Section V.D.2.

Guidance by source category: Annex C, Part II Source Categories

Sinter plants in the iron industry

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Guidelines on Best Available Techniques (BAT) for Sinter Plants in the Iron Industry

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1.0 Process Description

Iron sintering plants are associated with the manufacture of iron and steel, often in integrated steel mills. The sintering process is a pre-treatment step in the production of iron, where fine particles of iron ores and in some plants, also secondary iron oxide wastes (collected dusts, mill scale), are agglomerated by combustion. Agglomeration of the fines is necessary to enable the passage of hot gases during the subsequent blast furnace operation.[1]

Sintering involves the heating of fine iron ore with flux and coke fines or coal to produce a semi-molten mass that solidifies into porous pieces of sinter with the size and strength characteristics necessary for feeding into the blast furnace. Moistened feed is delivered as a layer onto a continuously moving grate or "strand." The surface is ignited with gas burners at the start of the strand, and air is drawn through the moving bed causing the fuel to burn. Strand velocity and gas flow are controlled to ensure that "burn through" (i.e. the point at which the burning fuel layer reaches the base of the strand) occurs just prior to the sinter being discharged. The solidified sinter is then broken into pieces in a crusher and is air-cooled. Product outside the required size range is screened out, oversize material is recrushed, and undersize material is recycled back to the process. Sinter plants that are located in a steel plant recycle iron ore fines from the raw material storage and handling operations and from waste iron oxides from steel plant operations and environmental control systems. Iron ore may also be processed in on-site sinter plants.[2]

The flexibility of the sintering process permits conversion of a variety of materials, including iron ore fines, captured dusts, ore concentrates, and other iron-bearing materials of small particle size (e.g., mill scale) into a clinker-like agglomerate.[3]

Waste gases are usually treated for dust removal in a cyclone, electrostatic precipitator, wet scrubber or fabric filter.

Figure 1 provides a schematic of an iron sintering plant using wet scrubber and Figure 2 provides a schematic for a typical iron sintering plant which uses an electrostatic precipitator for dust control.

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[1] United Nations Environment Programme (UNEP), *Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases*, (Switzerland: UNEP Chemicals, 2003), p. 60

[2] Environment Canada, *Environmental Code of Practice for Integrated Steel Mills – CEPA 1999 Code of Practice,* (Canada: Public Works and Government Services, 2001), p. 18.

[3] William T. Lankford Jr., Norman L. Samways, Robert F. Craven, and Harold E. MacGannon, eds., *The Making, Shaping and Treating of Steel, 10th Edition*, (USA: Association of Iron and Steel Engineers, 1985), p. 305-6.

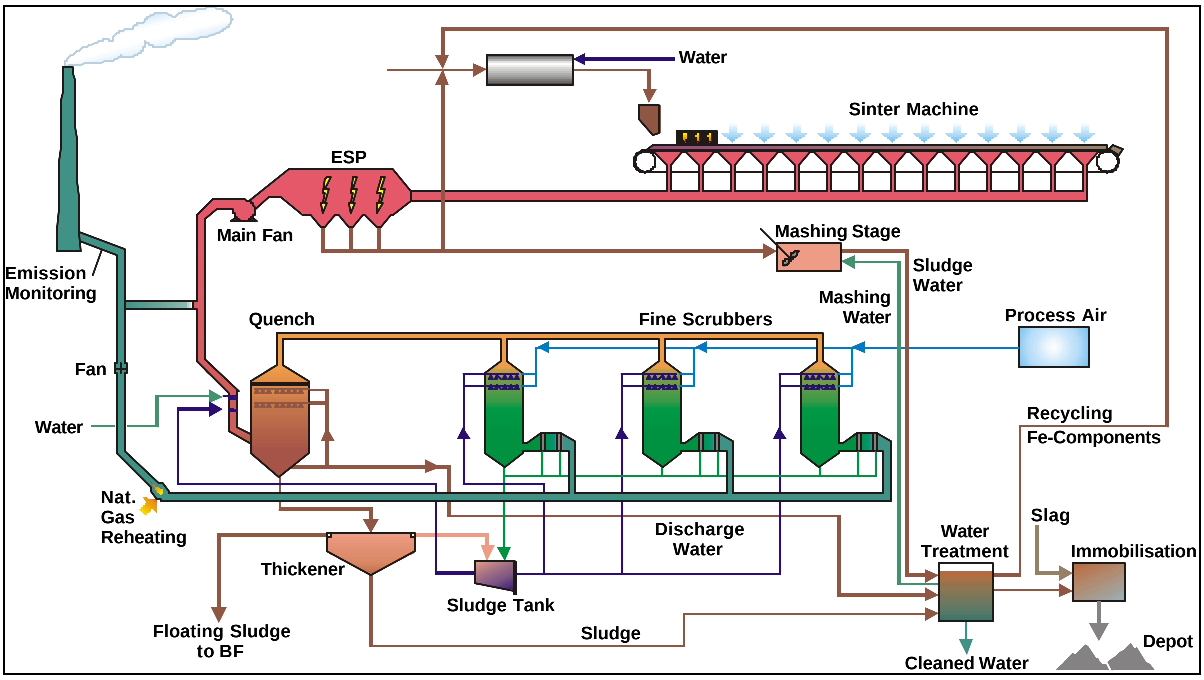

Figure 1: Process Diagram from a Sinter Plant (Source: K. Hofstadler et al., *Dioxin at Sinter Plants and Electric Arc Furnaces – Emission profiles and removal efficiency*: downloaded May 2003 http://g5006m.unileoben.ac.at/downloads/Dioxin.doc)

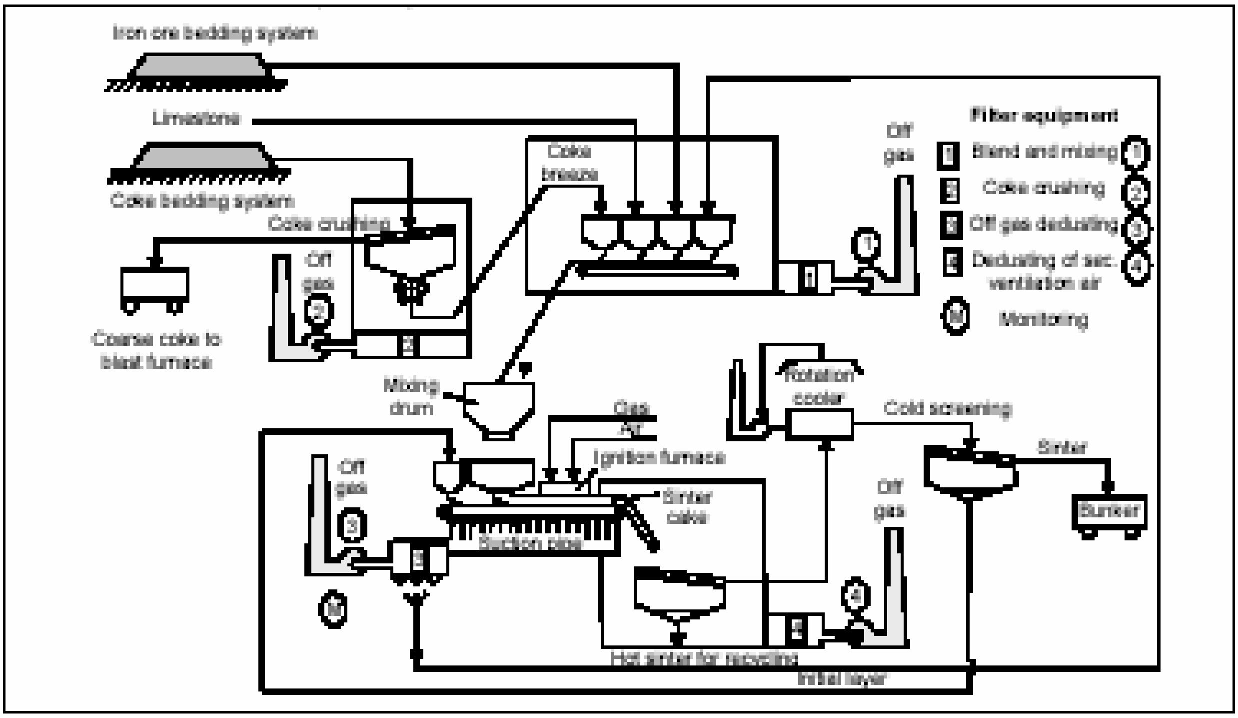

Figure 2: A Typical Iron Sintering Plant (Source: United Kingdom Environment Agency, *Integrated Pollution Prevention and Control: Guidance for the Coke, Iron and Steel Sector*, Sector Guidance Note IPPC S2.01, 2001)

2.0 Sources of Unintentional POPs

Iron sintering has been identified as a source of polychlorinated dibenzoparadioxins (PCDD) and polychlorinated dibenzofurans (PCDF). The formation and release of hexachlorobenzene (HCB) and polychlorinated biphenyls (PCB) are less understood from this potential source.

2.1 Releases to Air

2.1.1 General Information on Emissions from Iron Sintering Plants 4

"*Emissions from the sintering process arise primarily from materials-handling operations, which result in airborne dust, and from the combustion reaction on the strand. Combustion gases from the latter source contain dust entrained directly from the strand along with products of combustion such as CO, CO_2, SO_x, NO_x, and particulate matter. The concentrations of these substances vary with the quality of the fuel and raw materials used and combustion conditions. Atmospheric emissions also include volatile organic compounds (VOCs) formed from volatile material in the coke breeze, oily mill scale, etc., and dioxins and furans, formed from organic material under certain operating conditions. Metals are volatilized from the raw materials used, and acid vapours are formed from the halides present in the raw materials.*

Combustion gases are most often cleaned in electrostatic precipitators (ESPs), which significantly reduce dust emissions but have minimal effect on the gaseous emissions. Water scrubbers, which are sometimes used for sinter plants, may have lower particulate collection efficiency than ESPs but higher collection efficiency for gaseous emissions. Significant amounts of oil in the raw material feed may create explosive conditions in the ESP. Sinter crushing and screening emissions are usually controlled by ESPs or fabric filters. Wastewater discharges, including runoff from the materials storage areas, are treated in a wastewater treatment plant that may also be used to treat blast furnace wastewater.

Solid wastes include refractories and sludge generated by the treatment of emission control system water in cases where a wet emission control system is used. Undersize sinter is recycled to the sinter strand."

[4] Environment Canada, *Environmental Code of Practice for Integrated Steel Mills – CEPA 1999 Code of Practice,* (Canada: Public Works and Government Services, 2001), p. 23-25.

2.1.2 Emissions of PCDD and PCDF[5]

The processes by which PCDD/PCDF are formed are complex. PCDD/PCDF appear to be formed in the iron sintering process via *de novo* synthesis. PCDF generally dominate in the waste gas from sinter plants.

The PCDD/PCDF formation mechanism appears to start in the upper regions of the sinter bed shortly after ignition, and then the dioxin/furan and other compounds condense on cooler burden beneath as the sinter layer advances along the sinter strand towards the burn through point. The process of volatilization and condensation continues until the temperature of the cooler burden beneath rises sufficiently to prevent condensation and the PCDD/PCDF exit with the flue gas. This appears to increase rapidly and peak just before burn through and then decrease rapidly to a minimum. This is supported by the dioxin/furan profile compared to the temperature profile along the sinter strand in several studies.

The quantity of PCDD and PCDF formed has been shown to increase with increasing carbon and chlorine content. Carbon and chloride are present in some of the sinter feed materials typically processed through a sinter plant.

2.1.3 Research findings of interest:[6]

It appears that the composition of the feed mixture has an impact on the formation of PCDD/PCDF i.e., increased chlorine content results in increased PCDD/PCDF formation while the replacement of coke as a fuel with anthracite coal appears to reduce PCDD/PCDF concentration.

The form of the solid fuel may also impact furan emissions. Coal, graphite, and activated coke in a Japanese laboratory research program reduced pentachlorinated dibenzofuran emissions by approximately 90 percent.

The operating parameters of the sintering process appear to have an impact on the formation of PCDD/PCDF.

2.2 Releases to Other Media

No information was identified on releases of UPOPs from iron sintering operations to other media such as through wastewater or collected dusts.

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[5] William Lemmon & Associates Ltd., *Research on Technical Pollution Prevention Options for Iron Sintering, Draft of 2003/05/17* (Canada: prepared for the Canadian Council of Ministers of the Environment, 2003), p.20-21

[6] Ibid.

3.0 Alternatives

In accordance with the POPs Convention, when consideration is being given to proposals for construction of a new iron sintering plant, priority consideration should be given to alternate processes, techniques or practices that have similar usefulness but which avoid the formation and release of the identified substances.

Alternate processes to iron sintering include:

The FASTMET process: This process converts iron oxide pellet feed, oxide fines, and/or steel mill wastes into metallic iron, and produces a direct reduced iron (DRI) product suitable for use in a blast furnace. Emission concentration of PCDD and PCDF from the FASTMET process is reported to be <0.1 ng TEQ/m^3. Carbon contained in the wastes or added as coal, charcoal or coke is used as the reductant.

Direct reduction processes: This technique processes iron ore to produce a direct reduced iron (DRI) product which can be used as a feed material to steel manufacturing electric arc furnaces, iron making blast furnaces, or steelmaking basic oxygen furnaces. Natural gas is reformed to make hydrogen and carbon dioxide, where hydrogen is the reductant used to produce the DRI product. The availability and cost of natural gas will impact the feasibility of using this technique.

Direct smelting processes: Direct smelting replaces the traditional combination of sinter plant, coke oven and blast furnace to produce molten iron. A number of direct smelting processes are evolving and are at various stages of development/commercialization.

4.0 Primary and Secondary Measures

Primary and secondary measures for reducing emissions of PCDD and PCDF from iron sintering processes are outlined below.

The extent of emission reduction possible with implementation of primary measures only is not readily known. It is therefore recommended that consideration be given to implementation of both primary and secondary measures at existing plants.

4.1 Primary Measures

Primary measures are understood to be pollution prevention measures that will prevent or minimize the formation and release of the identified substances (PCDD, PCDF, HCB and PCB). These are sometimes referred to as process optimization or integration measures. Pollution prevention is defined as: *The use of processes, practices, materials, products or* *energy that avoid or minimize the creation of pollutants and waste, and reduce overall risk to human health or the environment.*

Primary measures have been identified which may assist in preventing and minimizing the formation and release of the identified substances. Emission reductions associated with implementation of the following primary measures only is not known. It is recommended that the following measures be implemented together with appropriate secondary measures to ensure the greatest minimization and reduction of emissions possible. Identified primary measures include:

1. Stable and consistent operation of the sinter strand: Research has shown that PCDD/PCDF are formed in the sinter bed itself, likely just ahead of the flame front as the hot gases are drawn through the bed. Disruptions to flame front (i.e., non-steady-state conditions) have been shown to result in higher PCDD/PCDF emissions.

   Sinter strands should be operated to maintain consistent and stable process conditions (i.e., steady-state operations, minimization of process upsets) in order to minimize the formation and release of PCDD, PCDF and other pollutants. Operating conditions to consistently manage include strand speed, bed composition (consistent blending of revert materials, minimization of chloride input), bed height, use of additives (e.g., addition of burnt lime may help reduce PCDD, PCDF formation), minimization of oil content in mill scale, minimization of air in-leakage through the strand, ductwork and off-gas conditioning systems, and minimization of strand stoppages. This approach will also have beneficial operating performance improvements (e.g., productivity, sinter quality, energy efficiency).[7][8]

2. Continuous Parameter Monitoring: A continuous parameter monitoring system (CPMS) should be employed to ensure optimum operation of the sinter strand and off-gas conditioning systems. Various parameters are measured during emission testing to determine the correlation between the parameter value and the stack emissions. The identified parameters are then continuously monitored and compared to the optimum parameter values. Variances in parameter values can be alarmed and corrective action taken to maintain optimum operation of the sinter strand and/or emission control system.

   Operating parameters to monitor may include damper settings, pressure drop, scrubber water flow rate, average opacity, strand speed, etc.

[7] European Integrated Pollution Prevention and Control Bureau (EIPPCB), *Best Available Techniques Reference Document on the Production of Iron and Steel*, (Seville, Spain, 2000), p.47.

[8] U.K. Environment Agency, *Integrated Pollution Prevention and Control (IPPC) Guidance for the Coke, Iron and Steel Sector*, (United Kingdom: Environment Agency, 2001), p. 39.

Operators of iron sintering plants should prepare a site-specific monitoring plan for the CPMS that addresses installation, performance, operation and maintenance, quality assurance and record keeping, and reporting procedures. Operators should keep records documenting conformance with the identified monitoring requirements and the operation and maintenance plan.[9]

3. Recirculation of Off-gases: Recycling of sinter off-gas (waste-gas) has been shown to minimize pollutant emissions, and reduce the amount of off-gas requiring end-of-pipe treatment. Recirculation of part of the off-gas from the entire sinter strand, or sectional recirculation of off-gas, can minimize formation and release of pollutants. The European Integrated Pollution Prevention and Control Bureau (EIPPCB) BREF document on Iron and Steel Production and the ECSC Steel Research and Technology Development Programme[10] provide additional information on this technique.[11]

   Recycling of iron sintering off-gases can reduce emissions of PCDD, PCDF, NOx and SO_2.

4. Feed material selection: Unwanted substances should be minimized in the feed to the sinter strand. Unwanted substances include POPs and other substances associated with the formation of PCDD, PCDF, HCB and PCB (e.g., chlorine/chlorides, carbon, precursors, oils, etc.).

   A review of feed inputs to determine its composition/structure and concentration of substances associated with POPs and their formation should be conducted. Options to eliminate or reduce the unwanted substance in the feed material should be identified. For example:

   - removal of the contaminant from the material (e.g., de-oiling of mill scales);
   - substitution of the material (e.g., replacement of coke breeze with anthracite);
   - avoid use of the contaminated material (e.g., avoid processing ESP sinter dusts which have been shown to increase PCDD/PCDF formation and release[12]);
   - specification of limits on permissible concentrations of unwanted substances (e.g., oil content in feed should be limited to less than 0.02 percent[13]).

[9] U.S. Environmental Protection Agency, *National Emission Standards for Hazardous Air Pollutants: Integrated Iron and Steel Manufacturing; Final Rule*, (United-States: 40 CFR Part 63, Federal Register/ Vol. 68, No. 97, May 20, 2003), URL: www.epa.gov

[10] European Coal and Steel Community (ECSC), *The Impact of ECSC Steel Research on Steel Production and Sustainability*, downloaded 2003/09/15, URL: http://www.stahl-online.de//medien_lounge/medieninformationen/hintergrundmaterial.htm

[11] European Integrated Pollution Prevention and Control Bureau (EIPPCB), *Best Available Techniques Reference Document on the Production of Iron and Steel*, (Seville, Spain, 2000), p. 56-62

[12] Kasai, E. et al, Effect of Additives on the Dioxins Emissions in the Iron Ore Sintering Process. *ISIJ International*, Vol. 41 (2001), No.1, pp. 93-97.

Documented procedures should be developed and implemented to carry out the appropriate changes.

5. Feed material preparation: Fine feed materials (e.g., collected dusts) should be adequately agglomerated before they are placed on the sinter strand and feed materials should be intimately mixed or blended. These measures will minimize formation and entrainment of pollutants in the waste gas, and will also minimize fugitive emissions.

4.2 Secondary Measures

Secondary measures are understood to be pollution control technologies or techniques, sometimes described as 'end-of-pipe' treatments.

Primary measures identified earlier should be implemented together with appropriate secondary measures to ensure the greatest minimization and reduction of emissions possible. Measures that have been shown to effectively minimize and reduce PCDD and PCDF emissions include:

1. Removal Techniques

   a. Adsorption/Absorption and High Efficiency De-dusting: This technique involves sorption of PCDD and PCDF to a material such as activated carbon together with effective particulate matter (de-dusting) control.

      For *regenerative activated carbon technology*[14] an ESP is used to reduce dust concentration in the off-gases prior to entry to the activated carbon unit. The waste gas passes through a slowly moving bed of char granules which acts as a filter/adsorption medium. The used char is discharged and transferred to a regenerator, where it is heated to elevated temperatures. PCDD and PCDF adsorbed to the char are decomposed and destroyed within the inert atmosphere of the regenerator. This technique has been shown to reduced emissions to 0.1 to <0.3 ng TEQ/m^3.

      Another sorption technique is the use of *lignite or activated carbon injection, together with a fabric filter*. PCDD and PCDF are sorbed onto the injected

[13] U.S. Environmental Protection Agency, *National Emission Standards for Hazardous Air Pollutants: Integrated Iron and Steel Manufacturing; Final Rule*, (United-States: 40 CFR Part 63, Federal Register/ Vol. 68, No. 97, May 20, 2003), URL: www.epa.gov

[14] William Lemmon & Associates Ltd., *Research on Technical Pollution Prevention Options for Iron Sintering, Draft of 2003/05/17* (Canada: prepared for the Canadian Council of Ministers of the Environment, 2003), p.29-30

material, and the material is collected in the fabric filter. Along with good operation of the sinter strand, this technique is associated with PCDD/PCDF emission concentrations ranging from 0.1 to 0.5 ng TEQ/m^3.[15]

b. Fine Wet Scrubbing System: The Airfine scrubbing system, developed by Voest Alpine Industries (Austria), has been shown to effectively reduce emission concentrations to 0.2 to 0.4 ng TEQ/m^3. The scrubbing system uses a counter current flow of water against the rising waste gas to scrub out coarse particles and gaseous components (e.g., sulphur dioxide (SO_2)), and to quench the waste gas. (Note, an ESP may also be used upstream for preliminary dedusting.) Caustic soda may be added to improve SO_2 absorption. A fine scrubber, the main feature of the system, follows, employing high-pressure mist jet co-current with the gas flow to remove impurities. Dual flow nozzles eject water and compressed air (creating microscopic droplets) to remove fine dust particles, PCDD and PCDF.[16,17]

   This technique should be combined with effective treatment of the scrubber waste waters and waste water sludge should be disposed of in a secure landfill.[18]

The following measures can assist in minimizing pollutant emissions, but should be combined with other measures (e.g., adsorption/absorption, recirculation of off-gases, etc.) for effective PCDD/PCDF formation and release.

2. General Measures

a. De-dusting of the sinter off-gases. It has been suggested that effective removal of dust can help reduce emissions of PCDD and PCDF. Fine particles in the sinter off-gas have extremely large surface area for adsorption and condensation of gaseous pollutants, including PCDD and PCDF.[19] Best available technique for de-dusting is use of fabric filters to remove particulate matter. Use of fabric

[15] U.K. Environment Agency, *Integrated Pollution Prevention and Control (IPPC) Guidance for the Coke, Iron and Steel Sector*, (United Kingdom: Environment Agency, 2001), p. 135.
[16] William Lemmon & Associates Ltd., *Research on Technical Pollution Prevention Options for Iron Sintering, Draft of 2003/05/17* (Canada: prepared for the Canadian Council of Ministers of the Environment, 2003), p.29-30
[17] EIPPCB, *Best Available Techniques Reference Document on the Production of Iron and Steel*, (Seville, Spain, 2000), p. 72-74, URL: http://eippcb.jrc.es
[18] Ibid.
[19] K. Hofstadler et al., *Dioxin at Sinter Plants and Electric Arc Furnaces – Emission profiles and removal efficiency*, (Austria: VOEST ALPINE Indstrienlagenbau GmbH, no date), Url: g5006m.unileoben.ac.at/downloads/Dioxin.doc (May 2003)

filters for sinter plants is associated with particulate matter emission concentrations of <10 to <30 mg/m^3.[20,21]

Other dedusting options that are commonly used for sinter plant off-gases include ESPs and wet scrubbers. Particulate removal efficiency is not as high as for fabric filters. Good performance of ESPs and high efficiency wet-gas scrubbers is associated with particulate matter concentrations of <30 to 50 mg/m^3.[22,23, 24]

Adequately sized capture and dedusting controls for both the feed and discharge ends should be required and put in place.

b. Hooding of the sinter strand: Hooding of the sinter strand reduces fugitive emissions from the process, and enables use of other techniques, such as waste gas recirculation.

5.0 Emerging Research

Catalytic Oxidation:
Selective catalytic reduction (SCR) has been used for controlling NOx emissions from a number of industrial processes, including iron sintering. Modified SCR technology (i.e., increased reactive area) and select catalytic processes have been shown to decompose PCDD and PCDF contained in off-gases, likely through catalytic oxidation reactions. This may be considered as an emerging technique with potential for reducing POPs emissions from iron sintering plants and other applications.

A study investigating stack emissions from four sinter plants, noted that those with SCR had lower concentrations of PCDD/PCDF (0.995 – 2.06 TEQ/Nm^3) in the stack gases than a sinter plant without SCR (3.10 ng TEQ/Nm^3), and that the PCDD/PCDF degree of chlorination was lower for plants with SCR. It was concluded that SCR did indeed decompose PCDD/PCDF, but would not necessarily be sufficient as a stand alone

[20] United Nations Economic Commission for Europe (UNECE), Annex III Best available techniques for controlling emission of heavy metals, *Protocol to the 1979 Convention on Long-Range Transboundary Pollution on Heavy Metals (Aarhus)*, (Geneva: UNECE, 1998), URL: www.unece.org

[21] UK Environment Agency, *Integrated Pollution Prevention and Control (IPPC) Guidance for the Coke, Iron and Steel Sector*, (United Kingdom: Environment Agency, 2001), p. 131.

[22] Ibid.

[23] William Lemmon & Associates Ltd., *Research on Technical Pollution Prevention Options for Iron Sintering, Draft of 2003/05/17* (Canada: prepared for the Canadian Council of Ministers of the Environment, 2003), p.26.

[24] UNECE, Annex III Best available techniques for controlling emission of heavy metals, *Protocol to the 1979 Convention on Long-Range Transboundary Pollution on Heavy Metals (Aarhus)*, (Geneva: UNECE, 1998), URL: www.unece.org

PCDD/PCDF destruction technology to meet stringent emission limits. Add-on techniques (e.g., activated carbon injection) to SCR may be required.[25]

Further study of the use of SCR and other catalytic oxidation techniques at iron sintering applications is needed to determine its value and effectiveness in destroying and reducing PCDD/PCDF released from this source.

Urea Injection:
Tests using urea injection to suppress formation of dioxins and furans have been conducted at an iron sintering plant in the United Kingdom. Controlled quantities of urea prills were added to the sinter strand, and this technique is thought to prevent/reduce both PCDD/PCDF and sulphur dioxide emissions. The trials indicate that PCDD/PCDF formation was reduced by approximately 50%. It is estimated that a 50% reduction in PCDD/PCDF would achieve a 0.5 ng TEQ/m^3 emission concentration. Capital costs are estimated at £0.5 to £1.0 million per plant (UK) (approximately $0.9 million to $1.8 million USD).[26]

5.0 Summary of Measures

The following tables present a summary of the measures discussed in previous sections.

Table 5.1 Alternatives and Requirements for New Iron Sintering Plants

Measure	Description	Considerations	Other comments
New Iron Sintering Plants			
Alternate Processes	Priority consideration should be given to alternate processes with potentially less environmental impacts than traditional iron sintering.	Examples include: -FASTMET -direct reduction of iron -direct smelting	
Performance Requirements	New iron sintering plants should be permitted to achieve stringent performance and reporting requirements associated with best available techniques.	Consideration should be given to the primary and secondary measures listed in Table 5.2 below.	Performance requirements for achievement should include: - <0.2 ng TEQ/Rm^3 for PCDD/PCDF -<20 mg/Rm^3 for particulate matter

Table 5.2 Summary of Primary and Secondary Measures for Iron Sintering Plants

Measure	Description	Considerations	Other Comments
Primary Measures			

[25] Wang, L-C, et al. Emission of polychlorinated dibenzo-p-dioxins and dibenzofurans from stack flue gases of sinter plants, *Chemosphere*, Vol. 50, Issue 9, March 2003, pg 1123-1129.
[26] Entec UK Limited, *Development of UK Cost Curves for Abatement of Dioxins Emissions to Air, Final Report – draft for consultation*, November 2003, pg D-10 to D-20.

Measure	Description	Considerations	Other Comments
Stable and consistent operation of the sinter plant.	The sinter strand should be operated to maintain stable consistent operating conditions (e.g., steady-state conditions, minimization of process upsets) to minimize formation of PCDD, PCDF and other pollutants.	Conditions to optimize operation of the strand include: -minimization of stoppages -consistent strand speed -bed composition -bed height -additives (e.g., burnt lime) -minimization of oil content -minimization of air in-leakage	This approach will have co-benefits such as increased productivity, increased sinter quality and improved energy efficiency.
Continuous Parameter Monitoring	A continuous parameter monitoring system (CPMS) should be employed to ensure optimum operation of the sinter strand and off-gas conditioning systems. Operators should prepare a site-specific monitoring plan for the CPMS and keep records that document conformance with the plan.	Correlations between parameter values and stack emissions (stable operation) should be established. Parameters are then continuously monitored in comparison to optimum values. System can be alarmed and corrective action taken when significant deviations occur.	
Recirculation of Waste Gases	Waste gases should be recycled back to the sinter strand to minimize pollutant emissions and reduce the amount of off-gas requiring end-of-pipe treatment.	Recirculation of the waste gases can entail recycling of part of the off-gas from the entire sinter strand, or sectional recirculation of off-gas.	This technique will result in only a modest reduction of PCDD/PCDF.
Feed material selection: ***Minimization of feed materials contaminated with POPs or leading to POPs formation.***	A review of feed materials and identification of alternate inputs and/or procedures to minimize unwanted inputs should be conducted. Documented procedures should be developed and implemented to carry out the appropriate changes.	Examples include: -removal of the contaminant from the material (e.g., de-oiling of mill scales) -substitution of the material (e.g., replacement of coke breeze with anthracite) -avoid use of the material (e.g.,	

Measure	Description	Considerations	Other Comments
		collected sinter ESP dust) -specification of limits on permissible concentrations of unwanted substances (e.g., oil content in feed should be limited to less than 0.02 percent)	
Feed material preparation	Fine material (e.g., collected dusts) should be agglomerated before being placed on the sinter strand. Feed materials should be intimately mixed before placement on the sinter strand.		These measures will help reduce entrainment of pollutants in the waste gas, and minimize fugitive emissions.
Secondary Measures			
The following secondary measures can effectively reduce emissions of PCDD/PCDF and should be considered as examples of best available techniques.			
Adsorption/ Absorption and high efficiency dedusting.	Use of this technique should include an adsorption stage together with high efficiency particulate control as key components of the off-gas conditioning system.	Two adsorption techniques have been demonstrated: (1) regenerative activated carbon technology where off-gases are first cleaned by ESP, and passed though moving adsorption bed (char) to both adsorb PCDD, PCDF, and to filter particulates. Adsorptive material is then regenerated. (2) injection of activated carbon, lignite or other similar adsorptive material into the gas stream followed by fabric filter dedusting.	These techniques are associated with the following emission concentration levels: (1) <0.3 ng TEQ/m^3 (2) 0.1 to 0.5 ng TEQ/ m^3
Fine wet scrubbing of waste gases	Use of this technique should include a preliminary counter current wet scrubber to quench gases and remove larger particles, followed by a fine scrubber using high pressure mist jet co-current with off-gases to remove fine particles and impurities.		The fine wet scrubbing system under the trade name Airfine ® as developed by Voest Alpine Industries, has been shown to reduce emission concentrations to 0.2 to 0.4 ng TEQ/m^3.
The following secondary measures should not be considered as BAT on their own. For effective minimization and			

Measure	Description	Considerations	Other Comments
reduction of PCDD, PCDF and other POPs, the following should be employed in concert with other identified measures.			
De-dusting of waste gases.	Waste gases should be dedusted using high efficiency techniques, as this can help minimize PCDD/PCDF emissions. A recommended BAT for dedusting is the use of fabric filters. Feed and discharge ends of the sinter strand should be adequately hooded and controlled to capture and dedust fugitive emissions.	Fabric filters have been shown to reduce sinter off-gas particulate emissions to <10 to <30 mg/m^3.	Other dedusting techniques used include ESPs and high efficiency scrubbers. Good performance of these technologies are associated with particulate concentrations of <30 to 50 mg/m^3.
Hooding of the sinter strand	The sinter strand should be hooded to minimize fugitive process emissions.		Hooding of the strand will enable use of other measures, such as waste gas recirculation.

6.0 Achievable Levels

Achievable levels were identified for emissions of PCDD/PCDF only. No levels were identified for the other unintentionally produced POPs or for releases to other media.

6.1 Achievable Levels of PCDD/PCDF

Achievable levels for emissions of PCDD/PCDF from iron sintering plants are identified as follows:

Source Type	Emission Limit Value
New Plants	<0.2 ng TEQ/Rm^3
Adsorption/Absorption and High Efficiency De-dusting	0.1 to 0.5 ngTEQ/Rm^3
Fine Wet Scrubbing System	0.2 to 0.4 ng TEQ/Rm^3

6.2 Country Emission Limits for Iron Sintering

The following provides a brief overview of emission concentration limits that have been established for or are applicable to iron sintering operations.

Country	Emission Limit (PCDD/PCDF)	Comment
Austria	0.4 ng I-TEQ/m3	Applicable to new plants built after 2001
Canada	0.2 ng I-TEQ/Rm^3	For new plants
	<1.35 ng I-TEQ/Rm^3	For existing plants, to be achieved by 2002
	<0.5 ng I-TEQ/Rm^3	For existing plants, to be achieved by 2005
	<0.2 ng I-TEQ/Rm^3	For existing plants, to be achieved by 2010
Germany	0.1 ng I-TEQ/m^3	Target
	0.4 ng I-TEQ/m^3	Upper limit
Japan	0.1 ng WHO-TEQ/m^3	For new plants
	1 ng WHO-TEQ/m^3	For existing plants
Netherlands	0.1 ng I-TEQ/m^3	Desirable
United Kingdom	0.1 – 0.5 ng I-TEQ/m^3	Benchmark emission values
Other	(PLEASE PROVIDE ANY ADDITIONAL	

	INFORMATION ON EMISSION LIMITS)	