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Information on Emissions from the Secondary Aluminium and Manganese Industries

Katja Kraus, Chair of the Task Force on Heavy Metals

Introduction

The Chair of the Task Force on Heavy Metals was asked to provide information on two sectors under discussion to be included in a revised heavy metals protocol.

This paper discusses the secondary aluminium production and manganese industry sectors. The secondary aluminium industry appraisal was first proposed to be included in a draft background report by the German Institute DFIU, Karlsruhe in 2005. The manganese industry assessment was proposed by Norway in June 2007.

A) Secondary Aluminium Industry

Secondary aluminium is produced from secondary raw materials reclaimed from production processes, swarfs and scrap. The aluminium (Al) produced is of the same quality as primary metal. The production and refining of secondary aluminium is much less energy demanding, i.e. it consumes about 5% of the energy needed to produce the primary metal. In several countries, secondary aluminium production already exceeds that for primary. For example, in Germany, in 2008, 57% of all aluminium produced originates from secondary sources. In 2007, within the EU-27, 3.1 Mio tonnes have been produced as primary and 5.1 Mio tonnes as secondary aluminium. It is noteworthy that 5.1 Mio tonnes represents about one third of worldwide secondary aluminium production.

Typical sources of aluminium scrap are process waste, used beverage cans, foils, extrusions, commercial scrap, turnings and old rolled or cast metal. In addition, aluminium is also recovered from skimmings or dross and salt slag. Various contaminants may be present and this is taken into account in the choice of pre-treatment and/or in furnace design. Contaminated scraps sometimes need to be de-coated or de-oiled prior to melting in order to improve melting rate (and thermal efficiency) and to reduce the potential for emissions.

Secondary raw material may be contaminated with a variety of other materials such as oils, acids and organic matter which could be washed into drainage systems. Secondary raw materials that contain components of high environmental concern, e.g. lead and cadmium, are treated with the most effective measures that are technically available according to the draft BREF document from 2009. In this regard, attention is drawn to the fact that volatile metals are often present and these can be emitted from the pot room and the cast house locations.

The type and quality of scrap have a major influence on the significance of the emissions. It is assumed that mainly colour pigments and stabilisers on coatings contribute to emissions of heavy metals (i.e. lead, cadmium and organic tin compounds)[1i]. Other factors which can influence these emissions are type of furnace and process steps, the dust levels achieved, and especially process parameters like waste gas temperature and raw gas contamination. When comparing data the effect of different measuring locations has to be taken into account.

Most installations use high efficiency fabric filters, although some use ceramic filters[2], to remove dust. In general, emissions of dust range between 0.6 and 10 mg/Nm^3 (with a 95 percentile below 5mg/Nm^3) of which 0.01 to 10 % can be metals. This dust corresponds to an emission factor of 0.03 kg/t of product.

A German research project (not yet officially published) measured emissions of metals. It searched in official declarations of producers in different sectors of the non-ferrous metals industry to generate

1 Personal information: Rainer Remus, IPPC Bureau Seville, author of the BREF on Non-Ferrous Metals Industry
[2] Ceramic filters are still emerging and maybe not applicable in every case yet due to incompatible raw gas properties

new emission factors for reporting purposes.
Using the current emission factor of 2g Pb/t Al produced in our reporting system, the secondary aluminium industry contributes 1.4% to the entire German air lead emissions inventory. For cadmium, the contribution is 0.2% and for mercury 0.04%. The newly-generated emission factor for lead, not yet used for official calculations, is much smaller at 8.3 mg Pb/t Al, which corresponds to a value well below 1%. A different picture could arise for cadmium, but here verification is still necessary.

There exist 16 smelters for secondary aluminium in Germany. Very few up-to-date results from direct measurements of Cd and cadmium compounds are available. An emission factor for elemental Cd at 36 mg/t Al (one installation) and for cadmium compounds at 2.5 mg/t Al (from two smelters) is stated. Not enough information is available on scrap used or other influencing factors. Therefore it can't be generalised and seen as representative for all smelters. If this factor is used in a worst case scenario, and most installations of the same type of smelter and scrap and with comparable operating conditions emitted corresponding amounts of Cd, the total amounts of cadmium would be about 30 kg/year and exceed 1 % of the national air emissions of Cd (2.7 tonnes per year).

In the Netherlands, the total capacity for the year 2010 is about 200,000 t secondary aluminium. All installations apply dust filters. For estimates, an emission factor for lead of 0.04 g/t Al was used. With an yearly emission of 45 tonnes of lead (worst case estimate), the contribution from the secondary aluminium industry is estimated to be 0.02%, or less.
The total emission of cadmium is calculated based on an emission factor of 0.005 g/ t Al. It is estimated at 1 kg/year. With yearly national emissions of 1 tonne cadmium this represents 0.1%.

These figures will be influenced by different trends in the future. The absolute production of secondary aluminium will rise because of increased recycling in this sector. Depending on the development of metal emissions from other sectors, the share in per cent contribution from the aluminium industry could rise even if the total amount of metal emissions declines, e.g. due to less emissions from products due to removal of HM. Another influencing trend is the reduction in the use of heavy metals as stabilisers, i.e. voluntary agreement of European PVC producers to substitute Pb in stabilisers from 2015.

All installations of the secondary aluminium industry within the EU are legally covered by permits. Generally, the following are identified as key environmental issues for secondary aluminium: dust, NOx, SO_2, VOCs, fumes, HF PCDD/Fs, chlorine and HCl, as well as residues, such as filter dust and salt slag. Generally, it seems not to be very common to measure emissions of individual metals. Of particular greater concern within this industry sector are emissions of dioxins. Nevertheless emissions of heavy metals should be observed and measured.

Conclusion

Installations of the secondary aluminium industry emit heavy metals. All installations considered were equipped with filters. Based on very limited data, the emissions of lead and cadmium in the considered cases are low. The relative contributions to the overall national emissions for these heavy metals are below 1 %. Using a worst case scenario for cadmium, the 1 % figure would only be slightly exceeded in Germany.

B) Manganese Industry

Manganese is produced from ore. Dependent on the provenience of the ore, the emissions of mercury can vary widely.
In 2002, mercury releases to air, soil and water from Norwegian sources totalled about 1,100 kg. The most important sources of mercury releases in Norway are land-based manufacturing industries including secondary steel production, road traffic and waste incineration plants. More than 80 per cent of mercury releases are to air.

Two Norwegian smelters for manganese changed their source of the ore. The emissions of mercury would have increased from 10 to 600 - 1000 kg/year if they continued to use the same process using the new source of ore. That would have almost doubled the national emissions to air. Under the permit as applied to both smelters, Hg emissions of 36 kg/a and 15 kg/a were allowed respectively.

To fulfil legal requirements, it was decided to install gas cleaning equipment. The cleaning process comprised different steps; i.e. wet scrubbing (for dust and PAH removal), wet electrostatic precipitation (for dust removal) and special mercury absorption.

As a direct result, the dust concentration after cleaning was below 1 mg/Nm^3 and the removal efficiency for mercury up to 99%.

Data on manganese (Mn) production were presented by Tor Faerden, Norwegian Pollution Control Authority (SFT) at the Vienna meeting of the TF HM in June 2007. Data documentation Manganese Industry:
http://www.unece.org/env/lrtap/TaskForce/tfhm/fourth%20meetingdocs/AddInfofromNorwayonHgreductionmeasuresWien.ppt

Conclusion

Installations of the Manganese industry can emit considerable amounts of mercury if the process is not adapted to the possible amount of metal emitted. Without a change in processing to control Hg emissions, the national emission in Norway would have increased considerably, i.e. they would have approximately doubled.

References

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[2] Minutes from IPPC BREF Notes – Aluminium Expert Group Meeting – Brussels, 1998

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[4] Greenmelt: an Environmentally Sound Remelting Concept, Laheye, R.; Burggraaf, D. 19989

[5] Electromagnetic Pumping Improves the Efficiency of Melting Aluminium, ETSU, McLellan, 1998

[6] Bereitstellung einer qualitätsgesicherten Datengrundlage für die Emissionsberichterstattung zur Umsetzung von Internationalen Luftreinhalte- und Klimaschutzvereinbarungen für ausgewählte Industriebranchen , Teilvorhaben vorläufiger Bericht Juli 2010, Umweltbundesamt, not yet published.

[7] VDI 2286 Aluminium Part 1 and 2, 2008

[8] Leitfaden zur Anwendung umweltverträglicher Stoffe, Teil 5, 5.3 Funktion: Pigmente und Stabilisatoren, 2003

[9] Norway's Action Plan for Reducing Mercury Releases,
http://www.klif.no/arbeidsomr/kjemikalier/kvikksolv/mercury_actionplan.pdf

Annex

The following figures are taken from the draft BREF document for the non-ferrous metals industry.

Rotary furnace melting (abated) (see page 382):

Dust emission factor: 20 g/t Al
Pb, Zn, Cr, Cu, Mn, V, Sn emission factor: 0.6 g/t Al (range 0.045 – 0.0047 mg/ Nm^3)

Tilting rotary furnace (abated) (see page 382):

Hg emisison factor: 0.01 g/t Al (0.0005 mg/ Nm^3)
Pb, Co, Ni, Se, Te emission factor: 0.07 g/t Al (range 0.003 – 0.005 mg/ Nm^3)

Plant visit report AMAG Austria, 2007 (see page 383):

Pb, Zn, Cr, Cu, Mn, V, Sn
Maximum value 0.047 mg/Nm^3
Minimum value 0.045 mg/Nm^3
Emission factor 0.6 g/ t Al