

# **Circulating fluidized bed for Waste-to-energy China**

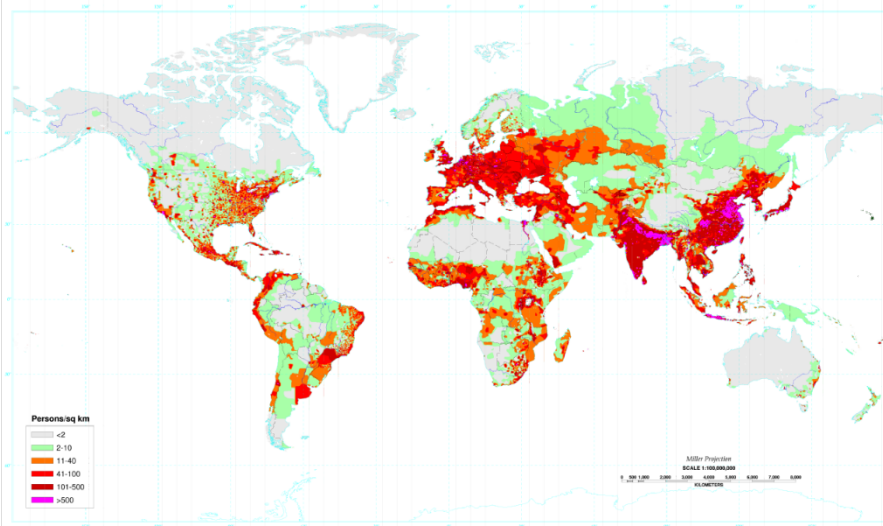


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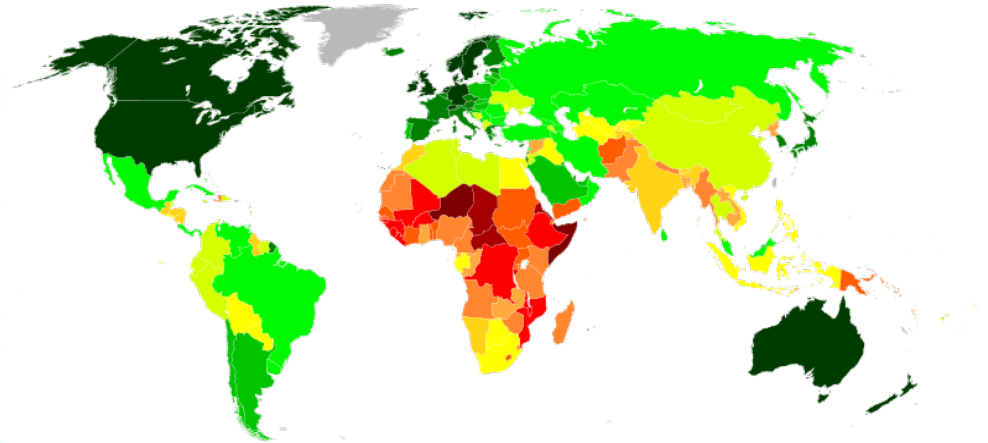


# China

- ◆ Largest population, 1.26 billion
- ◆ Fast urbanization
  - Beijing (\$10,000/m<sup>2</sup>)
  - Hangzhou (\$5,000/m<sup>2</sup>)
- ◆ Still developing country
  - Gross national income (GNI) per capital. **No.74**
  - Human development Index(HDI), **No.90**



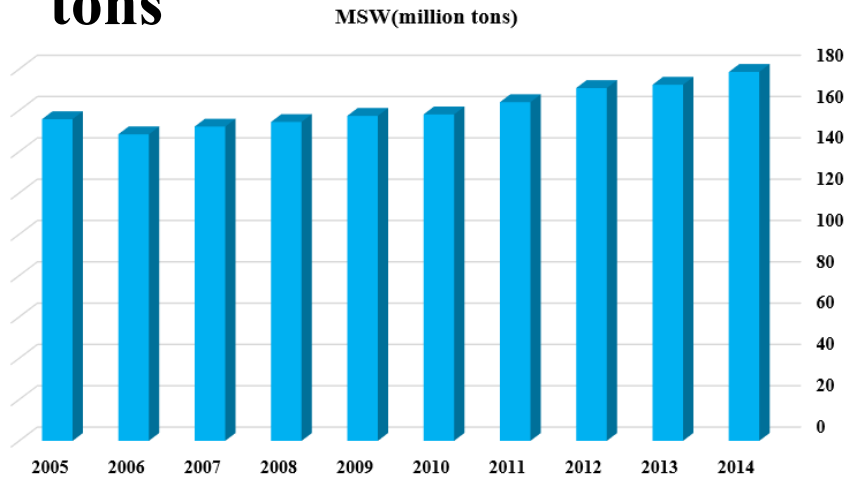
World population, 2012



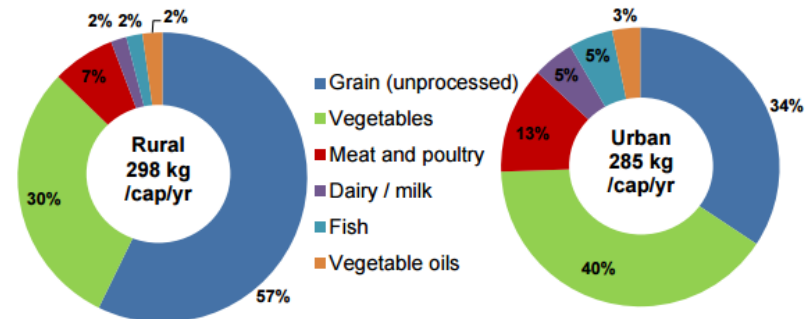
World human development index, 2014

# Municipal solid waste of China

## ◆ MSW Generation, 179 Million tons



[www.stats.gov.cn](http://www.stats.gov.cn), 2015



Gang Liu, 2013



# Village solid waste of China

◆ VSW Generation, over 110 Million tons, **>60% open dumping**





# Chinese MSW composition



# Composition (Manual sample data)

- ◆ High portion of moisture and incombustible components
- ◆ LHV:5000~6000 kJ/kg

|              | ORGANIC | INSEPERABLE | PAPER | TEXTILE | BIO  | PLASTIC | RUBBER | GLASS | METAL |
|--------------|---------|-------------|-------|---------|------|---------|--------|-------|-------|
| BELJING (1)  | 16.59   | 58.76       | 9.27  | 1.7     | 1.61 | 10.88   | /      |       | 1.19  |
| BELJING (2)  | 35.4    | 14.2        | 19.2  | 5.3     | 2.9  | 15.8    | /      | 3.79  | 1.4   |
| SHENGYANG    | 67.5    | 2.3         | 7.6   | 1.7     | 1.5  | 11      | /      | 2.8   | 0.5   |
| QINGDAO      | 42.2    | 36.1        | 4     | 3.2     |      | 11.2    | /      | 2.2   | 1.1   |
| XI'AN        | 15.74   | 63.52       | 3.35  | 2.48    | 3.94 | 7.93    | /      | 1.84  | 1.2   |
| ANHUI        | 67.6    | 19.5        | 4     | 0.6     |      | 1.7     | 3.6    | 2     | 1     |
| JIANGSU      | 44.4    | 34.6        | 3.56  | 3.15    | 1.8  | 7.95    | /      | 3.5   | 1.04  |
| PUDONG       | 55.33   | 11.13       | 12.3  | 2.64    | 0.78 | 13.98   | /      | 3.01  | 0.83  |
| SHANGHAI     | 67.33   | 1.37        | 8.77  | 1.9     | 1.27 | 13.48   | /      | 5.15  | 0.73  |
| CHONGQING    | 69.3    | 5           | 5.4   | 1.1     | 0.4  | 5       | /      | 3.9   | 1.2   |
| WUHAN(1)     | 52      | 19.78       | 7.12  | 1.42    | 1.71 | 9.29    | 0.56   | 7.14  | 0.98  |
| WUHAN(2)     | 60.65   | 8.9         | 12.16 | 1.17    | 1.53 | 9.08    | /      | 6.12  | 0.43  |
| WUHAN(3)     | 57.44   | 19.72       | 5.06  | 1.15    | 0.9  | 9.51    | /      | 3.02  | 3.18  |
| HANGZHOU     | 58.19   | 24          | 3.68  | 2.23    | 1.2  | 6.62    | 1.01   | 2.09  | 0.98  |
| NINGBO(1)    | 53.69   | 25.48       | 5.4   | 2.96    | 1.1  | 7.9     | /      | 2.43  | 1.04  |
| NINGBO(2)    | 55.71   | 9.65        | 7.85  | 4.36    | 3.82 | 12.27   | /      | 3.43  | 2.91  |
| NINGBO(3)    | 55.9    | 15.6        | 5.1   | 4.5     | 1    | 13.8    | /      | 3.2   | 0.5   |
| WENZHOU      | 44.7    | 17.9        | 7.68  | 1.69    | 1.87 | 23.86   | /      | 1.3   | 1     |
| GUANGZHOU    | 60.17   | 17.12       | 5.4   | 3.4     | 1.06 | 8.99    | /      | 3.37  | 0.49  |
| SHENZHENG(1) | 40      | 15          | 17    | 5       |      | 13      | 2      | 5     | 3     |
| SHENZHENG(2) | 50.62   | 7.96        | 14.24 | 6.72    | 7.16 | 13.3    | /      | /     | /     |
| FUZHOU       | 60.17   | /           | 13.72 | 4.2     |      | 10.66   | /      | 3.35  | 5.75  |
| SHAOXING     | 50      | 25.39       | 4.1   | 2.8     | 1.5  | 5.1     | 0.03   | 7.8   | 0.68  |
| FUYANG       | 38.57   | 26.8        | 7.09  | 6.04    | 2.59 | 17.86   | 0.31   | 1.26  | 0.74  |
| JINHUA       | 35.6    | 10          | 12.15 | 5.06    | 6.33 | 15.7    | /      | 2.03  | 3.8   |
| SHANDONG     | 42.5    | 25          | 5     | 2.5     | 1    | 10.5    | /      | 2     | 1.5   |
| PANJIN       | 64.5    | 20          | 4.1   | 1.5     | 1.3  | 5.8     | /      | 2.3   | 0.5   |
| DONGUANG     | 22.23   | 10          | 6.44  | 16.06   | 7.83 | 19.28   | /      | 3.37  | 6.1   |

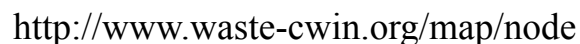


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- [illegible]



- <http://www.waste-cwm.org/map/node>



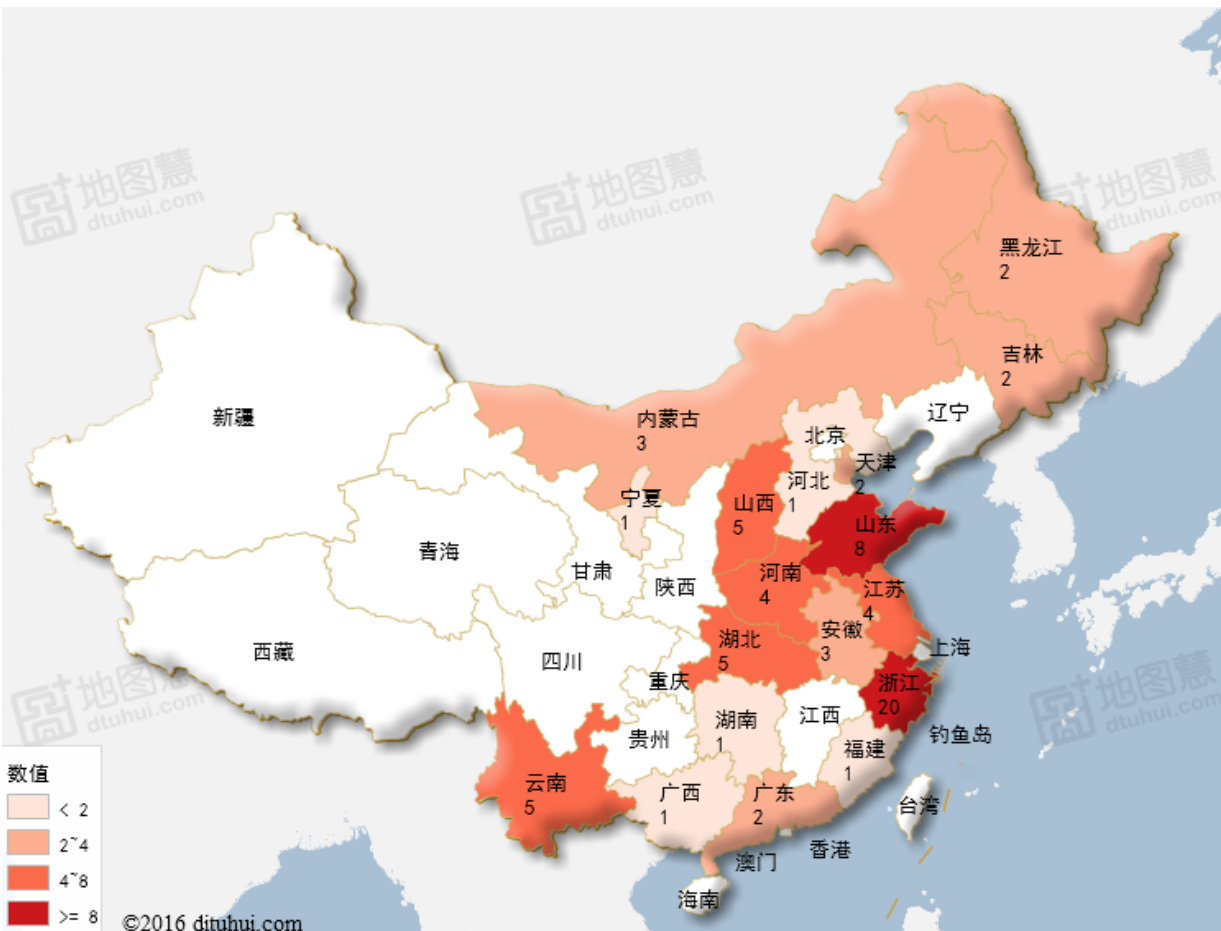
# WTE technology in China (2014)

| Types of Technology                      | Sources of Technology | Quantity                                         | Operating Capacity (t/d) |
|------------------------------------------|-----------------------|--------------------------------------------------|--------------------------|
| Grate furnace                            | Imported equipment    | 12 under operating;<br>18 are under construction | ~20000                   |
|                                          | Imported technology   | 24 under operating;<br>2 are under construction  | ~20000                   |
|                                          | Domestic              | 92 under operating;<br>19 are under construction | ~100000                  |
| Fluidized bed incinerator                | Imported equipment    | 2 under operating                                | ~2500                    |
|                                          | Domestic              | 54 under operating;<br>16 are under construction | ~67500                   |
| Pyrolysis & gasification & co-combustion | Imported equipment    | 1 under operating                                | ~600                     |
|                                          | Imported technology   | 1 under operating<br>1 under construction        | ~1500                    |
| Rotary kiln incinerator                  | Imported technology   | 1 under operating                                | ~600                     |
| Total                                    |                       |                                                  | ~200,000                 |



# Distribution of CFB waste incineration project in China

Total capacity 67500 t/d



| Province       | Input<br>tons/day | Installed power<br>MW |
|----------------|-------------------|-----------------------|
| Zhejiang       | 17000             | 321                   |
| Shandong       | 7000              | 171                   |
| Hubei          | 6600              | 168                   |
| Yunnan         | 5900              | 132                   |
| Inner Mongolia | 5300              | 92                    |
| Jiangsu        | 4400              | 102                   |
| Shanxi         | 3700              | 87                    |
| Henan          | 3200              | 102                   |
| Jilin          | 3000              | 48                    |
| Tianjin        | 2700              | 48                    |
| Anhui          | 1800              | 42                    |
| Guangdong      | 1800              | 54                    |
| Fujian         | 1400              | 24                    |
| Ningxia        | 1000              | 12                    |
| Hebei          | 800               | 24                    |
| Hunan          | 800               | 24                    |
| Heilongjiang   | 600               | 27                    |
| Guangxi        | 500               | 16                    |

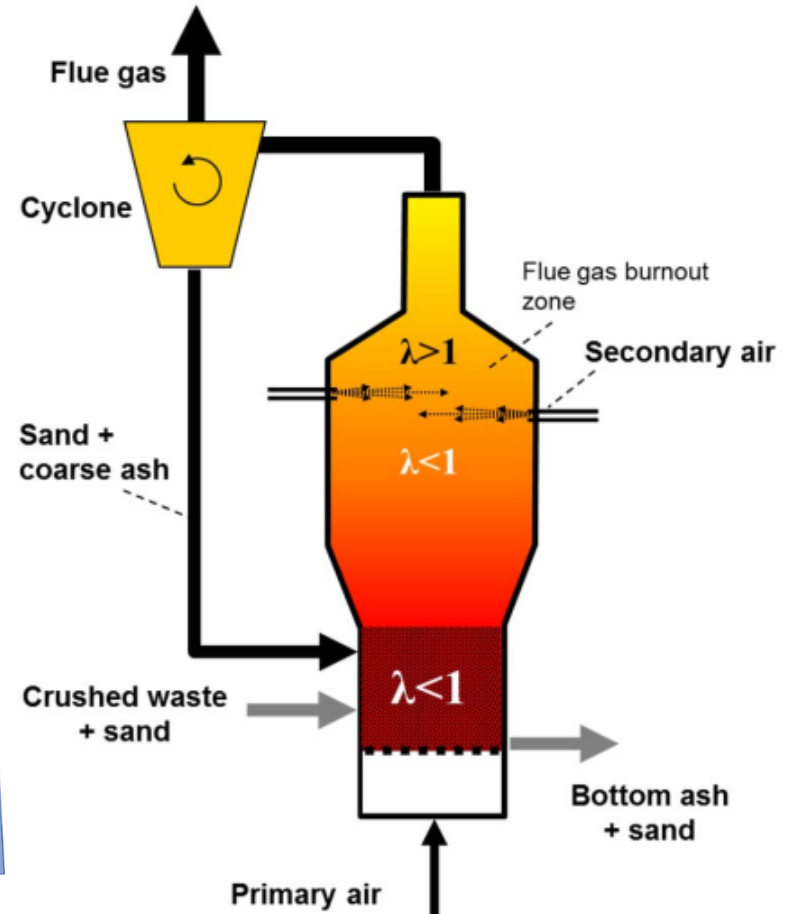
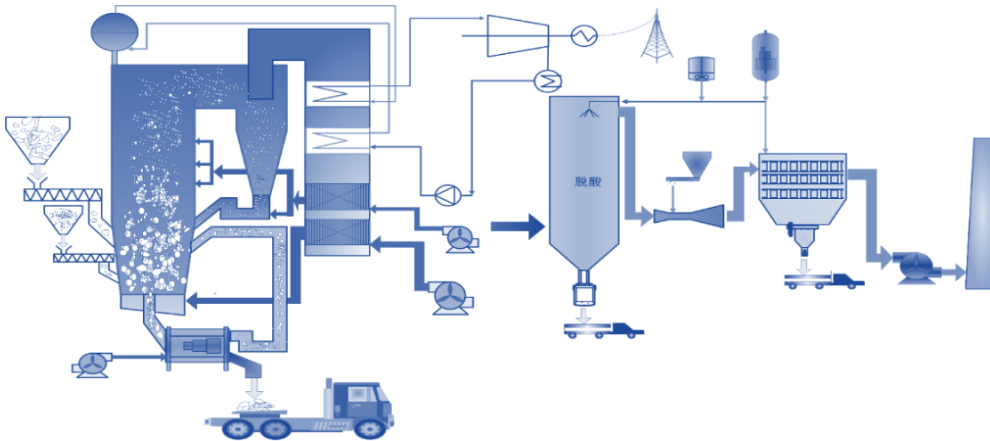
Data: jinjiang Group.

# Fluidized bed reactor

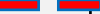
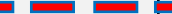
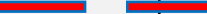
- ❑ Good gas-solid contact & mixing
- ❑ Uniform temperature distribution
- ❑ High heat & mass transfer rate
- ❑ Coal can be used as assistant fuel

## ◆ Disadvantages

- High ash content
- Carbon loss with fly ash
- Pre-treatment required



# particle size of some common waste composition

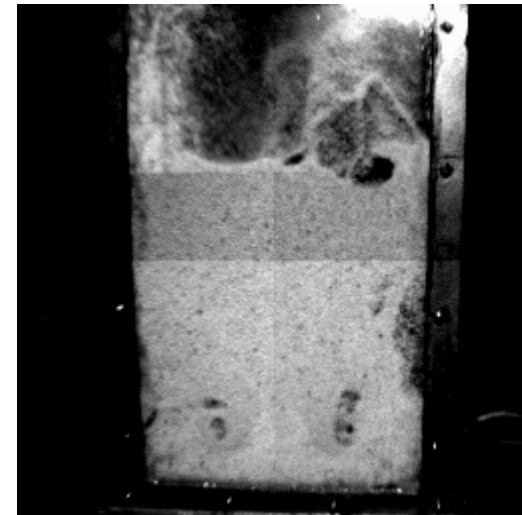
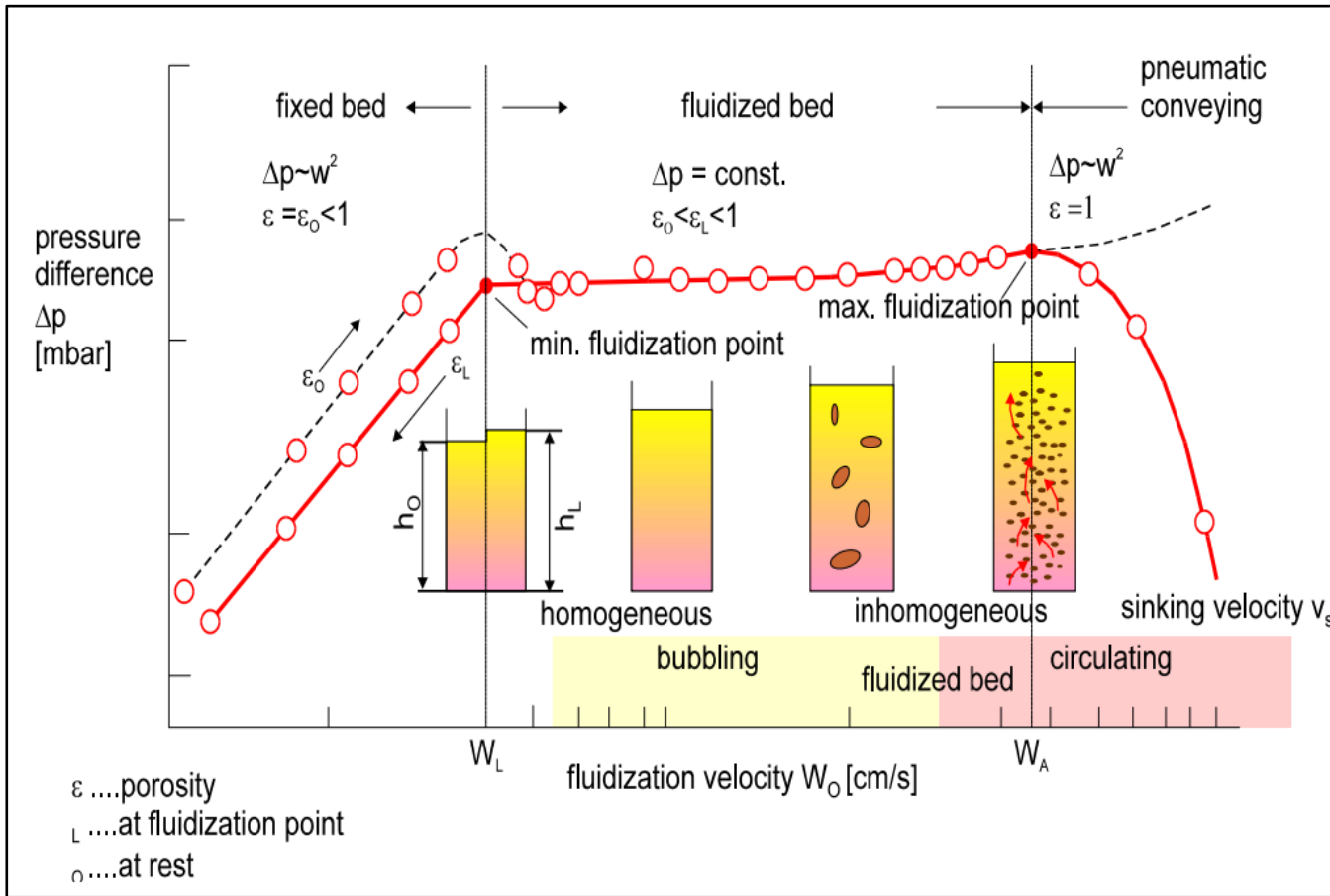
| Waste composition | Size distribution range (mm)                                                      |    |                                                                                    |     |                                                                                     |     |                                                                                     |
|-------------------|-----------------------------------------------------------------------------------|----|------------------------------------------------------------------------------------|-----|-------------------------------------------------------------------------------------|-----|-------------------------------------------------------------------------------------|
|                   | 0                                                                                 | 80 | 160                                                                                | 240 | 320                                                                                 | 400 | 480                                                                                 |
| Plastic           |  |    |  |     |                                                                                     |     |                                                                                     |
| Paper             |  |    |  |     |  |     |                                                                                     |
| Textile           |  |    |   |     |  |     |                                                                                     |
| Glass             |  |    |   |     |                                                                                     |     |                                                                                     |
| Cans              |  |    |   |     |                                                                                     |     |                                                                                     |
| Other metal       |  |    |   |     |                                                                                     |     |                                                                                     |
| Leather           |  |    |  |     |  |     |  |
| Food waste        |  |    |   |     |                                                                                     |     |                                                                                     |
| Mineral           |  |    |   |     |                                                                                     |     |                                                                                     |





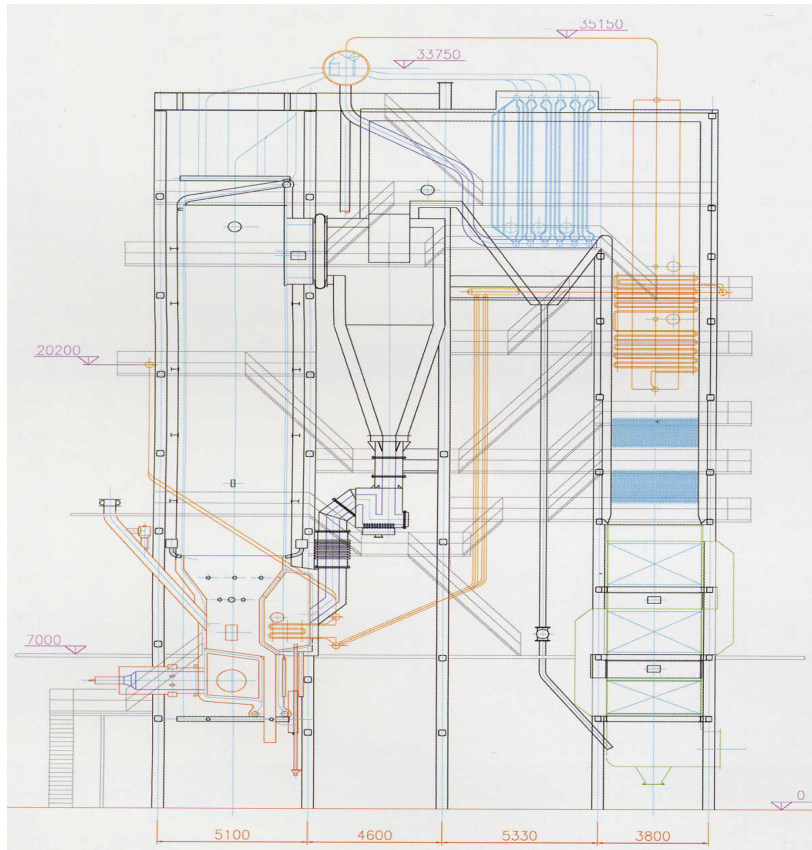
# Fluidization of MSW particles

## Parameter determination

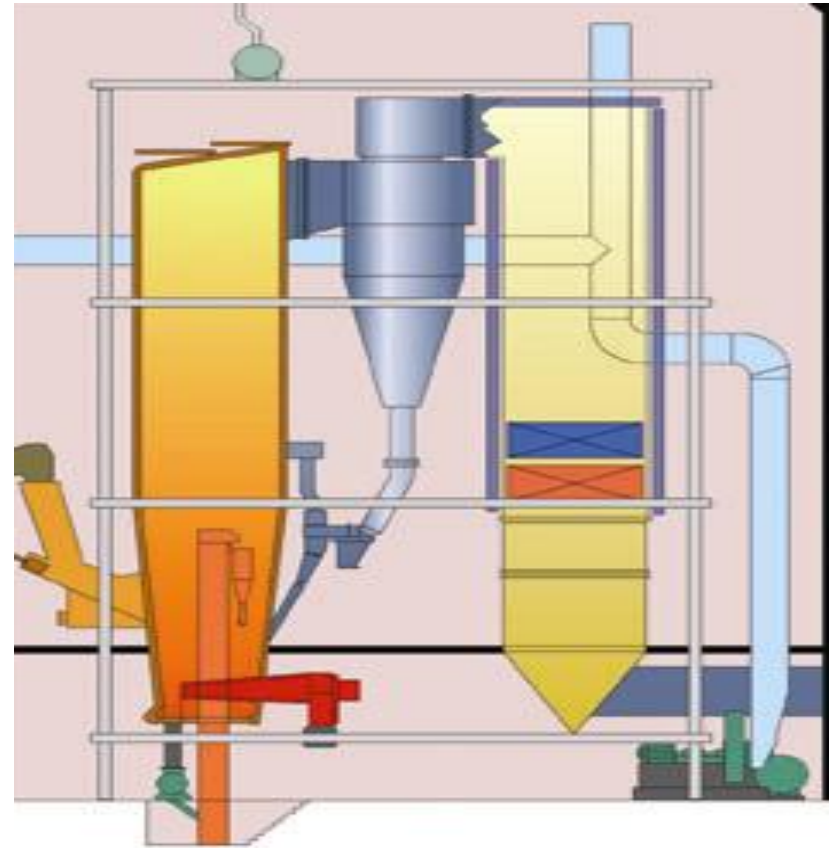


Schematic diagram of Fluidized bed

# Domestic Fluidized Bed Incinerator



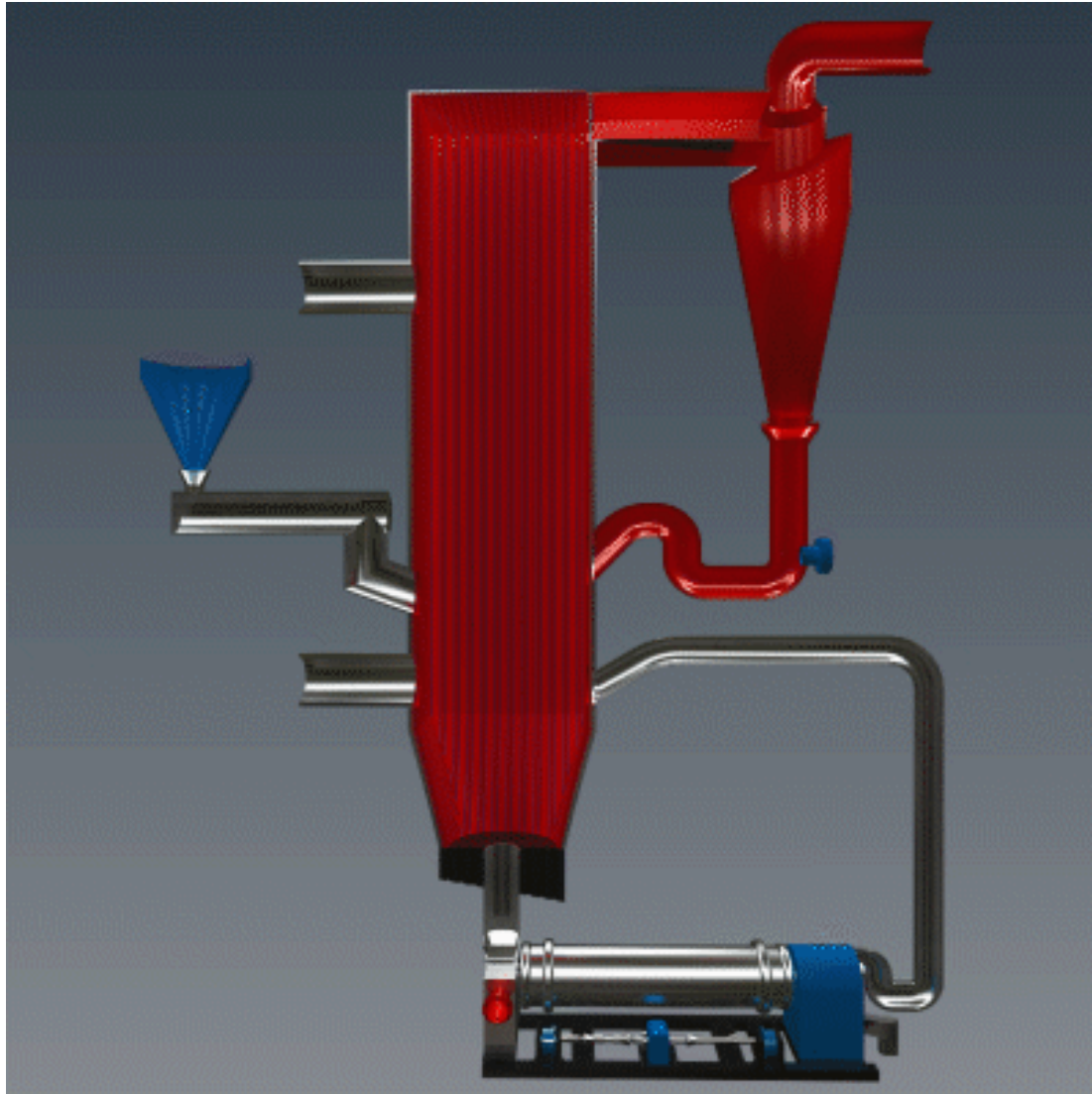
**CFB technology developed by GEE**



**CFB technology developed by THU**

# Combined-CFB incinerator of ZJU

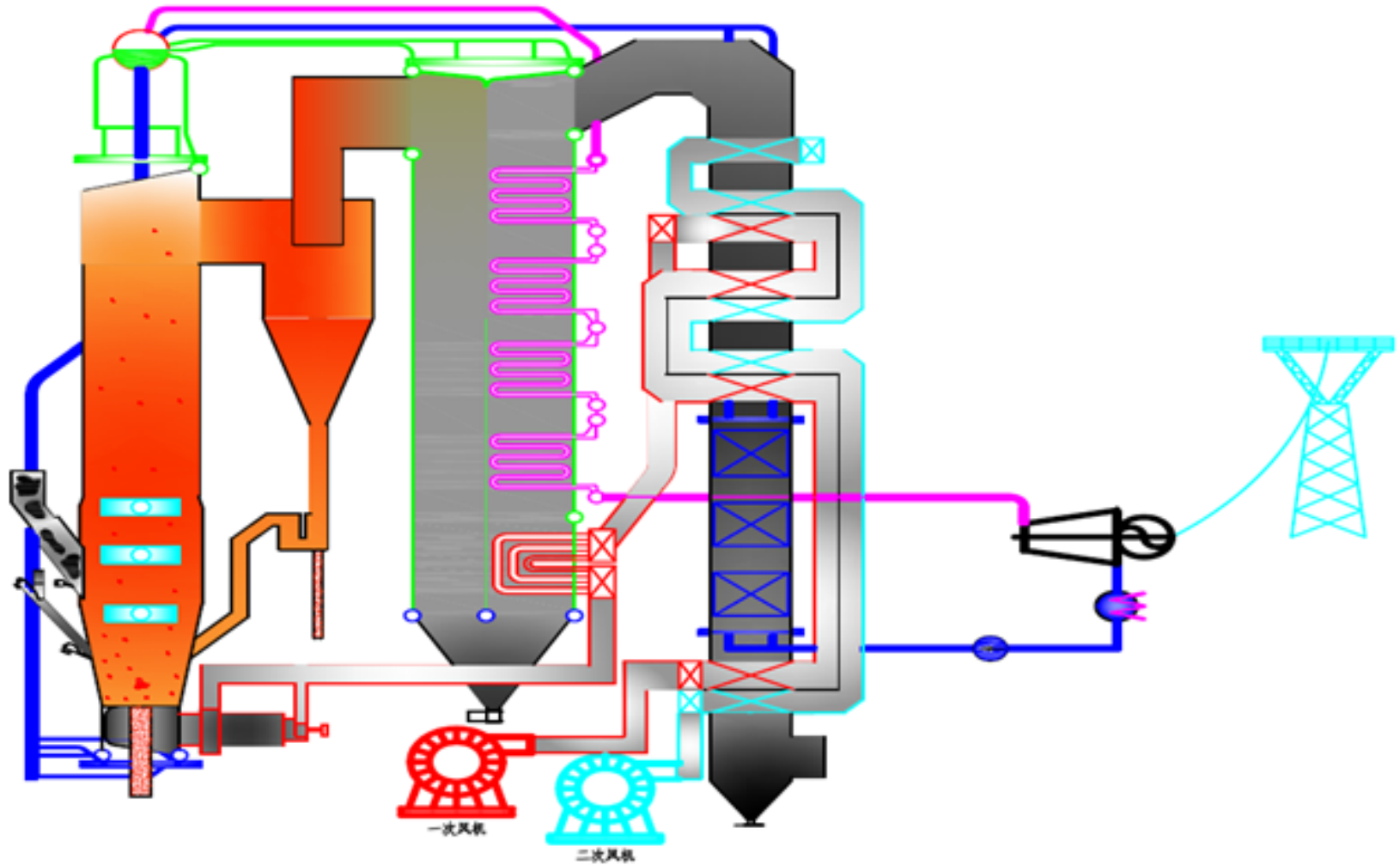
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- ◆ Combined circulation inside and outside the furnace
- ◆ Semi-adiabatic membrane wall
- ◆ Hot-cold grading air supply



# Domestic Fluidized Bed Incinerator

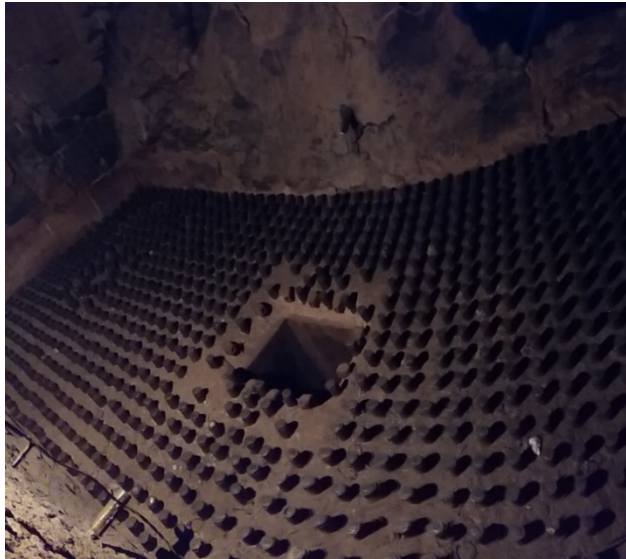


**Zhejiang Uni. CFB**

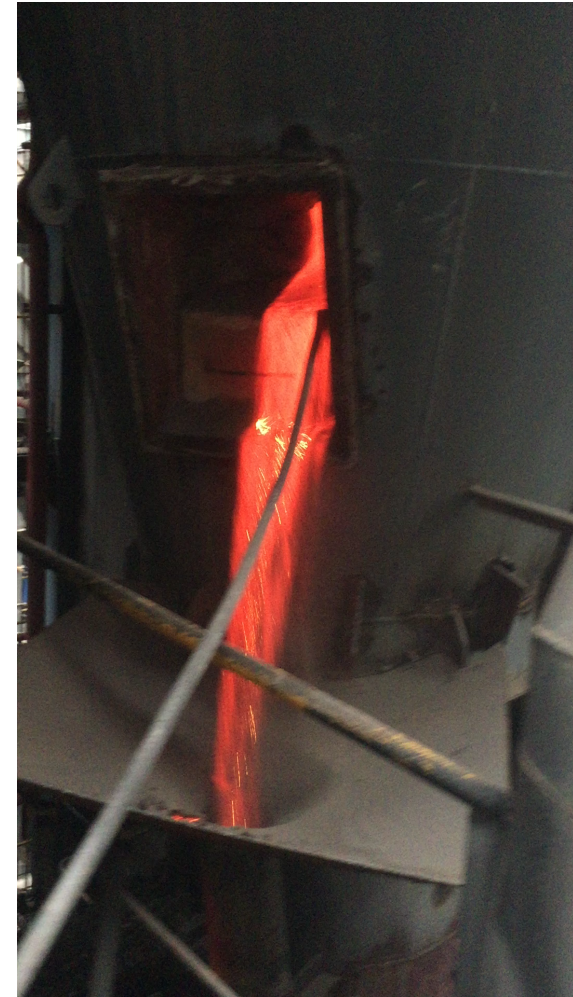
# Key instrument of CFB incinerator



**Shredder**



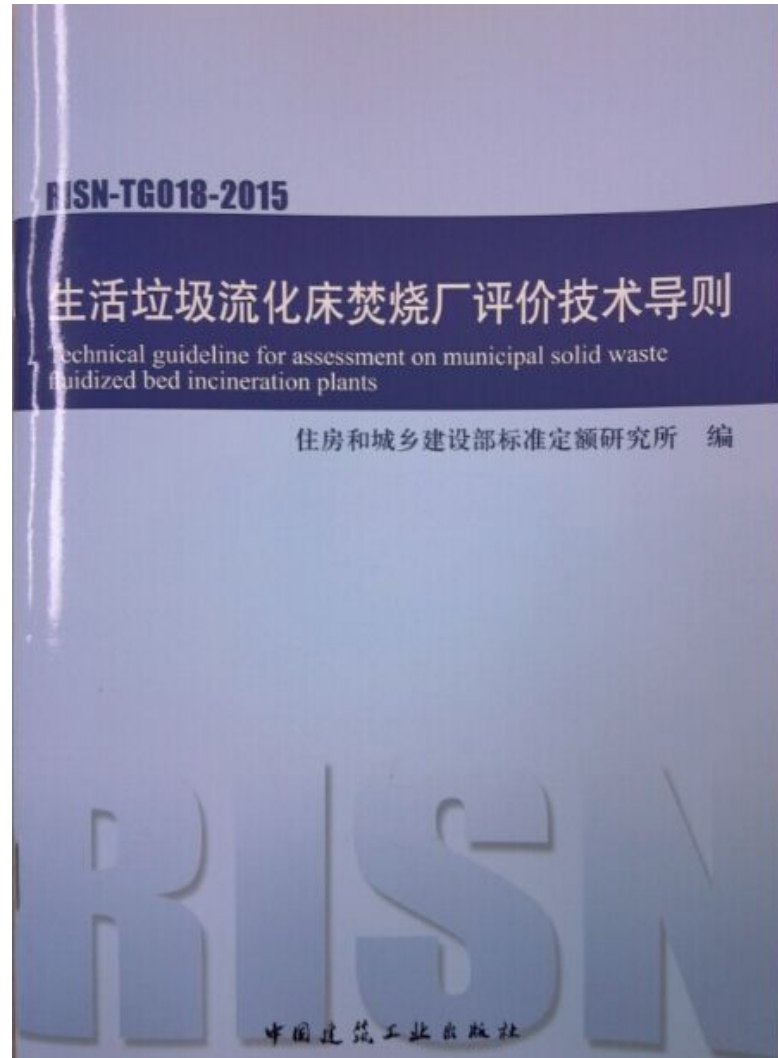
**Air distributor**



**Cyclone**

# National regulation for CFB WTE plant

- ◆ RISN-TG016-2014 for CFB WTE plant construction and operation
- ◆ RISN-TG018-2015 for CFB WTE plant performance assessment





# New regulation for MSWI fly ash



索引号: 000014672/2016-00563  
发布机关: 环境保护部  
名称: 《国家危险废物名录》(2016) 版解读  
文号:

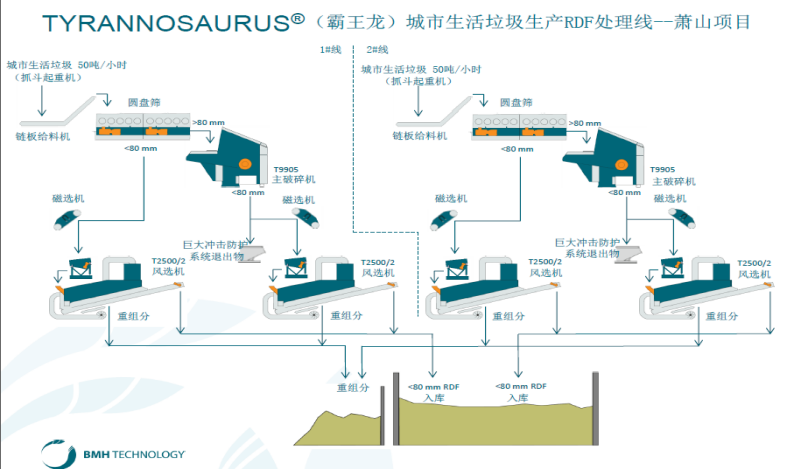
分类: 环境政务管理信息\新闻发布  
生成日期: 2016年06月21日  
主题词:

## 《国家危险废物名录》(2016) 版解读

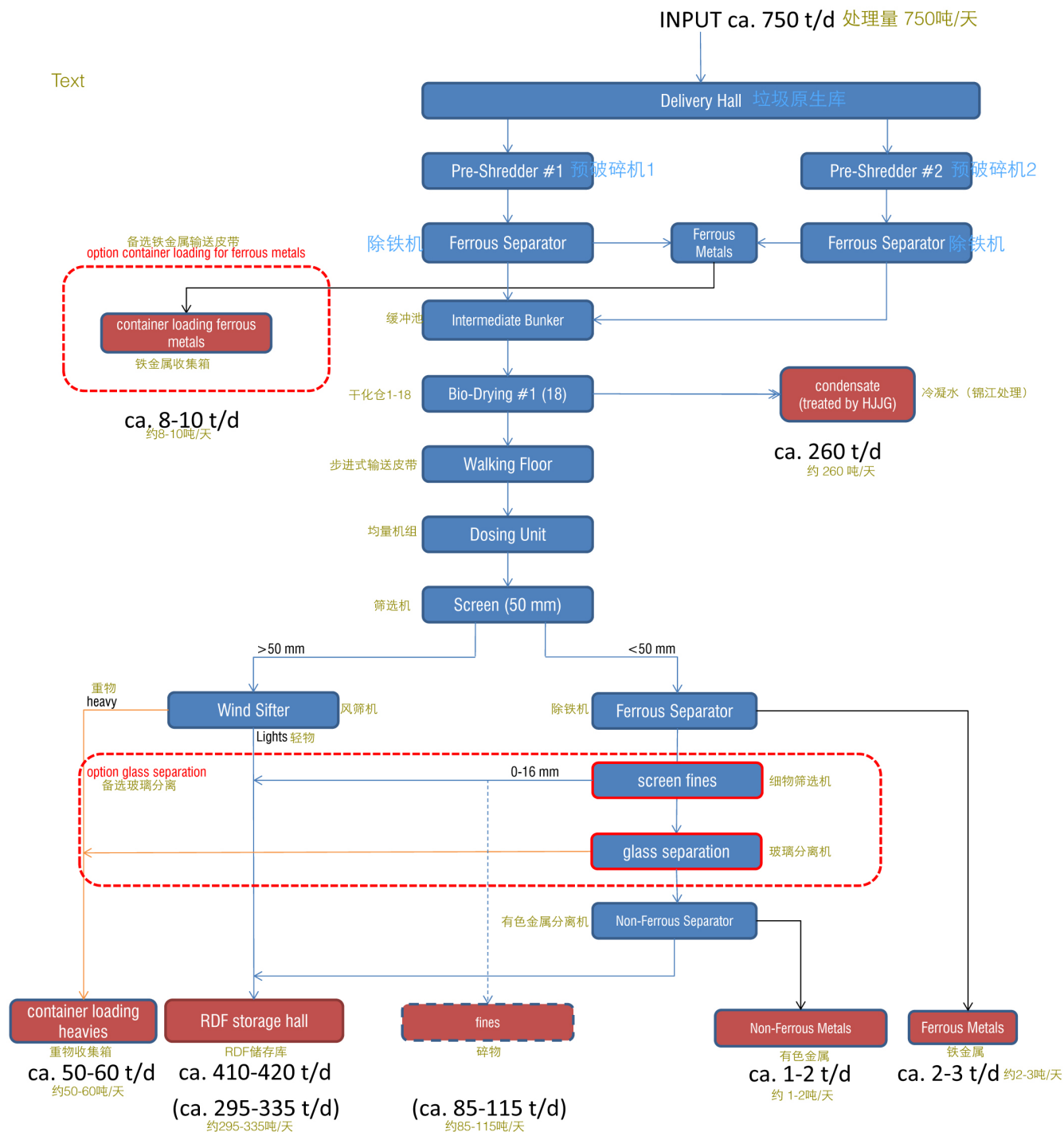
| 序号 | 废物类别/代码    | 危险废物     | 豁免环节 | 豁免条件                                            | 豁免内容               |   |            |          |    |                                                                          |
|----|------------|----------|------|-------------------------------------------------|--------------------|---|------------|----------|----|--------------------------------------------------------------------------|
| 4  | 772-002-18 | 生活垃圾焚烧飞灰 | 处置   | 满足《水泥窑协同处置固体废物污染控制标准》(GB30485-2013), 进入水泥窑协同处置。 | 水泥窑协同处置过程不按危险废物管理。 | 4 | 772-002-18 | 生活垃圾焚烧飞灰 | 处置 | 满足《生活垃圾填埋场污染控制标准》(GB16889-2008) 中 6.3 条要求, 进入生活垃圾填埋场填埋。<br>填埋过程不按危险废物管理。 |

can send for cement and normal landfilling

# Development of fluidized bed (1): in-plant fuel preparing



Text





# Application of Fuel preparation system



After preparation of the prepared waste:

- The combustion and temperature stability is greatly enhanced, low heat value fuel has been greatly enhanced, by this way auxiliary coal would be reduced.
- Waste feeding stable, by this way the chamber pressure fluctuation range is reduced.
- After burning waste disposal capacity increased; and in daily waste incineration increased by 15%, slag decrease of 18%, fly ash decrease of 11%.





# Development of fluidized bed (2): Co-combustion

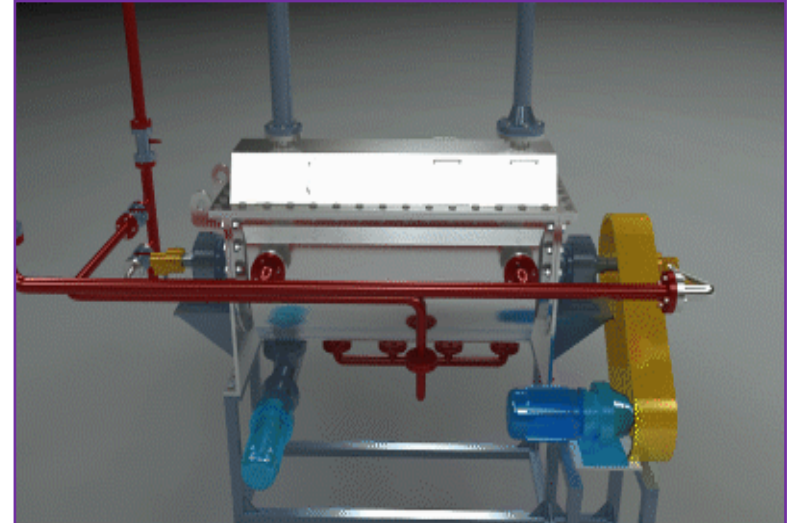
- **Difficulty:** The biggest advantage of the circulating fluidized bed is co-disposal of solid waste with sludge, biomass and so on.



# Co-combustion of sludge & MSW

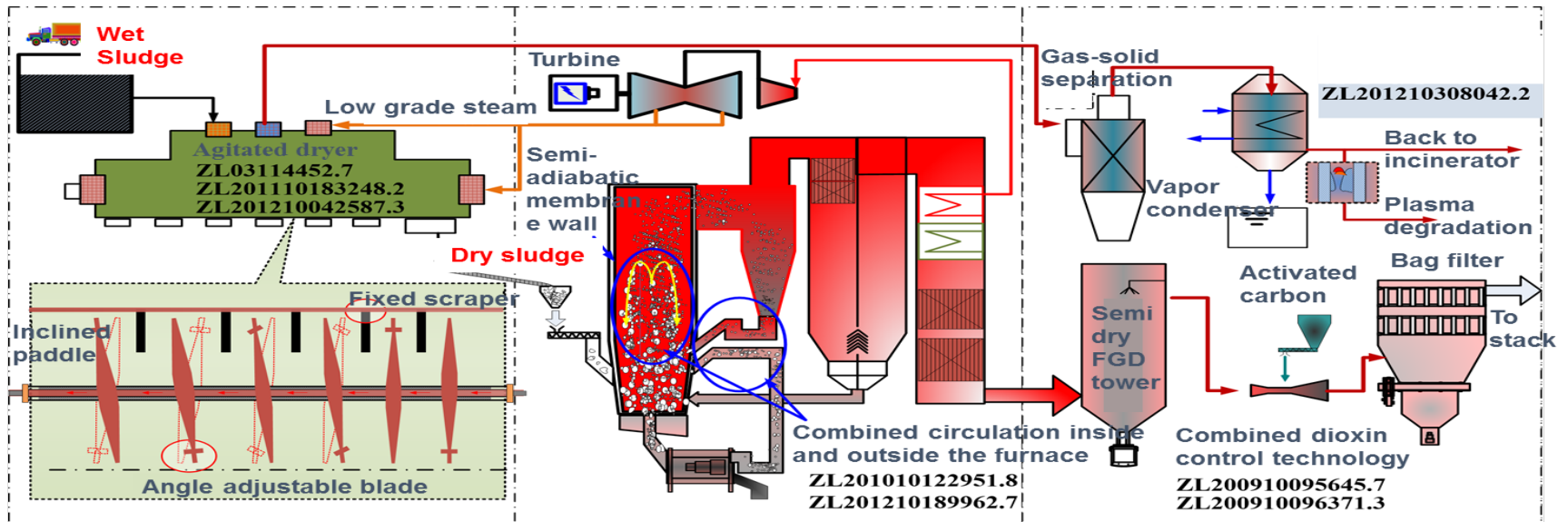


**Indirect thermal dryer**



**Combined CFB incinerator**

**Pollutant control**





# Larger Sludge & MSW co-combustion thermal

- **Location**  
Shaoxing MSW & Sludge co-treatment
- **Year**  
2012
- **MSW+Sludge**  
**1600 t/d MSW+ 2000 t/d (80%)**
- **Sludge is dewatered to 45-50% with sludge deep dewatering technique**



# Dioxin On-line Monitoring System

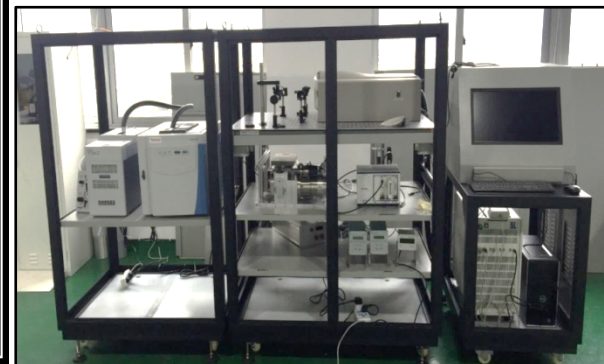
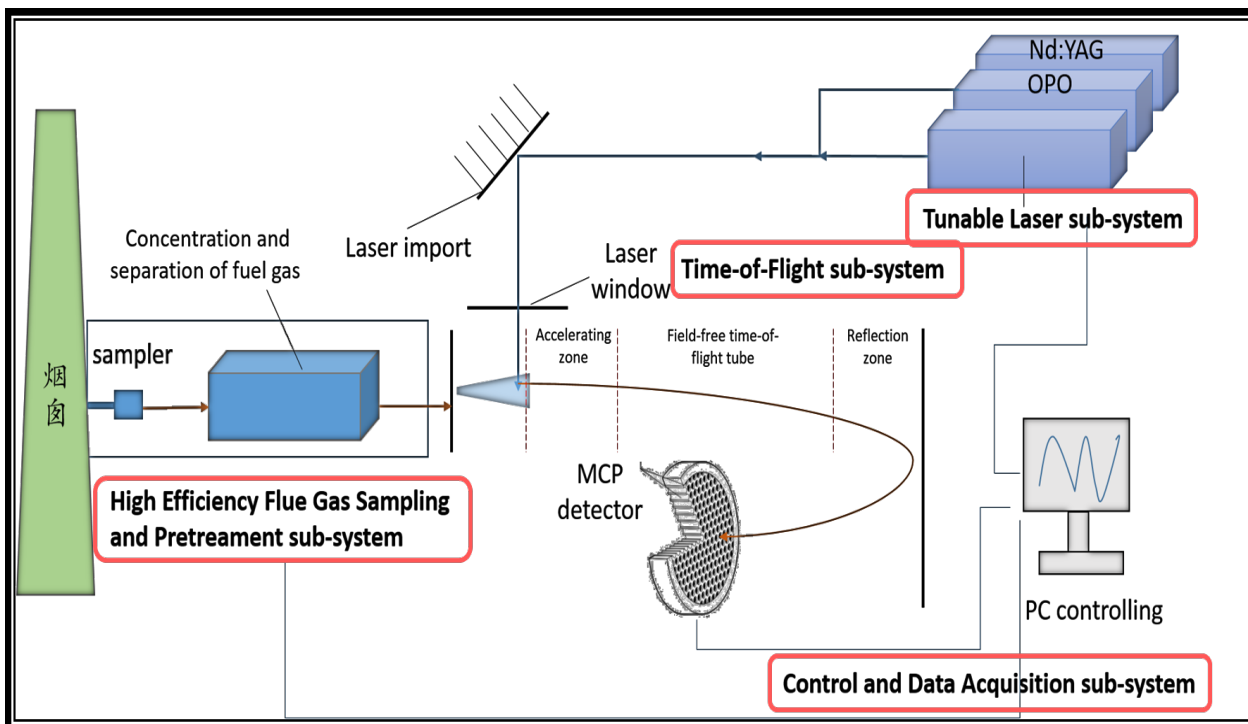
- Developed the highest accuracy and stability of the dioxin generation system
- Developed an on-line measurement method for dioxin emission based on the precursor correlation model.



generation system  
ZL201210230073.0



- UNEP Global POPs monitoring and analysis laboratory directory



# National Engineering Lab

## □ <<waste incineration technology and equipment national engineering laboratory>>



**Everbright environmental protection (Chinese) Limited company** mainly engaged in grate furnace and incineration technology



**Jinjiang Hangzhou Group Co., Ltd.** mainly engaged in waste incineration power generation project



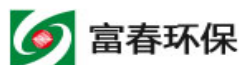
**Nantong Wanda Boiler Co. Ltd.** mainly engaged in a circulating fluidized bed boiler and grate furnace



**China Electric Power Construction Group Co., Ltd.** mainly engaged in the construction of electric power, involved in the waste incineration project



**Sinoma** mainly engaged in the production of cement kiln co-harmless treatment of garbage and hazardous waste



**Fuchun River environmental protection Limited by Share Ltd.** mainly engaged in waste incineration power industry



**Zhejiang Tianbao energy environmental protection Co. Ltd.** mainly engaged in waste incineration power generation, disposal of hazardous waste incineration



# Training class for developing countries

- ❑ Central government supported Sep.13 ~Sep. 25
- ❑ waste management class for researcher and officers from developing countries, including Thailand, India, Pakistan, Vietnam, Iran , Chad , Indonesia and so on



# Conclusion

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- **CFB is promising technology for low quality waste**
- **CFB is flexible for co-combustion of multiple waste**
- **Shreddering+separating+fuel preparing+CFB is very promising solution for waste treatment**