

## A. 21st Century Poison—Dioxins

### Dioxins

It is the name of all compounds with two oxygen atoms and one pair of benzene compound, including about 210 types of compounds.

→75 types of polychlorinated dibenzo-p-dioxins, known as PCDDs

→35 types of polychlorinated dibenzofurans, known as PCDFs

### Toxicity of Dioxins

→Carcinogenic, hard-to-be-decomposed, accumulative in organisms

→Chronic accumulative in environment, hazard to human through food chain

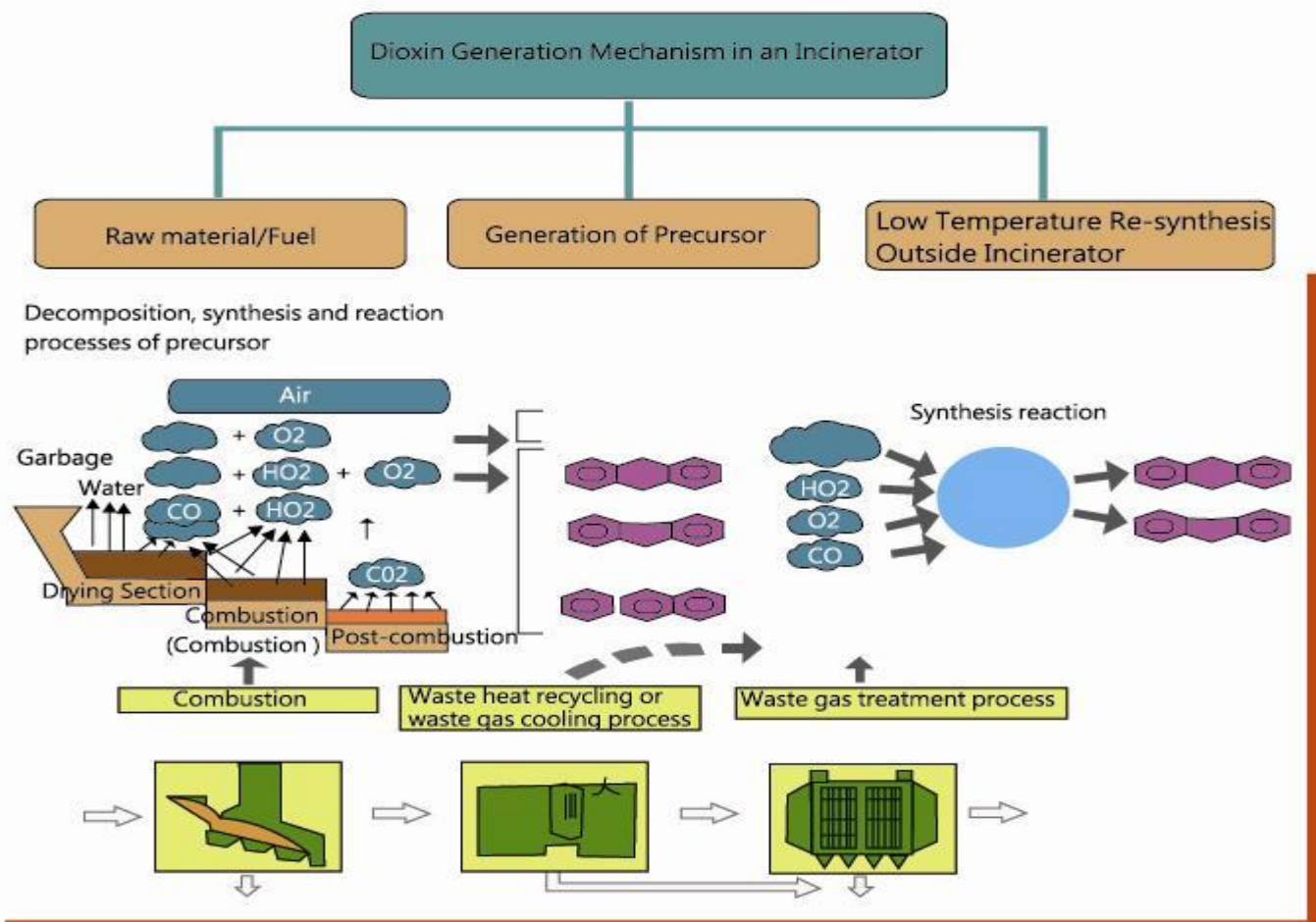
→Categorized as Restrained Persistent Organic Pollutant (POPs)—Stockholm Convention on persistent organic pollutants

### Exposure Paths of Dioxins

→Air->Plant->Animal

## B. Dioxin Generation Mechanism in an Incinerator

### B. Dioxin Generation Mechanism in an Incineration Plant



# C. Dioxin Emission Prevention Technology in Incinerator

## Dioxin Control Principles in Incinerator

- Avoid incinerating waste fluid or solid waste containing dioxin or its precursors.
- Facilitate dioxin decomposition inside the incinerator.
- Prevent re-generation of dioxin at low temperature environment
- Improve air pollution prevention equipment

## Dioxin Control Technology

### → Combustion Mechanism Control

- If the temperature in re-combustion space is high enough, retention time is long enough, and air turbulence is fair, complete combustion can be easily achieved. Thus, dioxins' major precursors, such as Chlorobenzenes and chlorophenols, are not easy to be generated.
- When the breakdown is kept fuel-rich in the combustion space and fuel-lean in the re-combustion space, the generation of Cl- and Cl<sub>2</sub> and follow-up synthesis of dioxin can also be effectively restrained.
- Dioxins would re-generate in low temperature. The regeneration temperature is 250°C ~400°C. Thus, if the temperature in cooling tower can drop to under 250°C rapidly, dioxin re-generation will be prevented effectively.

## Post Combustion Space Control

### → Active Carbon Adsorption

- ?● Adsorbing dioxins with activated carbon

???? 1. fixed-bed filters

???? 2. carbon entrained combined with fabric filtration

???? 3. carbon injection

### → Catalyst Oxidation

- ?● Decomposing dioxins to CO and HCl by catalysis of metal oxides, such as Pt/Al<sub>2</sub>O<sub>3</sub>, V<sub>2</sub>O<sub>5</sub>/TiO<sub>2</sub> and Fe<sub>2</sub>O<sub>3</sub>/TiO<sub>2</sub>. Following methods can be used:

???? 1. fixed-bed filters, with operation temperature at 170°C ~350°C

???? 2. injecting catalyst particles into exhaust flue

### → Re-heat Decomposition

- ?● Using heat-retaining feature of ceramic filter material, to preheat the waste gas and to save fuel cost

- ?● Breakdown the generated dioxins with heat decomposition method

???? 1. Temperature is between 850°C ~950°C

???? 2. Reaction time is below 1 second

- ?● Set behind the leading windmill

## D. Dioxin Control in Middle and Small Incinerators

### Application of the Standard

→ Industrial waste incinerators

→ General waste incinerators with design treatment amount < 10 tons/hr

### Pollution Regulation Items:

→ Dioxins???? ● Ng-TEQ/Nm<sup>3</sup>

Application Scope and Date of Regulation <sup>Ⓟ</sup>			Treatment Amount <sup>Ⓟ</sup>				
			4.0 Ton/h <sup>Ⓟ</sup>		10.0 Ton/h <sup>Ⓟ</sup>		
Waste <sup>Ⓟ</sup>	Existing / New established <sup>Ⓟ</sup>		Application Date <sup>Ⓟ</sup>	lower <sup>Ⓟ</sup>	equal or higher <sup>Ⓟ</sup>	lower <sup>Ⓟ</sup>	equal or higher <sup>Ⓟ</sup>
General <sup>Ⓟ</sup>	01/01/2001 <sup>Ⓟ</sup>	exist <sup>Ⓟ</sup>	> 4 T/h <sup>Ⓟ</sup> 01/01/2003 <sup>Ⓟ</sup>	0.5 <sup>Ⓟ</sup>	0.1 <sup>Ⓟ</sup>	Not Applicable <sup>Ⓟ</sup>	
			< 4 T/h <sup>Ⓟ</sup> 01/01/2004 <sup>Ⓟ</sup>				
	new <sup>Ⓟ</sup>	01/01/2001 <sup>Ⓟ</sup>	0.5 <sup>Ⓟ</sup>	0.1 <sup>Ⓟ</sup>			
Industrial <sup>Ⓟ</sup>	01/01/2001 <sup>Ⓟ</sup>	exist <sup>Ⓟ</sup>	> 4 T/h <sup>Ⓟ</sup> 01/01/2003 <sup>Ⓟ</sup>	0.5 <sup>Ⓟ</sup>	0.1 <sup>Ⓟ</sup>		
			< 4 T/h <sup>Ⓟ</sup> 01/01/2004 <sup>Ⓟ</sup>				
	new <sup>Ⓟ</sup>	01/01/2001 <sup>Ⓟ</sup>	0.5 <sup>Ⓟ</sup>	0.1 <sup>Ⓟ</sup>			

Emission standard: Ng-TEQ/Nm<sup>3</sup><sup>Ⓟ</sup>

Data Source: Dioxin Control and Emission Standard in Middle and Small Incinerators<sup>Ⓟ</sup>

## *What is TEQ?*

*Toxicity Equivalency Quantity is the toxicity weight equivalent to the concentration of dioxins.*

### Middle and Small Incinerator Control Specification—Operation Standard and Height of Exhaust Flue

→ Burning temperature

??? ● The hourly average of the burning temperature at the secondary air injection entrance shall be  $>850^{\circ}\text{C}$

→ Gas retention time

?●  $> 2$  seconds (new)

?●  $> 1$  second (existing)

→ Hourly kinetic average of CO at the exhaust flue exit

?●  $<100\text{ppm}$

→ Oxygen content in exhaust gas

?●  $> 6\%$

→ Waste gas temperature at the entrance of dust collector

?●  $< 200^{\circ}\text{C}$  (new)

?●  $< 280^{\circ}\text{C}$  (existing)

*For incinerators which can achieve equivalent outcome but not following the operation standard above, relevant proving documents may be submitted to the local authority to apply for operation in different standards.*

### Middle and Small Incinerator Control Specification—Operation Standard and Height of Exhaust Flue

→ Relevant regulations for operation, maintenance and recording of pollution prevention equipment?

??? ● For incinerators which reduce dioxin emission by using activated carbon injection equipment, the hourly activated carbon injection amount shall be recorded.

?● When an incinerator is normally operated, the activated carbon injection amount shall not be lower than the hourly average of the same-specification activated carbon used in the latest sampling which fulfills dioxin emission standard.

?● During operation, if the specification of activated carbon is changed, or the injection amount is decreased, the dioxin emission shall be sampled and analyzed again, to re-determine the lower limit of injection amount

→ Relevant Regulations for Starting Incinerator

?● The combustion-supporting burner shall be ignited first to rapidly raise the incinerator temperature, then the waste can be inputted.

→ Relevant Regulations for Stopping Incinerator

?● The combustion-supporting burner shall be ignited to keep high temperature in the incinerator and burn off all remaining waste; or stop air entering combustion space and start fire carrying out to reduce exhaust gas emissions.

→ Relevant Regulations for Height of Exhaust Flue

?● Treatment amount  $\geq 4$  Tons/hr, the height of exhaust flue shall be  $> 50\text{m}$

?● Treatment amount  $< 4$  Tons/hr, the height of exhaust flue shall be  $> 20\text{m}$

### Middle and Small Incinerator Control Specification

→For incinerators with one of the following condition, the operators may submit related documents to local authority for approval. They shall be regulated per the approved operation standards and the height of exhaust flue.

?●For incinerators which can not follow the operation standard above, another operation standard fulfilling dioxin emission standard may be submitted to apply for substitution.

?●For existing incinerators that are not installed with exhaust flues per the height specification above, if the carcinogenic risk of its emitted dioxin air pollutant is under 1 ppm, its exhaust flue height may be applied for substitution.

→Incinerators shall have monitoring equipment that can display operation condition immediately.

?●Monitoring result shall be recorded every hour.

?●On the 15th of every month, the monitoring and operation records of the former month shall be submitted to the local authority. Incinerators, that are not installed with the former monitoring equipment and recorded, may be monitored, recorded and submitted by other methods after approved by the local authority.

### **E. Sampling and Inspection Methods of Dioxins**

#### Sampling Method (NIEA A807.75C)

→14 institutes have been qualified by Environmental Analysis Laboratory.

→Dioxins and PCDFs contained in flue exhausted particles and gaseous materials are extracted in constant velocity and collected by sampling tube, filtering paper and adsorbent filled in adsorbing tube. After sampling, the sampling tube shall be washed in the order of acetone, methylene dichloride and toluene, in order to recycle the sample,

#### Inspection Method of Dioxins and PCDFs in Exhaust Flues (NIEA A808.74B)

→6 institutes have been qualified by Environmental Analysis Laboratory.

→Collect dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) in the flue by XAD-2 adsorbing tube, glass fiber filter paper and relevant sampling washing solvent. After completing extraction, concentration and purification, by using 13-C Isotope Dilution Method, one can then separate the component with gas chromatographer (GC), and analyze with High-Resolution Mass Spectrometer (HRMS), to determine the total toxicity equivalent quantity (TEQ) concentration of 2,3,7,8-chlorinated dioxins and PCDFs in Item 17.

For other questions about inspection, please check the website of Environmental Analysis Laboratory

→<http://www.niea.gov.tw/english/a001.htm>