet – DX4000. The FTIR system is shown in Figure 4.2.

An initial preliminary trial was carried out between 4th and 5th July 2017, to see if the lime injection would have any effect on the emission of HCl. The short trial test showed a reduction of HCl emissions of 66% for the batch formulation at that time, however, this also caused additional blinding of the filter bags due to the injected lime.

[1] Her Majesty's Inspectorate of Pollution, Pollution abatement technology for particulate and trace gas removal, Technical Guidance Note A3, April 1994
[2] JRC Reference Report, BAT Reference Document for the Manufacturer of Glass, 2013

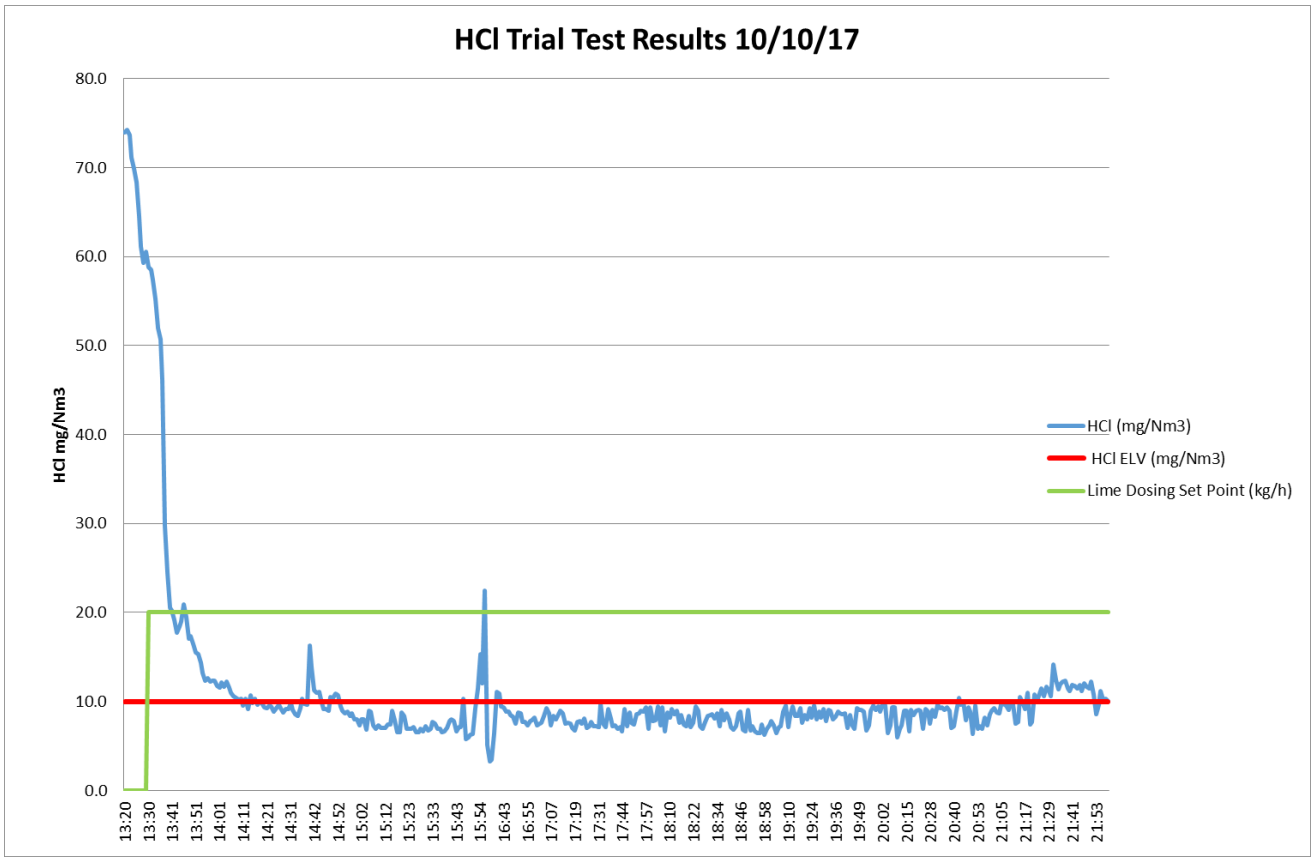
Figure 4.1 Lime Injection Rig

Figure 4.2 FTIR system



The second trial was undertaken on 10th October and used the same lime injection rig and test team as the previous trial. The trial period was 9 hours with an injection rate of 20 kg/h, resulting in a total lime use of 180 kg. The results from the FTIR are shown in Figure 4.3 below.

Figure 4.3 Initial Trial Test results waiting final validation – 10th October 2017



This shows the significant reduction in HCl emissions when lime was injected. There was a 2mbar increase in the differential pressure through the filter bags reflecting the coating of lime on the bags. Therefore, further consideration of the injection rate of lime to achieve the emission limit value and the impact on bag life is required.

Based on this injection rate of lime, the site would use approximately 160 tonnes of lime per annum and produce a similar increase in waste from the bag filter plant for disposal.

5. Conclusions

The injection of lime at 20 kg/h on the outlet of the W10 preheater achieved a substantial reduction in HCl emissions concentration to below 10 mg/Nm^3 as an average during the injection period. To develop a permanent solution Knauf insulation will review and optimise the dosing rate of lime and this test has been arranged for the end of quarter 4 2017. Concurrently, a review of the existing bag filters will be undertaken with the bag suppliers to identify if different bags or an increased filter area can maintain the filtration efficiency while controlling the differential pressure within the optimal operational range. The results of the additional investigations will be reported to NRW in January 2018.

While the additional investigations are proceeding, capital approval will be sort from Knauf management for the progression of detailed design of a permanent solution using lime injection, with procurement and construction taking place during the second half of 2018 and early 2019. The final commissioning date will be subject to the detailed design and the supplier's programme. Prior to commissioning of the lime injection, a permit variation will be submitted to NRW for approval.

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