September 26TH , 2008

Radicalplanet Technology Based on Mechano-Chemical Principle

Officially Granted by the Notification (No.25, April 1, 2004)

Chemical Reaction by using Mechanical Energy

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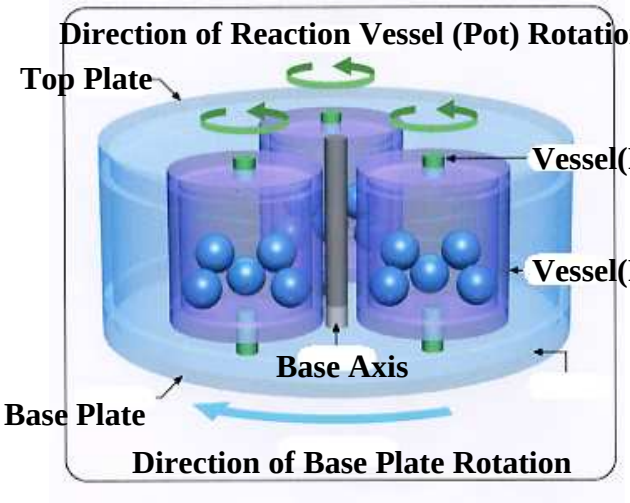
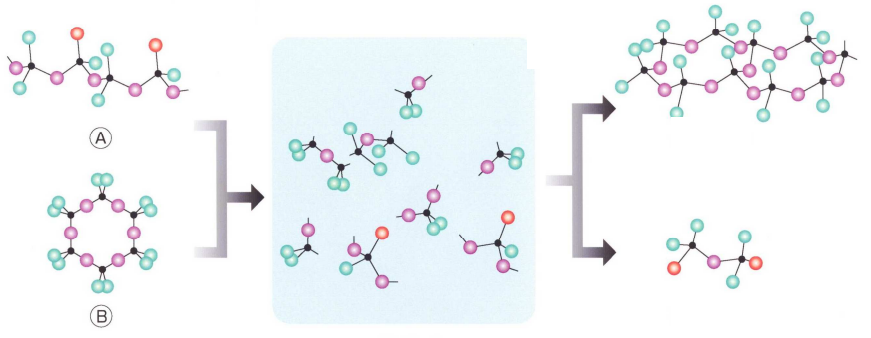
http://www.radicalplanet.co.jp/en

Principle of Mechano-Chemical Reaction



Grinding + Chemical Reaction



Raw Materials → **Radical State** → New Materials

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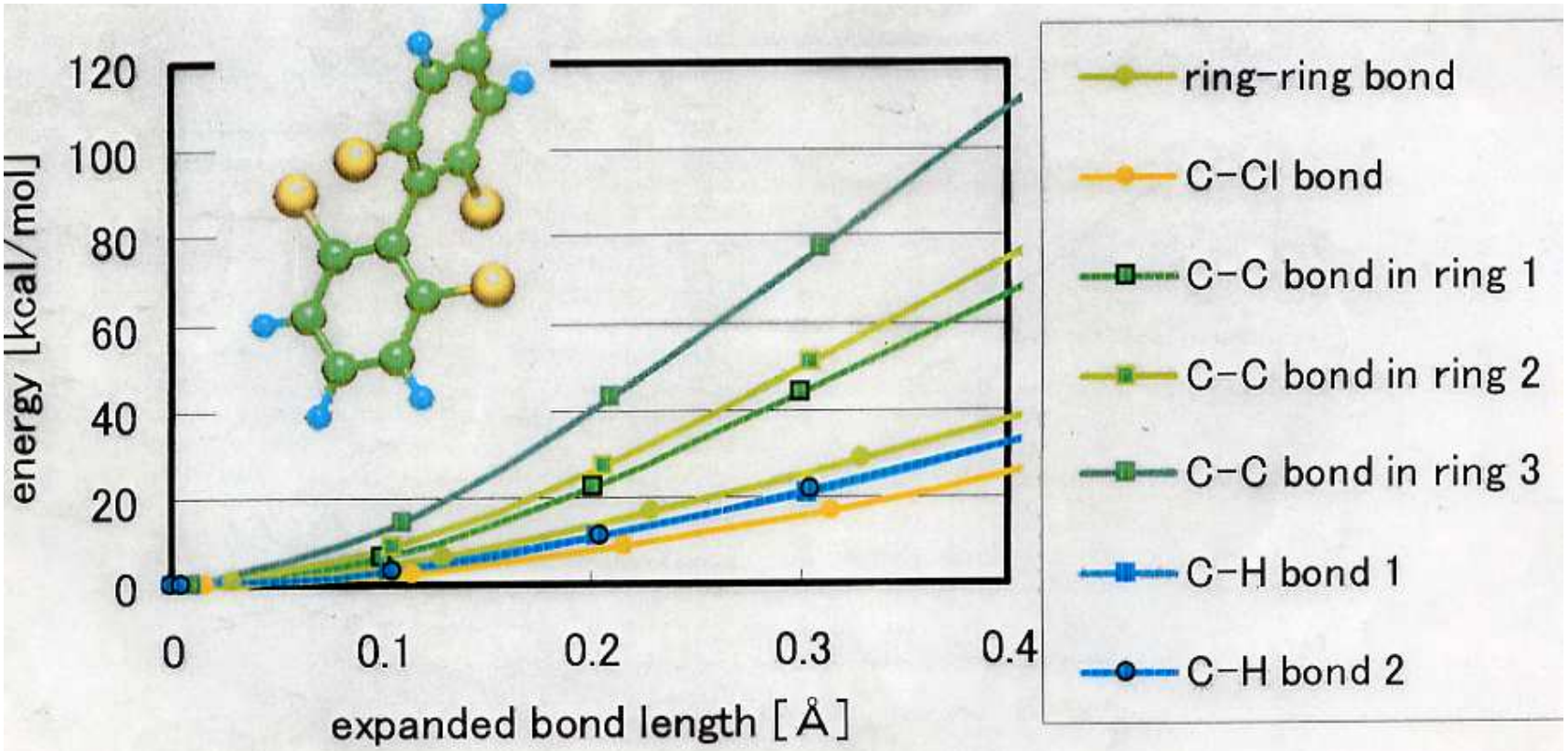
C-Cl Bond is most weak bond in this molecule (2,6,2',6'-PCB)

Given from F. Saito(Tohoku University)



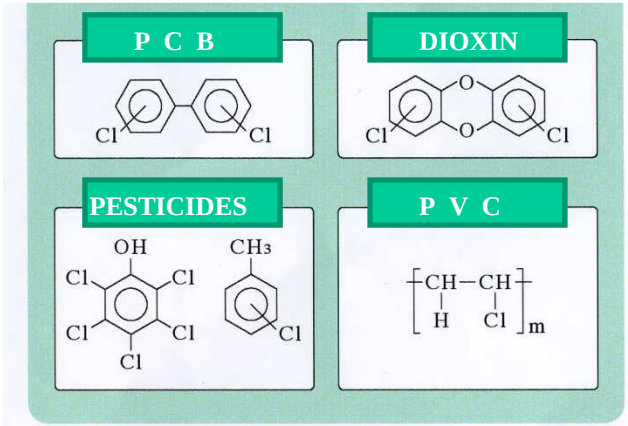
Relationships between expanded bond length and energy growth of 2,6,2',6'-PCB molecule

*C-Cl bond is most weak bond in this molecule.

*The bond between benzene ring is weaker than other C-C bonds, as weak as C-H bonds.

The Chlorine in organic compounds reacts chemically with CaO and changed to safety inorganic compounds, $CaCl_2$

Organic Compounds with chlorine

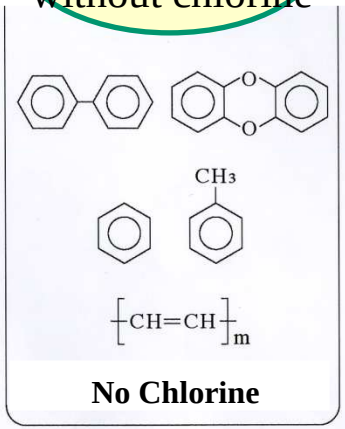


+CaO

Radicalplanet Treatment

No-Combustion
No-Exhaust gas
No-Effluents

Organic Compounds without chlorine



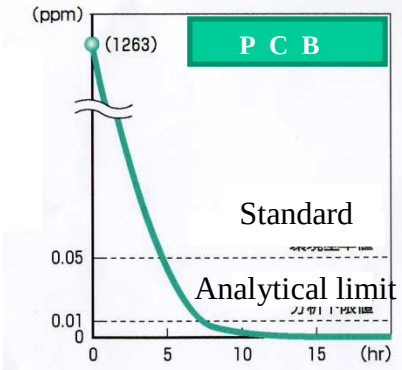
No Chlorine

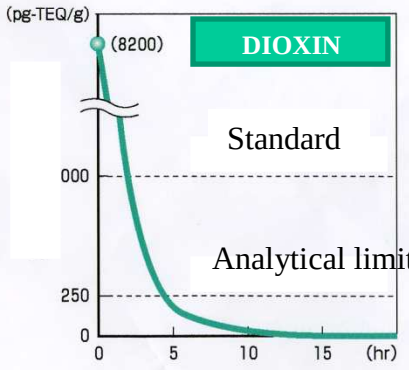
Inorganic Compounds with chlorine

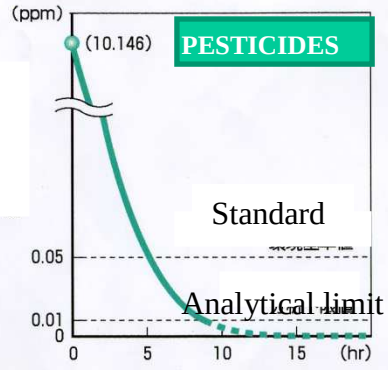
$CaCl_2$

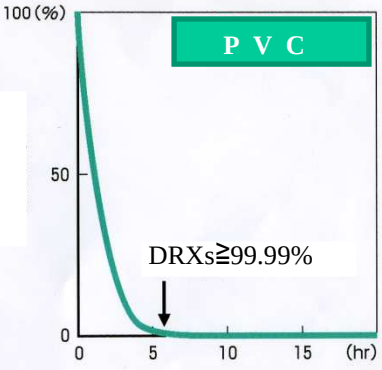
$Ca(OHCl)$

Behaviors of organic compounds during Radicalplanet treatment

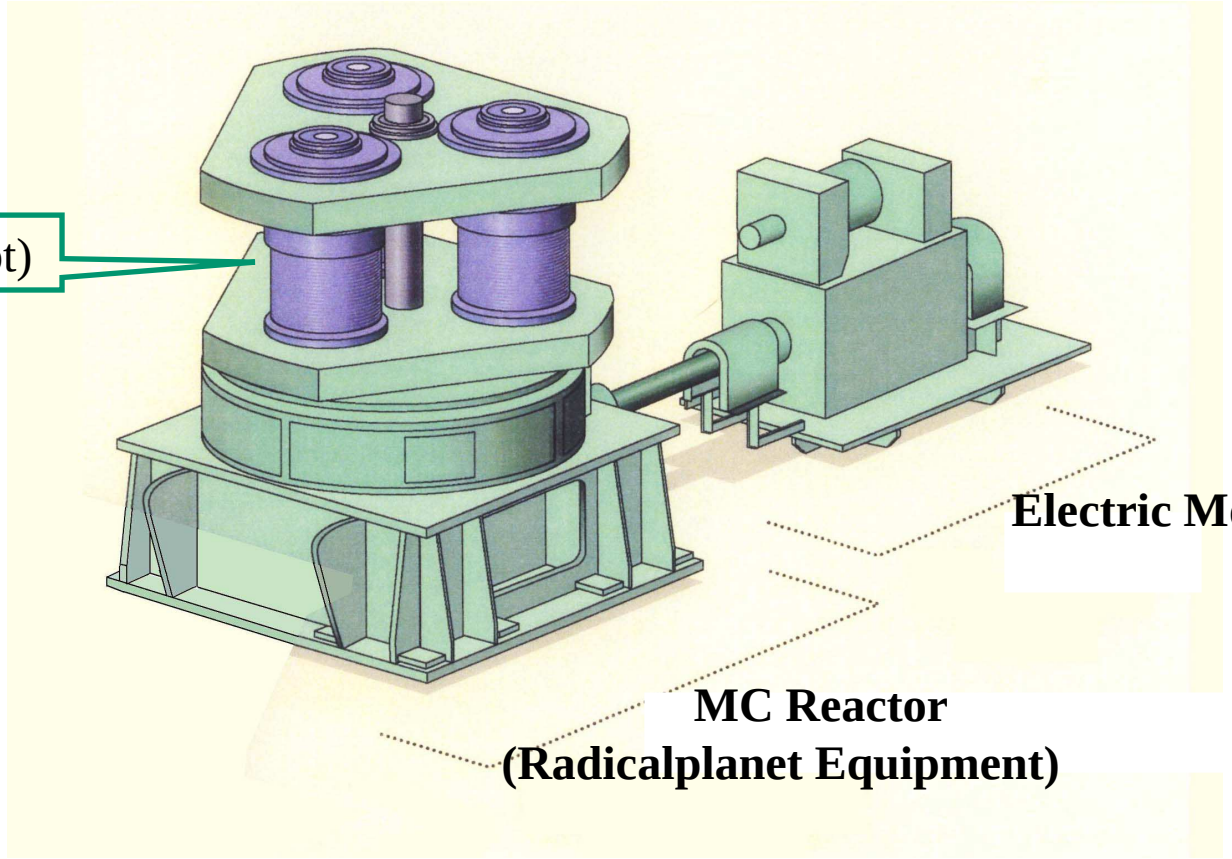








Schematic Profile of Main Equipment



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Radicalplanet Technology | Equipment

E-200 Type

Produced by Sumitomo Heavy Industries Techno-Fort Co.,Ltd.

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Applicable Pesticides and related POPs wastes

1. Materials

(1) PCP, Chlordane, BHC, DDT, Endrin, PCB, DXNs, ・ ・ ・
(2) Mixture of Pesticides and related POPs wastes
(3) Admixture (Soil, Stone, Concrete, Glass, Metal, Plastics) polluted by PCB oil and POPs wastes
(4) Fly ash and Incineration ash polluted by DXNs

2. Form and Conditions

(1) Solid and Powder
(2) Liquid and Emulsion
(3) Contaminated Materials (Fluorescent Stabilizer, Impact Paper)
(4) Admixture of POPs wastes

Main Process (Detoxification Treatment)

Target Substance → Radicalplanet Treatment → Safe and Fine Powder

Steel Balls and CaO

Steel Vessel (Pot)

Closed System

No Exhaust Gas and No Effluents

Closed

Opened

Powder Collection

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Pesticides and Agricultural Chemicals are stocked
in the basement and buried under the ground in Japan.

Stock house

Under the ground
in parking aria

Basement in the stock house

Under the ground
in fruits park

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Japan

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Let’s dig the Pesticides and Agricultural Chemicals from the ground !!!

Refill into the drums!!!

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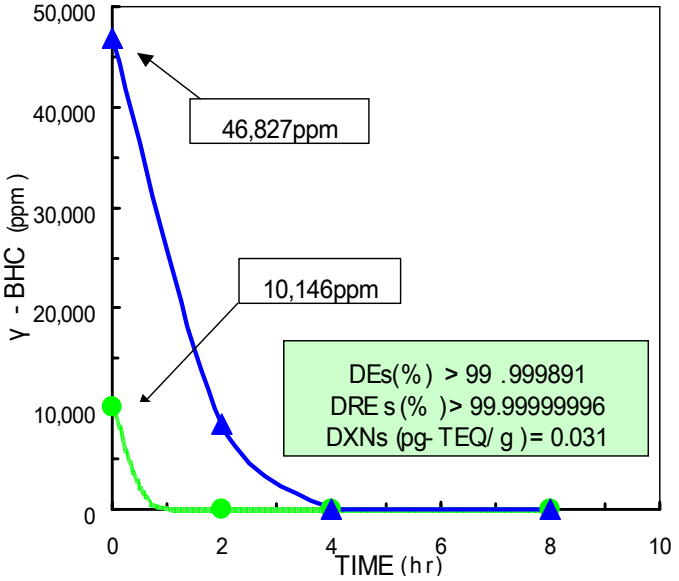
BHC（Agricultural Chemicals）Destruction Treatments

Liquid

(Powder)

Results of Radicalplanet Treatment



Effects of Rotation Speed

Rotaison Speed (rpm)	NOW		Calcurated Rotation Speed		
	70		140	210	280
0	10,146	46,827ppm (97.4%)			
1	(-)	(-)	(20)	(0.15)	ND(< 0.01)
2	0.52	8,400	(0.15)	ND(< 0.01)	↓
4	0.07	22.2	ND(< 0.01)	↓	↓
8	0.04	0.14	↓	↓	↓
16	ND (< 0.01)	0.08	↓	↓	↓

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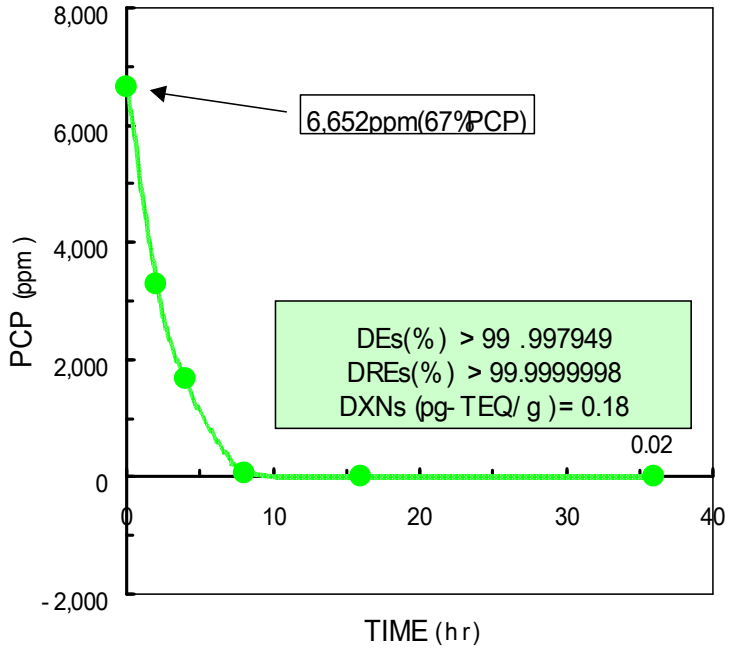
PCP（Agricultural Chemical）Destruction Treatments

Effects of Rotation Speed

Rotaison Speed (rpm)	NOW	Calcurated Rotation Speed		
	70	140	210	280
0	6 .652ppm (67%)			
1	(-)	(1,600)	(50)	ND(< 1.0)
2	3.297	(50)	ND(< 1.0)	
4	1.685	ND(< 1.0)		
8	56			
16	0.63			
36	0.02			

Results of Radicalplanet Treatment



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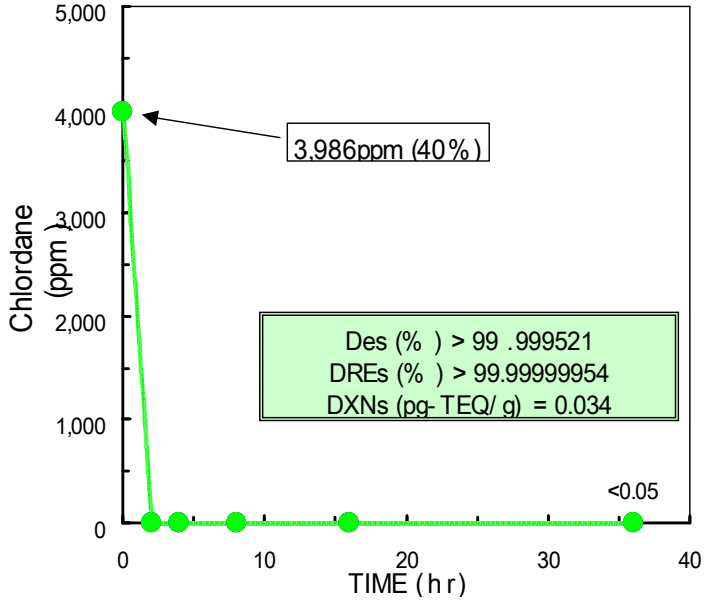
Radicalplanet Technology Treatments

Chlordane（Agricultural Chemicals）Destruction

Results of Radicalplanet Treatment



Effects of Rotation Speed

(Unit : ppm)

Rotation Speed (rpm) TIME(Hr)	NOW	Calcurated Rotaion Speed		
	70	140	210	280
0	3,986ppm(40%)			
1	(-)	(0.6)	(<0.05)	(<0.05)
2	5.32	(<0.05)		
4	0.61			
8	<0.05			
16	<0.05			
36	<0.05			

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Destruction of Mixed Agricultural Chemicals

Admixture of Powder

DDT Powder(2.5kg)

BHC Powder(2.5kg)

Endrin Powder(2.0kg)

Radicalplanet treatment

Results of Radicalplanet Treatment

(Unit :mg/ kg)

		8Hrs After
DDT	op' DDT	<0.001
	pp' DDT	<0.001
	pp' DDD	<0.001
	pp' DDE	0.003
BHC	α BHC	<0.001
	β BHC	<0.001
	γ BHC	<0.001
	δ BHC	<0.001
Endrin		<0.001

Without any Admixture Conditions (Baggage Shape and Material)

POPs Wastes Weights : 20~80kg / Charge

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Radicalplanet Technology

Pesticides Treatment Technology Fact Sheet (IHPA)

IHPA=international HCH and pesticides association

Vendor		Radicalplanet Research Institute co. Ltd.(former Sumitomometals co,Ltd.)							
Name of Process		Radicalplanet Technology							
POPs Wastes	Name	PCP	chlordane	BHC		chlordane	BHC	DDT	Endrin
	figure or state	liquid	emulsion	liquid		emulsion	admixture of powder (underground)		
	Input Weight(kg)	0.7	0.7	0.7	3.5	3.5	2.5	2.5	2
	DXNs(pg-TEQ/g)	1,600,000	990	26	26	190			
Agency for dechlorination: CaO		57.6	69.3	55.2	57.6	55.3	63		
The other added agency: SiO2		11.7	0	11.3	11.7	11.2	0		
Resules after Using Radicalplanet Technology									
Exhaust gas		non							
Effluents		non							
Powder	Weight(kg)	70.1	71.2	68.1	73.9	71.2	71.5		
	DEs(%)	> 99.997949	> 99.997530	> 99.999490	> 99.999891	> 99.999521	> 99.998903	> 99.999342	> 99.997943
	DREs(%)	> 99.9999998	> 99.999996	> 99.999999	> 99.999999	> 99.999999	> 99.999998	> 99.999998	> 99.99999681
	DXNs(pg-TEQ/g)	0.18	0.034	0.14	0.031	6.2	0.12		
Cooling water for machine(L)		15,000							
	DXNs(pg-TEQ/g)	0.016		0.024		0.056	0.056		
Powdr collectin gas (m3)		0.85	0.92	0.88	0.88	0.92	0.85		
	DXNs(pg-TEQ/m3N)	0.52	0.5	0.0023		0.00011	0.0024		

DEs :破壊効率(%)、DREs :破壊除去効率(%)

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Destruction Treatment of Mixed Wastes

POPs Wastes

Concrete ,Soil

Plastic Masks

Cloth Gloves

Protective clothing

Chipped Wood

Pieces of Paper

Pieces of PP,PVC

Pipes and Can made of Metal

Mixed Wastes in Vessel

Destruction

Powder after Treatment

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PCB（PCB-Oil and Mixed-Oil）Destruction Treatments

Results of PCB Concentration

Time(Hr)	PCB (mg/kg)
0	256
16	ND(<0.01)
32	ND(<0.01)
64	ND(<0.01)

Results of DXNs Concentration

DXNs (pg-TEQ/g)		
PCDDs+PCDFs	Co-PCB	Total
0.0020	0.0043	0.0063

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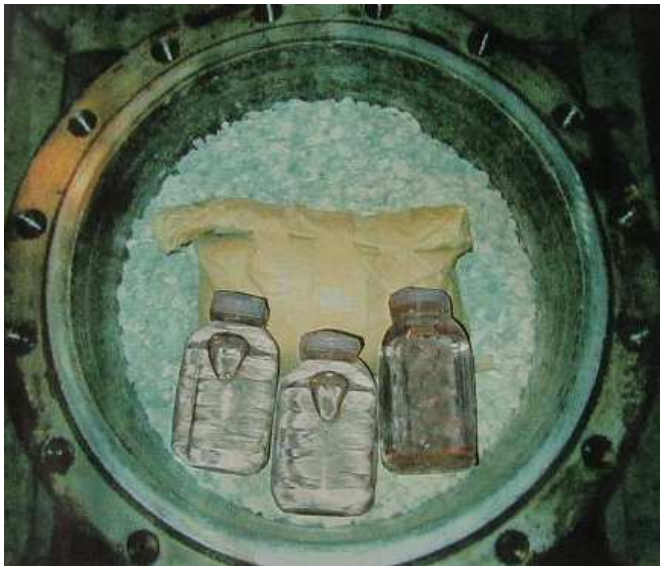
Radicalplanet Technology **PCB（Soil polluted by PCB） Destruction**

Treatments



Results of PCB Concentration

Time(Hr)	PCB (mg/kg)
0	1,283
16	1.5
32	0.12
64	ND(<0.01)

Results of DXNs Concentration

DXNs (pg-TEQ/g)		
PCDDs+PCDFs	Co-PCB	Total
0.00037	0.0041	0.0045

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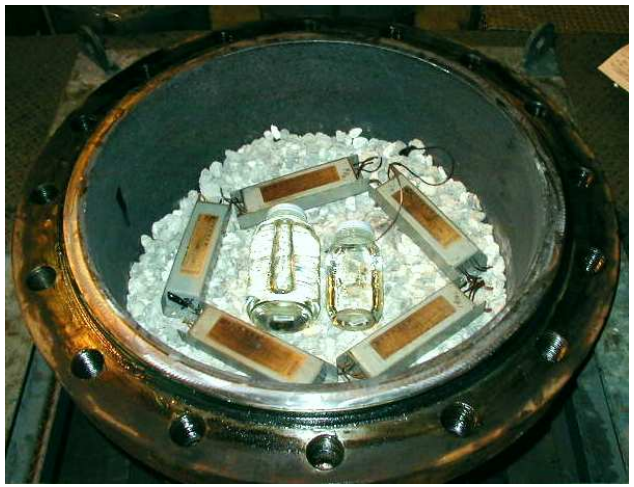
Radicalplanet Technology　PCB（Stabilizer containing PCB）Destruction Treatments



Results of PCB Concentration

Time(Hr)	PCB (mg/kg)
0	1,263
16	ND(<0.01)
32	ND(<0.01)
64	ND(<0.01)

Results of DXNs Concentration

DXNs (pg-TEQ/g)		
PCDDs+PCDFs	Co-PCB	Total
0	0.00027	0.00027

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Let’s repack the Soil contaminated by Dioxin !!!

Combustion furnace

Soil, which was contaminated by Dioxin, was stocked inside the concrete aria

Repackage into Rayon Bags

Radicalplanet Process

Pre-Treatment

Radicalplanet Treatment

E-500 (Recommended)

After-Treatment

Pesticides and POPs Wastes in Big Package (200～500kg Drums or Cloth) (Harmful Compounds)

Re-package (If needed)

Pre-treatment

Small Package (～20kg) [Vinyl or Double Paper Bags]

Put the Bags into Vessels

Radicalplanet Treatment

Vessel (Before)

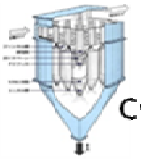
Closed System

Detoxification Reaction

Vessel (After)

E-500 (Recommended)

After-treatment



Cyclone

Powder Collection

Cyclone + Bag Filter

Safe Useful Materials (DXNs≦1pg-TEQ/g)

Example : Tetra Pots

Radicalplanet Technology　Destruction Treatments　(Soil contaminated by DIOXIN)

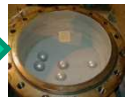
Pre-Treatment

Re-Package

DXNs Toxic Equivalent : 7,500 pg-TEQ/g

Radicalplanet Treatment

No Exhaust Gas
And No Effluents



Safe and Fine Powdered Particles

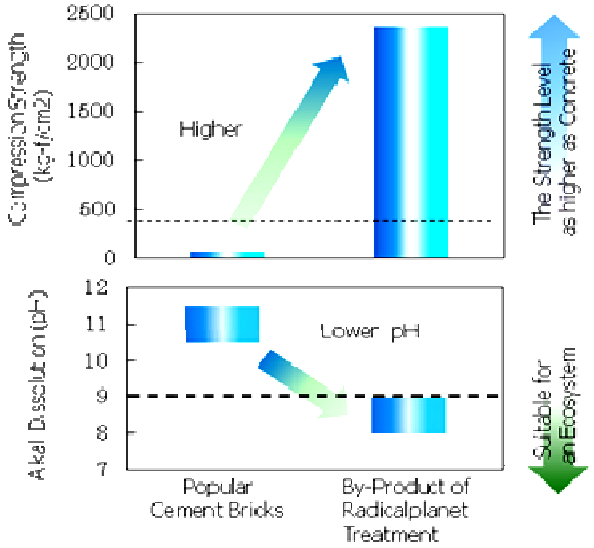
	Toxic Equivalent of DXNs (pg-TEQ/g)
Soil	0.0023～0.0030
Fly Ash	0.0052～0.012

Feature of reconstructed Materials which were ***solidified by mixing with water***

**Recycle Use for a high efficiency concrete

(1) The compression strength :
Increased as much as concrete strength

(2) The alkali dissolution (pH) :
Decreased as low as Ecosystem



Results (1) of Performance

Wastes Type	kg or tons treated	Concentration	Final Results DXNs (pg-TEQ/g)	Detoxification Agent
BHC	12kg	97% γ -BHC	0.031	CaO,EF-Slag
BHC	28kg	5%BHC	0.14	CaO
BHC	15.6kg	3%BHC	0.38	CaO
DDT (Powder)	18.5kg	5%DDT	0.08	CaO
DDT (ED-Powder)	5.2kg	2.5%DDT	0.18	CaO
Endrin	2kg	2%Endrin	0.28	CaO
DDT+Encrin+BHC	7kg	5%DDT,97%BHC,2%Endrin	0.12	CaO
PCP(Solution)	12.6kg	91%PCP	0.18	CaO,EF-Slag
Chlordane	12.6kg	95%Chlorcane	0.034	CaO
Chlordane	3.5kg	95%Chlorcane	6.2	EF-Slag
CPCNB	2kg	20%PCNB	0.54	CaO
PCB Oil	5g	100%PCB	0.031	CaO
PCB Oil	36kg	Pure-Oil(51.3%PCB +38.4%Trichloro-Benzen)	0.081	CaO
PCB Oil	39kg	8.6%Pure-Oil +91.4%Isolation-Oil	0.066	CaO
PCB Oil	45kg	0.7%Pure-Oil +99.3%Isolation-Oil	0.004	CaO
PCB Oil	125kg	4.28%Pure-Oil +95.72%Soil	0.004	CaO
PCB(Stablizer)	10kg	2%Pure-PCB	0.00027	CaO
PCB(Clothes)	12kg	0.2%Pure-Oil	0.0038	CaO
PCB(Mixed)	90kg	0.2%Pure-Oil	0.0018	CaO
Dioxin Soil	200kg	8,200 pg-TEQ/g	≦0.012	CaO
Dioxin burnt Ash	180kg	6,900 pg-TEQ/g	≦0.012	CaO
The Other				

Practical Use for the Pesticides wastes

We will recommend the use of A-500 Type.

A-500 Type : 3 Vessels (Each Inner-Volume : 500 liters)

Estimated : Decomposition Capacity Of One Equipment

Approximately : 500~677 tons/year
(Operation Time : 24 hours/ day)

Approximately : 165~210 tons/year
(Operation Time : 8 hours/ day)

***Depend on Figure and Concentration of Target Materials*

Standard Capacity and Electric Cost in A-500 type (One Plant / One Equipment) : 70 rpm

(*1)	Density (T/m3)	Kg/Charge (3 vessels)	Treat Time (hr)	Cycle Time (hr)	Work Time (hours)	Amount (t/day)	Amount (t/year)	Electric Cost (kw·h/ t)	Electric Cost (Mw·h/ y)
Pesticides A(s)	2	214	1.4	2.4	24	2.1	677(*2)	3,600	2,440
					8	0.6	219 (*3)		790
Pesticides B(L)	1.5	160	1.4	2.4	24	1.7	509(*2)	4,810	2,450
					8	0.5	165(*3)		790
PCB-OIL	2	75	2.0	3.0	24	0.6	190(*2)	14,670	2,790
					8	0.2	64(*3)		940
Stabilizer	3	113	2.0	3.0	24	0.9	284(*2)	9,730	2,760
					8	0.3	96(*3)		922
Soil polluted by Dioxin	3	1,125	1.4	2.4	24	11.4	3,555(*2)	684	2,430
					8	3.4	1,151(*3)		790

*1 : Treating Time and Capacity will depend on the concentration and conditions of the Element in POPs Wastes.

One Case: The concentration of γ-BHC will be supposed 5 % in the POPs Wastes.

One Case: The concentration of pure-PCB Oil will be supposed 0.4 % in the POPs Wastes.

*2 : 316 days/y : Machine Check= Two Days per Month and Machine Detail Check : 25 Days per Year

*3 : 341 days/y : Machine Check= After Work Time (1 hour) and Machine Detail Check : 25 Days per Year

Applicable Size of Pesticides and related POPs wastes

A Vessel of A-500 has one meter in diameter, 500 liters in volume :

The suitable receptacle-size of Pesticides and POPs wastes :

1. Maximum Weight:
   20~25kg / piece
2. Maximum Size:
   (30cm×45cm×10cm) /piece

Acceptable Receptacles

1. Card board
2. Plastic box
3. Glass bottle
4. Rayon bag
5. Thin metal can

**** If : Large drum (200 liters) and the other large one :***

These Pesticides and POPs wastes
should be **repackaged** to the above size.

Durability of the Equipment A-500 Type

The Life of the Main Machine will be estimated 17 years.

1. The current consumption of sections :
   Vessels and Steel Balls are estimated 2~3 years.
2. The current consumption of elements :
   Bearings and Axes are estimated 2 years.

**Depend on the conditions of operation*

Maintenance for the Main Machine

1. Machine Check :
   Daily check will be performed on the manual book.
2. Machine Maintenance :
   Maker check will be performed in 25 days per year.

The Equipment A-500 Type (Maker)

Prices of A-500 Type :

One equipment price : Approximately 500 million yen
/ 4.5 million USD : (in January 2008)
/ 3.3 million EURO : (in March 2008)
[One Main Machine and One Electric Motor]

Rental or Lease Prices of A-500 Type :

One equipment price : Approx. 120 million yen/year
/ 0.8~1.1 million USD : (in January 2008)
[One Main Machine and One Electric Motor]
Option: you can buy the installation after 5 years.

Separate account :

- *Pre- Treatment Equipment : approx. 0.3 million USD*
- *After-Treatment Equipment : approx. 0.4 million USD*
- *Installation costs : approx. 0.7 million USD*
- . . . . . .

Summery

A. Resource needs

1. Power source : AC440V, 550kw, 3φ, 60Hz and AC 220V, 30kw
   <Diesel generator can be operated.>

2. Water requirements : Main treatment plant requires cooling water
   which is recycled through heat exchangers.

3. Gas volumes : No gas and no fuel is consumed in the detoxification reaction.
   After detoxification treatment , air or inert gas will be used for safe powder collection.

4. Reagents volumes : In this technology, the reagents such as CaO may be added.
   In order to treat one kilogram BHC Wastes,
   more than 1.5kg CaO is needed for detoxification.
   The all chlorine in BHC should be reacted with CaO and be changed to CaCl2.

5. Weather tight building : The main treatment plant and working field will be required
   to be protected from the rain, strong wind and the direct sun-shine.
   <The required space for installation is approx 500m2 (65m2 for the setting of E-500)>

Summery

B. Main Costs

1. Installation and commissioning costs

Amortization of plant is approx 880 EURO/ton (approx **1250** $/ton).

<A-500 : Approx 3.3 million EURO (4.7 million $) (*March 2008, in Japan*)>

<Plant Life is over 17 years and depreciation period is 7 years.>

<Standard Capacity is 2.1 tonnes/day, 677 tonnes/year, by use of one plant.>

<Application of Plant is not only destruction of Pesticides but also the others.>

2. Pre- and Post- treatment equipments cost

Amortization of plant is approx 200 EURO/ton (approx **285** $/ton).

<Equipments : Approx 0.55 million EURO (April 2008)>

<Plant Life is over 10 years and depreciation period is 5 years.>

3. Running costs

- Electric costs: approx 240 EURO/ton (approx **345** $/ton)

<Electrical Consumption :3,600 kw-h/ton>

<Fee of Electric : 0.067 EURO/kw-h>

- Supplies expenses and Maintenance costs: approx 180 EURO/ton (approx **256**$/ton)
- Number of personnel required: 2 (skilled labour and unskilled labour)

4. Impact

- No air emissions during the process. =No need for exhaust gas treatment.
- No water is generated in the process. =No need for effluents treatment.
- No combustion system is required in the process. =No generation of CO2 gas .

Summery

C. Risks

1. Risks of Reagents applied

Very safe agents are applied in this technology,
such as CaO which is popular material in soil.

2. Risks of technology

No risks.

- The practical scale machine E-200 was already operated in Japan and officially granted by the notification on April 1ST ,2004.
- The polluted materials never expand, because this process is a closed system and never generate the exhaust gas and effluents during detoxification reaction.

3. Operational Risks

No risks.

- At the emergency, the system can be shut down completely.
- At the earthquake and natural phenomena, the system is stopped safety, immediately, automatically and completely.
- After then, the system can be continued to operate again safety.
- During the stopped periods, the operating vessels are kept to be closed tightly.

Summery

D. Ease of shipping/ transit

The main machine of Radicalplanet treatment plant is simple and compact in transit.
The main machine can be separated into two pieces for transport by large-sized trucks.

A. Discharge of the plant at port

E-200 type

C. Plant carried on trailer

B. From ship to trailer

D. To the workshop

Mobility of the Equipment A-500 Type

The Equipments can be carried by trailer

On Site Treatment

Site B in area Y

On Site Treatment

Site A in area X

Separable:
Upper:32 tons
Lower:40 tons

This photo is the equipment E-200 (72 tons)

Why do we focus on Radicalplanet Technology ?

Non-heating Process

Closed System

Non-Exhaust Gas
Non-Effluents

High Safety

+

On-Site Treatment by Mobile Equipment

Lower cost and remove anxiety without transfer of pollutants

Community and Public acceptance with confidence

Radicalplanet is applicable to remediation of small site

From the Report by Prof.M.HOSOMI ; NATO/CCMS Pilot Study Meeting (July, 2006, ATHENS)

Radical Planet Japan

Radicalplanet Research Institute Co. Ltd.

What we have been performed in 1999 - 2003

1. Hazardous wastes (1) : Pesticides and POPs wastes, PCB-Oil and wastes, Stabilizer, Dioxin wastes,

This Radicalplanet Technology was officially granted by the Notification No. 25 of the Japanese Ministry of Environment in April, 2004.

2. Hazardous wastes (2) : Asbestos
3. PVC : Sheet, Pipes wastes
4. Soil : for High Strength Concrete
5. Metal : for Powdered Special Alloy
6. CD and Tape : for Erasure of Data File
7. Plastic wastes : for Fuel
8. Wood chips and Grass : for Bio-Plastic and Bio-Fuel
9. Metal and IT wastes : for Recycle of Noble Metal and Rear-Metal
10. The other materials : for making the suitable conditions

What we have been performed in 2003 -

1. 2003(April) :
   We founded up ‘Radicalplanet Research Institute Co. Ltd.’ .

> We would like to enlarge scientific knowledge of ‘Mechano-Chemical’,
> (1) Chemical Reaction proceed by mechanical energy,
> with Non-Combustion, Non-Exhaust Gas, Non-Effluents,
> (2)The practical scale machine has been manufactured, in 1999, and
> the chemical reaction has been shown by the practical scale machine.
> (3) This technology will supersede the incineration method.

2. 2004-2005 :
   E-200 Type Machine was improved in order to measure
   the inside-temperature and pressure of the Vessel.
3. 2006 :
   A-500 Type Machine was designed in order to perform on a large-scale.
4. 2006- :
   Looking for the new practical location of the E-200 equipment.
   Now there is a plan of re-construction of the E-200 equipment.

Radicalplanet Treatment for ASBESTOS

Asbestos

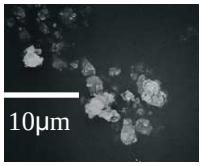
Fiber Plate

SEM

Radicalplanet Treatment

E-200 Type
(A-500 Type/Prepared)

Fine Powdered Particles



SEM

High Efficient Materials

Harmful For Health → **High Energy Grinding to Change the Composition** → Harmless Size, Shape and Composition → Solidification to Any Shape

Asbestos content:96%
Chrysotile
Amosite
Crosidolite

→ Radicalplanet Treatment

Microscopic: Spherical and Amorphous Particles

→ Solidify by Water

Observed Crystal Compositions
- Ca-Al-O System
- Ca-Al-Si-O System
- Mg-Al-Si-O System
- Si-O System

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Standard Capacity and Electric Cost in A-500 type (One Unit / Three Equipments) : 70 rpm

(*1)	Density (T/m3)	Kg/Charge (3 vessels) Each Machine	Treat Time (hr)	Cycle Time (hr)	Work Time (hours)	Amount (t/day)	Amount (t/year)	Electric Cost (kw·h/	Electric Cost (Mw·h/ y)
Pesticides A(S)	2	214	1.4	2.4	24	5.6	2,031 (*2)	3,600	7,310
					8	1.8	658 (*3)		2,370
Pesticides B(L)	1.5	160	1.4	2.4	24	4.2	1,524(*2)	4,810	7,330
					8	1.4	494(*3)		2,380
PCB-OIL	2	75	2.0	3.0	24	1.6	569(*2)	14,670	8,350
					8	0.5	192(*3)		2,820
Stabilizer	3	113	2.0	3.0	24	2.3	853(*2)	9,730	8,300
					8	0.8	288(*3)		2,800
Soil polluted by Dioxin	3	1,125	1.4	2.4	24	29.2	10,665(*2)	684	7,300
					8	9.5	3,453(*3)		2,360

*1 : Treating Time and Capacity will depend on the concentration and conditions of the Element in POPs Wastes.

One Case: The concentration of γ-BHC will be supposed 5 % in the POPs Wastes.

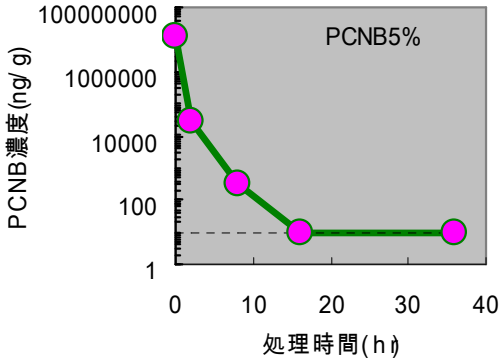
One Case: The concentration of pure-PCB Oil will be supposed 0.4 % in the POPs Wastes.

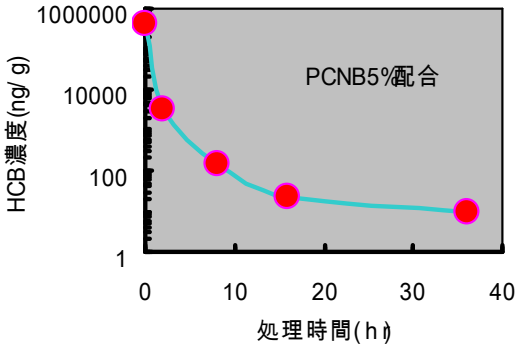
*2 : 316 days/y : Machine Check= Two Days per Month and Machine Detail Check : 25 Days per Year

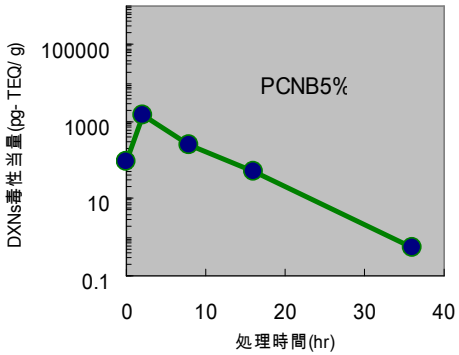
*3 : 341 days/y : Machine Check= After Work Time (1 hour) and Machine Detail Check : 25 Days per Year

Radicalplanet Technology

Destruction of Agricultural Chemical PCNB







TIME(Hr)	PCNB
0	11760000
2	28000
8	300
16	10
36	10

TIME(Hr)	HCB
0	395000
2	3400
8	150
16	22
36	10

TIME(Hr)	DXNs
0	95
2	1400
8	250
16	50
36	0.54

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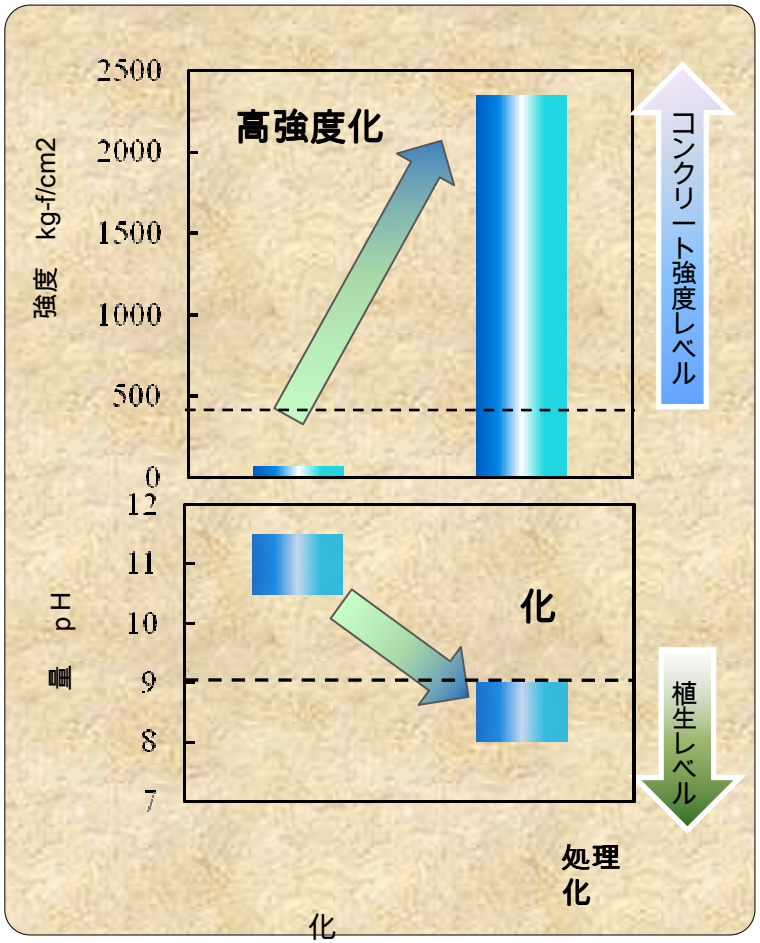
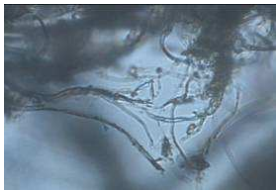

2500
2000
1500
1000
500
0
強度 kg-f/cm2
高強度化
コンクリート強度レベル
12
11
10
9
8
7
pH
量
化
植生レベル
処理
化
化

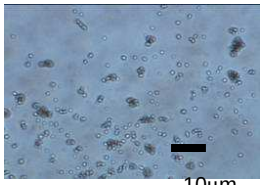
Radicalplanet Technology　Destruction of Asbestos Tohoku-Uni.



Harmful

Asbestos Fiber
(Chrysotile)

Mechanochemical Treatment
(Radicalplanet Technique)



Harmless Shape and Composition

Microscopic, Spherical and Amorphous Particles

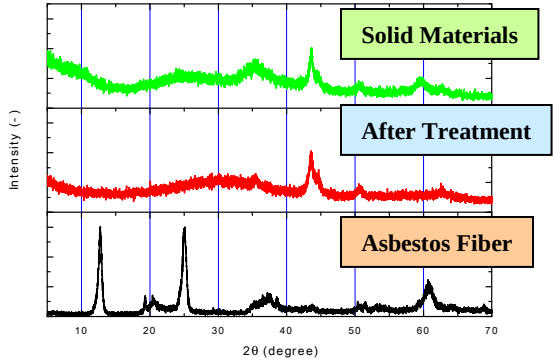
Solidification by Water
(Hold in a week , 60)

Solid Materials

High Tensile Strength or Good Materials for Plants

XRD Results A

[Asbestos Destruction Treatment]

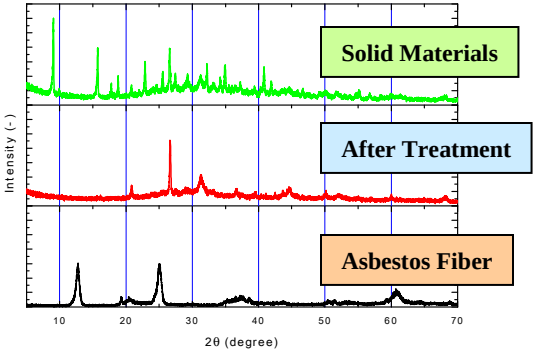


XRD Results C

[Asbestos (+Addition) Destruction Treatment]

[Observed Crystal Compositions]

Ca1.5SiO3.5·xH2O
Calcium Silicate Hydrate)
Mg4Al2(OH)12CO3·3H2O
(Quintinite-2H)、**SiO2** (Quartz)
Fe(Iron)、 **CaCO3**(vaterite)、
CaSO4!2H2O (Gypsum)、etc.



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Radicalplanet Technology

Destruction of Asbestos (Radicalplanet Co.Ltd.)

Asbestos Fiber

Radicalplenet Treatment

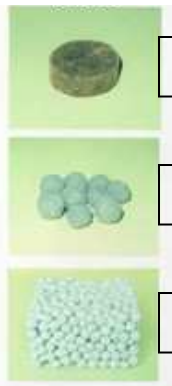
After Treatment

Solid Materials

Addition

E-200 Type Machine

Water



Tablets

Bricks

Pellets

Harmful for Health → **High Energy Grinding to change the composition** → **Harmless Size,Shape and Composition** → **Solidification To Any Shape**

Chrysotile 96% → **Microscopic, Spherical and Amorphous Particles**

[Observed Crystal Compositions]
Ca-Al-Si-O System
Ca-Al-O System
Mg-Al-Si-O System
SiO2 (Quartz), Fe, etc
Chrisotile System was not observed

High Tensile Strength or Good Materials for Plants

Radical Planet Japan

Radicalplanet Research Institute Co. Ltd.