**Facts upon the destruction of Dioxins in the high temperature rotary kiln incineration plant,engineered and produced by BIC SYSTEMS.**

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**Definition of Dioxins.**

Dioxins are organic molecules,composed by Hydrogen-,Chlorine-and Oxygen atoms
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They consist of two chlorinated benzene rings,coupled to each other by one or two oxygen atoms.

When both (chlorinated) benzene rings are coupled by only **one** oxygen atom,the molecule is called di-benzofurane or dioxin-like or PCB

When both (chlorinated) benzene rings are coupled with **two** oxygen atoms,the molecule is called a DIOXIN.

The chlorine atoms can be attached to the dioxin molecule at any one of the eight positions of the benzene ring.The more chlorine,the more toxic and the more stable becomes the dioxin.
For example,four chlorine atoms at positions 2,3,7,8 on the benzene ring,forms a molecule,which is called 2,3,7,8 tetrachlorodibenzo-p-dioxin (TCCD) .
Its toxicity is the highest in its class and it is therefore used as a standard for the degree of toxicity to which dioxins are compared (Toxic Equivalence).

**Formation of Dioxins.**

Unlike PCB's (Polychlorinated bi-phenyls,with only one oxygen coupling between both benzene rings),which were used in several industrial applications,dioxins have no uses.

They are formed unintentionally and are predominantly released as by-products of human activities,such as incineration and fuel combustion.They are also generated by natural processes,such as forest fires and volcanoes.

Their formation and their formation "de novo"is mainly due to *incomplete combustion* in :

-incinerators
-open fires
-high furnaces
-cement kilns
-thermal engines (motorcars)
-cigarettes (combined with chlorine bleached paper)

*Incomplete combustion*,is a reaction or a process,which entails only partial burning of a fuel.This may be due to a **lack of oxygen** or to a **low temperature**.
Carbonmonoxide is produced as a by-product from incomplete combustion of carbon.

Dioxins are produced as a by-product from incomplete combustion of *organic material*,in the presence of chlorine.

*Organic material* means any chemical compound,based on a hydrocarbon chain or ring,where carbon shares electrons to create a strong covalent bond.

**Destruction of Dioxins.**

Due to their extreme stability,dioxins can only be totally destroyed by :

-homogenous high temperature (< 850°C)
-excess of oxygen (<6 %)
-sufficient residence time at high temperature (<2 sec)

In any other case,the dioxin molecules tend to “crack” into smaller but reactive ones,which reform into new dioxin molecules,especially in the presence of heavy metals, acting as catalysts.(Reformation and “de novo” formation).

**Capture of Dioxins**.

Dioxins,as most of complex organic molecules,adsorb partly or completely on certain porous surfaces,like (sintered) dust particulates,entrained in the flue gases or more specifically on adsorbants,of which the best known (and most used),is activated carbon.

Adsorbants do not destroy in any way the captured dioxins.They simply fix them,awaiting further processing (i.g.destruction by complete combustion).

**The high temperature rotary kiln incinerating plant,engineered and produced by BIC SYSTEMS :**

Combines all the required conditions for :

1/ **Preventing the Formation of Dioxins**,by assuring a complete combustion at all times.

This is first achieved by *a slow continuous feed rate*,which is controled by the combustion temperature and the supply of oxygen.

The combustion temature in the system is maintained,almost isothermally,at values situated between 1100 and 1200°C,by *self ignition* of the waste feed stock. (where 850°C is known to destroy all eventually generated dioxins).

Because the combustion temperature is generated by *self ignition* of the waste,the heat is very *homogenously* distributed troughout the system,unlike most systems, where one or more burners create “hot zones”,leaving other areas at significantly lower temperatures.

The *supply of oxygen* in the system is controled by adjusting continuously the negative pressure,assuring at all times an excess of oxygen of 14%,by aspiration. (while 6% of oxygen is recognised to be sufficient for a *complete combustion* and thus for preventing the formation of dioxins).

The rotation of the kiln,produces a continuous mixing of the burning material with the freshly supplied oxygen,creating the ideal conditions for a *complete combustion.*

Residues (ashes) containing,as an average,less than 0,5 % of remaining carbon (compared to the EPCA requirements of 2 %) and the extremely low emissions of carbonmonoxide (CO) of less than 20 mg/Nm3 (where the EPCA requires only 100 mg/Nm3 ),indicate that combustion is complete and that therefore the conditions for the formation of Dioxins are never met.

2/ **The Destruction of ( eventually formed ) Dioxins.**

The rotary kiln,featuring continuous and homogenous combustion at high temperature and overstoechiometric oxidation,is followed by an advanced *post combustion system.*

This post combustion system is heated by radiation and by heat transfer from the continuous hot flue gas flow, issued by the rotary kiln and **not** by burners,which assures an equally distributed heat pattern with constant temperatures varying between 1100°C and 1200°C.

Here too,an excess of oxygen,reaching values in excess of 14%,is continuously supplied,assuring full oxidation of eventual unburnt gaseous remainings.

The post combustion system is further designed to achieve a residence time of the flue gases of more than 3 seconds at 1100°C (compared to EPCA requirements of 2 seconds).

All the above enumerated conditions,well in excess of the minimum requirements of :

- Homogenous high temperature (<850°C)
- Excess of oxygen (<6%)
- Sufficient residence time at high temperature (<2 seconds)

assure that not only the conditions for the formation of Dioxins are never met,but also that in the unlikely case any Dioxin molecule would be accidently generated, or regenerated, it would be destroyed immediately.

3/ **The capture of (eventually remaining) Dioxins.**

It has been demonstrated that Dioxins tend to adsorb on certain porous surfaces,such as (sintered) solid particles which are present in the flue gas flow and also,but more specifically,on activated carbon.

The flue gas treatment system,designed and produced by BIC SYSTEMS,injects activated carbon before filtering all solid particles present in the flue gas,down to an extremely low level of 5 mg/Nm3 (100 mg/Nm3 is the EPCA requirement).

Should there be any doubt about eventually remaining Dioxins,being adsorbed on the filtered particulates,it would be advisable to feed them back to the incinerator for complete destruction.

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