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(54) **Iron ore sintering process with reduced emissions of toxic gases by waste gas recirculation**

(57) A method of sintering iron ore in a sinter strand comprises providing a sinter feedstock and depositing said feedstock onto a travelling grate, igniting said feedstock using a sinter strand burner(s), and combusting said feedstock by drawing air through the feedstock with a plurality of wind boxes situated along the length of the strand, to produce sintered products rich in iron and

waste gases. Waste gases from only those wind boxes whose temperature exceeds a predetermined level (200-250°C) are recycled to provide combustion feed air for the feedstock or air for the sinter strand ignition burner(s), thereby substantially reducing or eliminating the production and/or emission of dioxins.

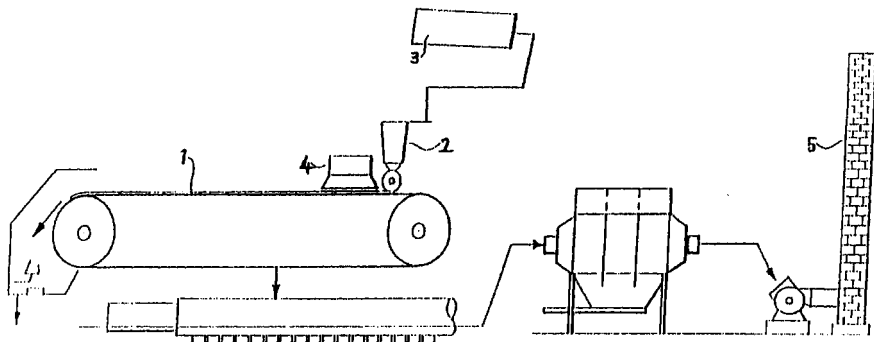


FIGURE 3

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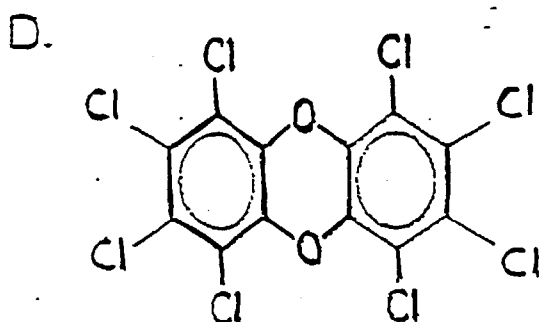
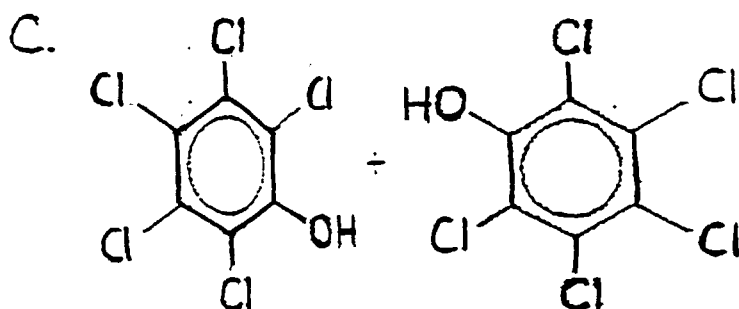
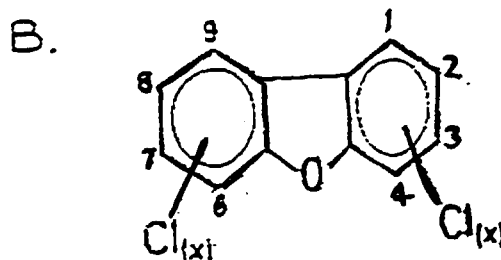
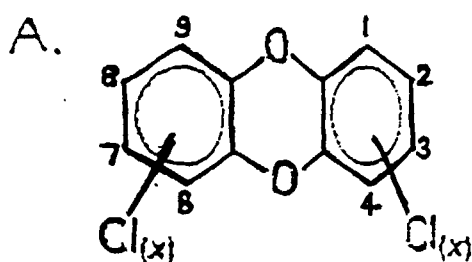
Description

[0001] This invention relates to the suppression of toxic byproducts which are generated during sintering of iron ore. In particular, the invention concerns a method of and apparatus for suppressing the synthesis of chloro-organic pollutants, especially polychlorinated dioxins and furins (hereinafter referred to as PCDD/Fs), and the release of acidic gases during sintering.

[0002] The conversion of iron ore into for example iron rich agglomerates, for subsequent reduction in blast furnaces is a process known as sintering. The sinter process comprises heating a layer of iron ore until partial melting occurs to cause individual iron particles to become fused together. The heat necessary to achieve this is provided by forced combustion of fine coke (known as coke breeze) which is mixed *inter alia* with the iron ore to be reduced and fluxes prior to delivery to a sinter plant. The process is continuous; a travelling grate transports the sinter mix as a bed to an ignition hood which ignites the coke in the upper surface of the sinter bed. Thereafter, the combustion of the coke lower down in the mix is maintained by air flowing through the bed. The air flow may be generated by a suction fan. Typically, the travelling grate carries the sinter mix over a series of "wind boxes" which draw air through the sinter mix.

[0003] In a conventional sinter strand, the waste gases pass from wind boxes through "wind legs" which link to a "wind main". These gases contain noxious emissions including *inter alia* PCDD/Fs, oxides of nitrogen and other acidic compounds such as hydrogen chloride and sulphur dioxide. Therefore, the waste gas is typically treated to clean the gas before being exhausted to the atmosphere.

[0004] PCDD/Fs present two of the most potentially harmful combustion by-products of the sinter process. PCDD/Fs are a family of chlorinated organic compounds having a general formula (A) and (B) respectively:



[0005] The degree of toxicity varies and depends on the number and position of chloride substitutions on the aromatic carbon ring.

[0006] There is evidence to suggest that PCDD/F precursors are formed from the pyrolysis and chlorination of the organic material that represents the more primary combustion products such as hydrogen chloride, carbon monoxide, water, hydrogen, ethylene and acetylene. PCDD/Fs are thus synthesised *de novo* as a result of thermal reactions between precursor compounds. For example, the precursor pentachlorophenol (C) can interact to produce the dioxin octachlorodioxin (D). After formation, some of the PCDD/Fs may recombine downstream to produce a different set of compounds which may have higher or lower toxicity. Some of the non-toxic isomers may be converted to toxic isomers and vice versa.

[0007] It is also claimed that the 'fingerprint' of toxic isomers is specific to their formation mechanism; for example in combustion processes, furans are synthesised to a greater extent than dioxins and the pentachlorinated furan is the major contributor to total toxicity.

[0008] The increasing awareness of the long term deleterious effects on the environment by the release of such toxic compounds into the atmosphere, has generated a need to produce a relatively cheap and effective mechanism of decreasing the chloro-organic and acidic compounds released as gaseous by-products of combustible processes.

[0009] In the past, much effort has been directed towards reducing the toxic organic gases released in stack emis-

sions from incineration of municipal waste materials. The most frequently applied control technology involves the use of a spray dryer absorber followed by a particulate matter control device, most commonly a fabric or activated carbon filter. This technology controls the emission of acidic gases such as hydrogen chloride by providing a neutralising reaction with calcium carbonate (lime). The resulting solid materials (e.g. CaCl_2) are captured downstream of the lime injection site. PCDD/F gases are assumed to be captured by surface absorption by the filter deposit. Although this method reduces gaseous toxic emissions from incinerator plants to a limited extent, it is capital intensive and procedurally complex. In addition, it significantly increases the mass of solid waste to be disposed of and introduces the problem of toxic chloro-organic solid waste disposal.

[0010] Another method used in municipal waste disposal is exemplified in EP-A-371945. This document discloses a method for extracting dioxins from a gas which comprises contacting the gas with a liquid aerosol over a predetermined period of time. The particles present in the aerosol are electrically charged and subsequently separated from the gas with the aid of a wet electrostatic precipitator or electric field.

[0011] Ammonia gas or ammonia releasing compounds such as alkanolamines, have demonstrated a potential to control simultaneously emissions of several pollutants of concern, such as dioxins, hydrogen chloride, sulphur dioxide and oxides of nitrogen.

[0012] The present inventors have disclosed in EP-A-0 875 587 an efficient and cost effective method of reducing toxic emissions, more especially PCDD/F formation, from a sinter strand, whilst keeping the quantity of ammonia gas released into the atmosphere at low levels and without the need to introduce complex modifications to existing strand equipment.

[0013] Their method comprised the sequential steps of producing a sinter feedstock by substantially homogeneously mixing *inter alia* iron ore with 0.01 to 0.09% by weight of a solid compound which releases ammonia on thermal decomposition, depositing said feedstock onto moving grate and combusting the same to produce sintered products rich in iron.

[0014] The present inventors have now discovered an alternative method of reducing toxic emissions *with or without* the addition of exogenous chemicals to the sinter strand.

[0015] Dioxins are known to be formed in the approximate temperature range 200 to 400°C. Dioxin formation has been reduced in other industries by ensuring that waste gases which may produce dioxins are cooled to below 250°C as soon as possible to avoid prolonged reaction times in this critical temperature range. However, in a sinter strand the situation is more complex; the gas passes through a packed bed of sinter mix and the gas temperature at the bottom of the sinter strand as it enters each wind box will be different depending on the position of the wind box along the strand. Typically, for the first 70% or so wind boxes, the exit temperature is relatively stable at approximately 100°C. This rapidly rises towards the end of the strand, peaks at up to 400°C and then drops slightly at the end of the strand.

[0016] It has been found that a good correlation exists between the gas temperature at the sampling point and the dioxin level measured in the gas. Figure 1 illustrates the correlation between the temperature of the waste gases and the windleg number along the sinter strand. Figure 2 illustrates the correlation between the PCDD/F formation in the waste gases and the wind box number along the sinter strand.

[0017] Accordingly, in one aspect the invention provides a method of sintering iron ore in a sinter strand comprising providing a sinter feedstock and depositing said feedstock onto a travelling grate, igniting said feedstock using a sinter strand burner(s), and combusting said feedstock by drawing air through the feedstock with a plurality of wind boxes situated along the length of the strand, to produce sintered products rich in iron and waste gases,

characterised in that waste gases from only those wind boxes whose temperature exceeds a predetermined level are recycled to provide combustion feed air for the feedstock or air for the sinter strand ignition burner(s), in order to substantially reduce or eliminate the production and/or emission of dioxins.

[0018] It has been found that recycling the waste gases in this way consumes the dioxins at the flame front as the dioxins pass through the sinter mix or at the burner.

[0019] Preferably, waste gases of a temperature greater than 200°C are recycled. Typically, waste gases of a temperature greater than 250°C are recycled. As figure 2 shows, it has been found that significant dioxin formation only occurs in the wind boxes wherein the temperature of the gases exceeds approximately 200°C.

[0020] In one embodiment of the invention, the waste gases are recycled from the final 25% of the wind boxes, preferably the final 20% of the wind boxes. Accordingly, the waste gases may only be recycled from a wind box if the temperature of the waste gases present within that wind box is greater than 200°C. Therefore, the advantage of the invention in suit is that the toxicity of waste gases produced during sintering can be minimised by recycling only a fraction of the total waste gas.

[0021] In one embodiment, the waste gases which have a temperature of greater than about 200°C may be rapidly cooled to below about 200°C to substantially reduce or eliminate the production of dioxins.

[0022] In another aspect, the invention provides a method of sintering iron ore in a sinter strand comprising providing a sinter feedstock and depositing said feedstock onto a travelling grate, igniting said feedstock using a sinter strand burner(s), and combusting said feedstock by drawing air through the feedstock with a plurality of wind boxes situated

along the length of the strand, to produce sintered products rich in iron and waste gases,

characterised in that waste gases from the sinter strand which have a temperature of greater than about 200°C are rapidly cooled to below about 200°C substantially to reduce or eliminate the production of dioxins.

[0023] The invention may involve the cooling of the waste gases in one or more of the wind boxes. In one embodiment, the temperature may be reduced by injecting a liquid or a gas (e.g. gaseous ammonia) into the waste gases in the or each wind box, and/or into the waste gases in their passage subsequent to the or each wind box. The liquid may be water for example, the water may be added in the form of steam. Preferably, the liquid comprises ammonia which may further reduce the level of dioxins in the gas. The rate at which the liquid may be introduced may be determined by the rate at which air is drawn into the wind boxes.

[0024] Alternatively or in addition, the external surface of the or each wind box and/or the external surface of any conduit leading from the or each wind box may be cooled by a supply of fluid, either liquid or gas, e.g. water, for example, in the form of steam.

[0025] Alternatively or in addition, the travelling grate of the sinter strand may be cooled, for example, with water, e.g. steam.

[0026] In another embodiment, a heat exchanger may be used to lower the temperature of the waste gases.

[0027] The sinter feedstock may include 0.01 to 0.09% by weight of a solid compound which releases ammonia on thermal decomposition. The ammonia compound may be substantially homogeneously mixed with iron ore in the sinter feedstock.

[0028] In yet another aspect, the invention provides a sinter strand which includes means for recycling waste gases from those wind boxes in the strand whose temperature exceeds a predetermined level, to provide combustion feed air for sinter feedstock for subsequent sintering, or air for a sinter strand ignition burner(s).

[0029] The sinter strand may further comprise means to cool waste gases which have a temperature of greater than about 200°C to below about 200°C to substantially reduce or eliminate the production of dioxins.

[0030] In still a further aspect, the invention provides a sinter strand which includes means to cool waste gases from the sinter strand which have a temperature of greater than about 200°C to below about 200°C to substantially reduce or eliminate the production of dioxins.

[0031] The invention will now be described by way of example only, with reference to the accompanying diagrammatic drawings in which:-

Figure 1 illustrates the correlation between the temperature of the waste gases and the windleg number along the sinter strand as described in the text above;

Figure 2 illustrates the correlation between the PCDD/F formation in the waste gases and the wind box number along the sinter strand as described in the text above; and,

Figure 3 illustrates a conventional sinter strand.

[0032] Referring now to Figure 3, the strand comprises a travelling grate 1, onto which pre-mixed constituents of a sinter bed are deposited via a hopper 2. Mixing of these constituents is effected in a blender 3. The mixed constituents include iron ore and iron ore fines, burnt lime, coke breeze and optionally measured quantities of ammonia releasing compounds in solid, e.g. pellet form.

[0033] The deposited sinter bed feedstock passes below an ignition hood 4, which ignites the coke breeze, combustion being enhanced and continued by the flow of large quantities of air, drawn through the bed by a series of wind boxes (not shown) along the stack. Sintered ore leaves the bed at the end of the grate remote from the hopper 2 and passes through a series of treatment stages. Waste gases of combustion leave the furnace through more stacks 5.

[0034] The illustrated strand is typical of many conventional strands, the essential difference being that the waste gases which contain levels of toxicity exceeding desired limits are specifically recycled or that the waste gases of a temperature suitable for the formation of toxic dioxins are rapidly cooled.

[0035] It will be appreciated that the foregoing is merely exemplary of methods and apparatus in accordance with the invention and that various modifications can readily be made thereto without departing from the scope of the invention.

Claims

1. A method of sintering iron ore in a sinter strand comprising providing a sinter feedstock and depositing said feedstock onto a travelling grate, igniting said feedstock using a sinter strand burner(s), and combusting said feedstock by drawing air through the feedstock with a plurality of wind boxes situated along the length of the strand, to produce sintered products rich in iron and waste gases,

characterised in that waste gases from those wind boxes whose temperature exceeds a predetermined level are recycled to either provide combustion feed air for the feedstock or air for the sinter strand ignition burner(s) in order to substantially reduce or eliminate the production of dioxins.

- 5 **2.** A method as claimed in claim 1 wherein waste gases of a temperature greater than 200°C are recycled.
- 3.** A method as claimed in claim 1 or claim 2 wherein waste gases of a temperature greater than 250°C are recycled.
- 4.** A method as claimed in any one of the preceding claims wherein the waste gases are recycled from the final 25%
10 of the wind boxes.
- 5.** A method as claimed in claim 4 wherein the waste gases are recycled from the final 20% of the wind boxes.
- 6.** A method as claimed in any one of the preceding claims wherein the waste gases are recycled from a wind box
15 where the temperature of the waste gases (present within that wind box) is greater than 200°C.
- 7.** A method as claimed in any one of the preceding claims wherein the waste gases which have a temperature of greater than about 200°C are cooled to below about 200°C to substantially reduce or eliminate the production of dioxins.
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- 8.** A method of sintering iron ore in a sinter strand comprising providing a sinter feedstock and depositing said feedstock onto a travelling grate, igniting said feedstock using a sinter strand burner(s), and combusting said feedstock by drawing air through the feedstock with a plurality of wind boxes situated along the length of the strand, to produce sintered products rich in iron and waste gases,
25 characterised in that waste gases from the sinter strand which have a temperature of greater than about 200°C are rapidly cooled to below about 200°C substantially to reduce or eliminate the production of dioxins.
- 9.** A method as claimed in claim 7 or claim 8 wherein the temperature of the waste gases is reduced in a wind box.
- 30 **10.** A method as claimed in claim 9 wherein the temperature of the waste gases is reduced by injecting a liquid or a gas (e.g. gaseous ammonia or steam) into a wind box.
- 11.** A method as claimed in any one of claims 7 to 10 wherein the temperature of the waste gases is reduced by adding liquid or gas (e.g. gaseous ammonia or steam) to the waste gases after they leave the or each wind box.
35
- 12.** A method as claimed in any one of claims 7 to 11 wherein the external surface of a wind box and/or the external surface of any conduit leading from a wind box is cooled by a supply of fluid.
- 13.** A method as claimed in any one of the preceding claims wherein the sinter feedstock includes 0.01 to 0.09% by
40 weight of a solid compound which releases ammonia on thermal decomposition.
- 14.** A method as claimed in claim 13 wherein the ammonia compound is substantially homogeneously mixed with iron ore in the sinter feedstock.
- 45 **15.** A sinter strand which includes means for recycling waste gases from only a selection of wind boxes in a sinter strand whose temperature exceeds a predetermined level, to provide combustion feed air for sinter feedstock for subsequent sintering, or air for a sinter strand ignition burner(s), in order to substantially reduce or eliminate the production of dioxins.
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FIGURE 1

Relation between gas temperature and windbox position

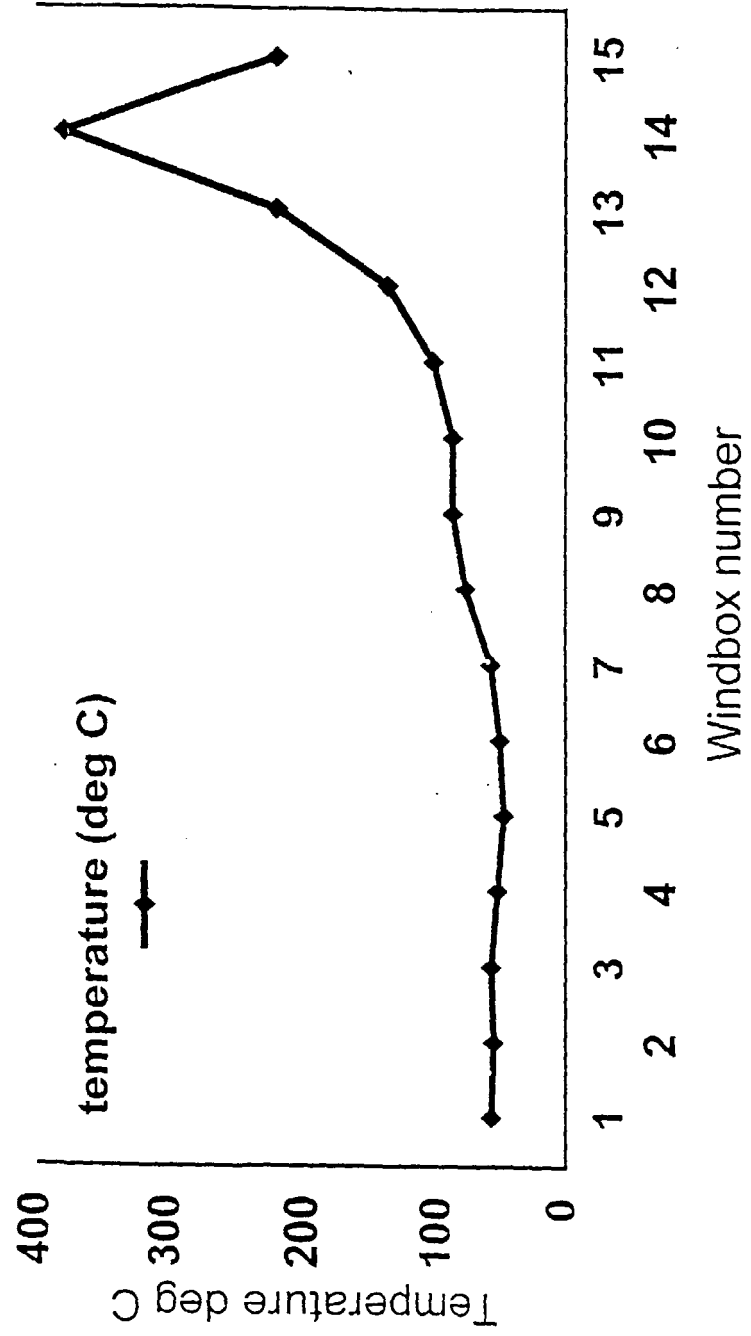
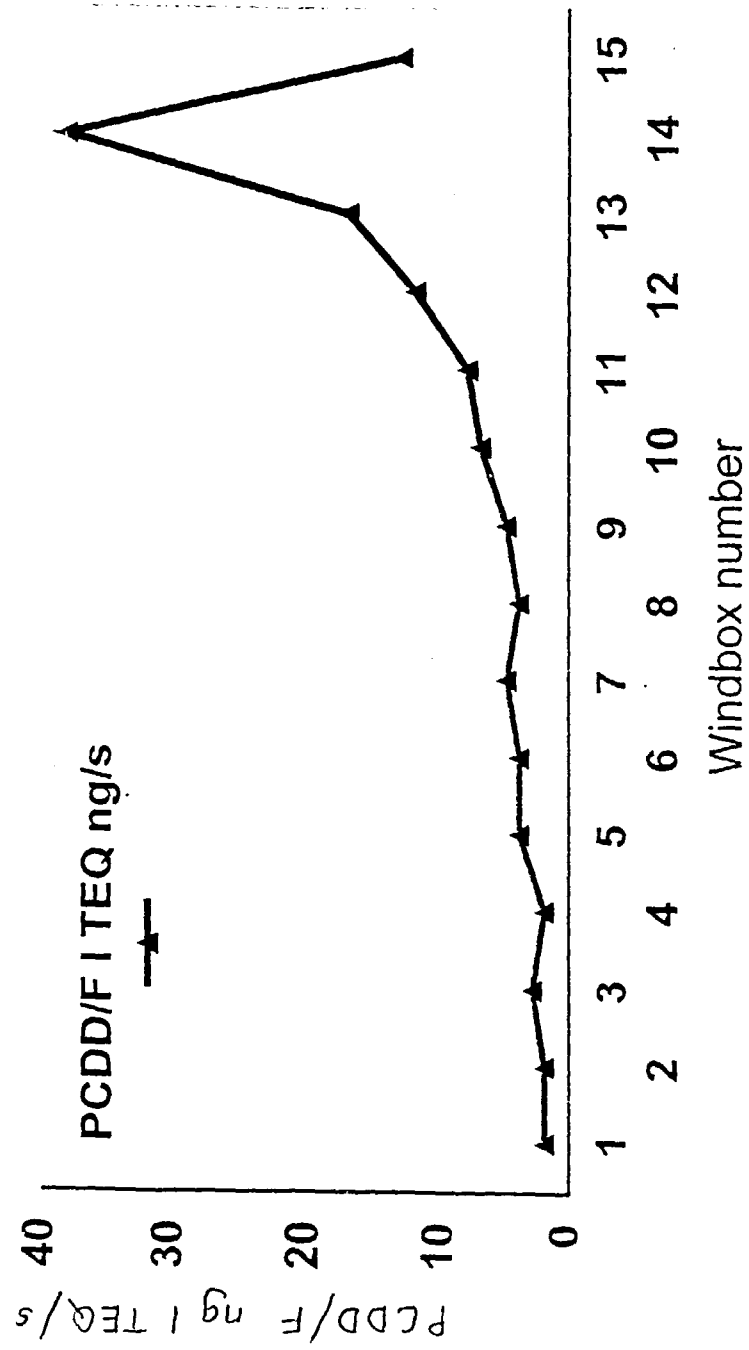


FIGURE 2

Relation between PCDD/F formation and windbox position



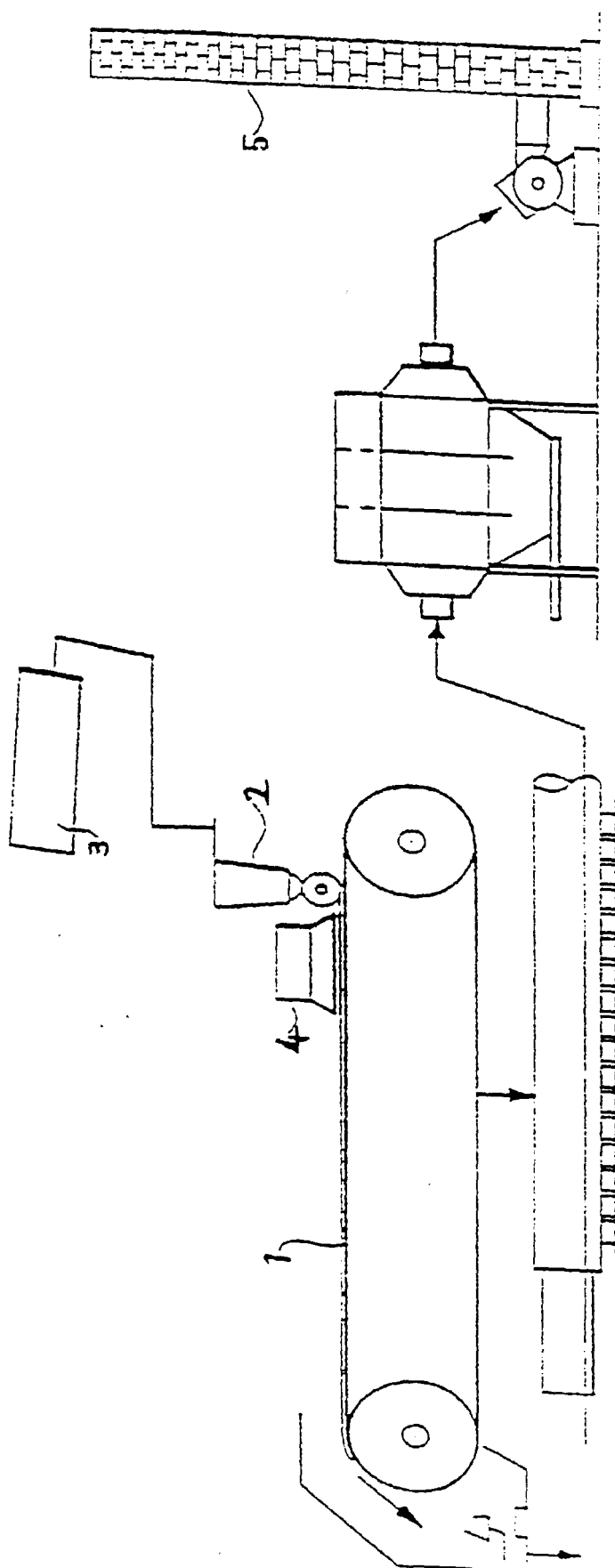


FIGURE 3