China Opportunities

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VOC

Hazardous Waste

Industrial Wastewater

Soil Remediation

1. Overview of VOCs Treatment Industry

About VOCs

In China, the volatile organic compounds (VOCs) are defined as organic compounds that can take part in atmospheric photochemical reactions. Main effects include biological toxicity, precursors of PM2.5 particulates and ozone, precursors of photochemical smog. In China, the main sources of anthropogenic VOCs emissions are industries including: petrochemical industry, coating industry, printing industry, paper and pulp industry, textile industry, etc.

The major characteristics of VOCs emission in China are as following.

1. Non-governed emission is majority;
2. Pollution sources are widely distributed.
3. Large variety of pollutants occur.
4. Emission accounting is complex;
5. Whole process pollution control is required. Largest VOCs emissions are in Shandong, Jiangsu, Zhejiang, three highly industrialized provinces.

Policy Driven

In the 13th Five-Year Plan (FYP), VOCs emission control in key regions and key industries is included in the total emission control. The target is to have 10% emission reduction during the period of 13th FYP. VOCs governance regulations of emission fees and relevant subsidies will be gradually implemented.

Current Status Of Vocs Control In Different Industries

Petrochemical industry: The earliest VOCs control started from petrochemical industry. The whole industry was required to meet the criteria of VOCs control standards before July 1st, 2017. The VOCs emission is required to reduce by 30% by the end of 2017 compared to the emission level of year 2014.

Package printing industry: VOCs emission is about 2 million tons/year. In 2014, only 53 out of 469 press printers installed terminal emission control facilities, and 218 press printers were to be installed. Among the 40,000 enterprises, only a few large enterprises implement VOCs control systems, and most of small enterprises are wait-and-see.

Paint, ink, & coating production industry: Non-organized emission accounted for 50-90%. The local VOCs emission standard has been issued in Shanghai.

VOCs Treatment Market

Market size: The total revenue in 2014 was more than 7 billion RMB (from *China Environmental Protection Association*). The investment demand of industrial VOCs treatment is about 40 billion RMB (*Key Air Pollution Prevention and Control* in the 12th FYP). The expected market size will exceed 40 billion RMB (Sealand Securities Co., Ltd.).

VOCs Treatment Technologies

Recycle Technologies: Absorption, adsorption with activated carbon and zeolite concentration rotor, membrane separation, etc.

Removal technologies: Combustion (RTO, direct combustion, etc.); bio-filtration; photo-catalysis; low temperature plasma (DDBD), etc.

Business Model

At present, the main models are VOCs treatment equipment sales contract and third-party managment service contract. For example, the package printing industry of a whole city/county/industrial park entrusts a third party for VOCs treatment package service. In the

future, the Leak Detection and Repair (LDAR), and both process control and end treatment will be gradually implemented.

Conclusion

At present, VOCs treatment industry is in the initial stage of development. During the 12th FYP, the industrial emissions treatment were focused on the desulfurization, denitrification and dust removal. VOCs emission treatment had not received adequate attention yet. Most of the policies related to the VOCs control were issued in 2014. In the period of 13th FYP, VOCs control is one of the key aspects of environmental governance. Large VOCs treatment companies are expected to be on stage.

However, the top level plan is not perfect enough, technical guidance is insufficient, and the current VOCs treatment technology advanced level in China is also weak. VOCs treatment is still dominated by the capital-sufficient enterprises, such as 'three barrels of oil' enterprises (PetroChina, Sinopec, CNOOC). Market release for SMEs remains to be seen.

There are many VOCs market segments and the market is scattered. The current VOCs treatment companies all compete in a number of leading industries, Now
comers and should be carefully beware of possible low price competition.

The growth of VOCs treatment industry during the 13th FYP period is depended on the progress and improvement of all above mentioned aspects.

Table1. Typical VOCs Treatment Enterprises in China

Company	Est.	Core business	Technology	Advantage	Main customers
Xianhe Zhengyuan Environmental Management Technology Co., Ltd.	2015	VOCs treatment	Combination of catalysis, combustion, adsorption and plasma technology	Cooperate with Hebei Sailhero Environmental Protection High-tech Co., Ltd. R&D supported by Environmental Science Research Center of PLA; Big orders from cluster governance	Packaging and printing industry; Coating industry; Glass fiber industry; Hebei Xiongxian order of 1.8 billion RMB
Bay Environmental Technology (Beijing) Corp.	1994	VOCs treatment; Oil and gas recovery; NOx treatment; 25% market share of oil and gas recovery	RCO, RTO, CO, TO	PetroChina, Sinopec first-tier supplier; Whole industrial chain of petrochemical industry; Technology cooperation with California University	“Three barrels of oil” enterprises (PetroChina, Sinopec, CNOOC) and other petrochemical enterprises;
Jiayuan Environmental Protection Technology co., Ltd.	1998	VOCs end of pipe treatment; Landfill leachate treatment	RTO, Activated carbon adsorption and recovery technology	In house developed technologies of adsorption and recovery; Undertake nation’s 863 program on VOCs treatment research; Good at integrated plan of Production, Learning and Research	Chemical and printing companies in Shanghai and Jiangsu province; Paint processing companies; 6 preference cases on the official website
ECOTEC Asia (Beijing)Co., Ltd	2006	VOCs harmless treatment; Oil and gas recovery; LDAR;Industrial energy saving; Low carbon CHP; Wind power services	All the currently available technologies are involved; Wide selection of combined process	International cooperation experience; Customer advantage; Competent at bargaining of international advanced technology transfer	“Three barrels of oil” enterprises (PetroChina, Sinopec, CNOOC) ; New times energy; Have projects in the United States, South Korea, Canada and the United Arab Emirates (shown on official website)
Guangzhou Zike Environmental Protection Technology co., Ltd.	2002	Organic waste gas; VOCs treatment; Contractor and operator of odor treatment project	Composite photo-catalysis for VOCs treatment and plasma deodorization	Equipped with environmental protection equipment subsidiary; Covering the whole industrial chain; Composite photo-catalysis technology	Chemical, machinery, rubber industry, etc.,; The official website lists more than 40 customers, including Haier, MITSUBISHI and other large enterprises
Shandong Pallet Environmental Engineering Co., Ltd.	2008	Industrial waste gas (including VOCs); Odor treatment; sometimes involving in industrial wastewater treatment	Low temperature plasma technology	DDBD, patented low temperature plasma treatment technology ranking no.1 in China; Industrialized patent from Fudan University; Outstanding technology advantages; Grade B in environmental engineering design	Have business in major polluting industries, mainly in petrochemical and pharmaceutical industries located in Shandong, Jiangsu, Zhejiang and Shanghai

CECEP Tianchen (Beijing) Environmental Protection S&T Co., Ltd.	2006	LDAR and detection; VOCs adsorption and recovery- activated carbon adsorption; Third party service of VOCs destruction	Several technologies and mainly focus on activated carbon fiber adsorption, RCO, RTO, rotor, and direct combustion	Backed on CECEP group; Invested 300 million RMB on Guangdong printing industry governance; Many years' experience on activated carbon fiber adsorption; National high-tech enterprise	Petrochemical industry; Packaging and printing industry; 300 million RMB project of printing industry governance in Guangdong
Shanghai Anjule Environmental Protection Technology Co., Ltd.	2009	Sales of VOCs treatment equipment, and hydrogen photo catalyst purifier and reagents	Hydrogen photo catalyst generally for VOCs concentration below 100ppm	Suitable for small and medium size projects such as sewage odor and garbage odor treatment	Petrol industry; Wood processing industry; Paint processing industry; Plastic industry; Mechanical and electrical industry, etc. The size of the customers are ≥10 million RMB
Hebei Tianlong Environmental Protection Technology Co., Ltd.	2013	VOCs treatment; Solvent recovery	Activated carbon adsorption (N2 protection); Rotor; RTO; RCO	Project experience and technology advantages in printing industry VOCs treatment	Printing and coating industry
Dalian Juyang Technology Co., Ltd	2008	Petrochemical industry waste gas recovery and treatment, including oil and gas recovery and VOCs recovery, odor treatment	Gas station exhaust gas adsorption technology; Patents of concentrated adsorption and absorption of various volatile compounds	Second-tier supplier of PetroChina and Sinopec; Technology advantages of multi VOCs treatment	Gas station and plants of Sinopec; PetroChina; Port(reference case: Port of Yingkou, China Silk Cooperation, year 2012)
Hangzhou Zhongbing Environmental Protection Co., Ltd.	2005	VOCs treatment equipment; and engineering design and installation	Oxidation	Technology and experience in rubber industry	Mainly are rubber and machinery coating company in Hangzhou
Beijing Top Oasis Environment Technology Co., Ltd.	2014	Leak detection, repair and emission inspection; LDAR, VOCs emission source inspection; consultancy for local Environmental protection bureau on LDAR auditing	Focus on LDAR and emission inspection; From current information, the company is not involved in the VOCs terminal treatment	Zhongguancun high-tech enterprises; Leader of LDAR technology; Self-developed software systems; Many reference cases	"Three barrels of oil" enterprises (PetroChina, Sinopec, CNOOC) and other petrochemical enterprises; Local environmental protection bureau; latest customer shown on the official website is Tianjin Petrol Chemical LDAR project

2. Hazardous Waste Management – Incineration Fly Ash Treatment Processes

About Hazardous Wastes

Hazardous wastes (radiative waste exclusive)are wastes that pose a threat to human health or the environment, and usually have the characteristics of toxicity, flammability, reactivity, corrosion, explosive or infectiousness. Under National Hazardous Waste List released in 2016, the listed wastes are classified into 46 categories and 479 sorts.

About Incineration

Based on National Hazardous Waste List, the original resources of Cat. HW18 wastes include household wastes and other hazardous wastes incineration fly ash and the pyrolysis slag. The incineration fly ash production reached 1 million tons in China in 2010. However, the new list of exemptions in 2016 Hazardous Waste List excludes the land disposal of household wastes incineration fly ash from hazardous waste management, when the *Landfill Waste Pollution Control Standards* (GB16889-2008) 6.3 is satisfied. In addition, supplyment to the certain standard, landfill coupled with cement kilns treatment processes are also excluded from the waste management. As incinerated fly ash consists of heavy metals (mainly cadmium, zinc, lead, chromium, etc.) and dioxin-like toxic pollutants, they can't degrade easily under natural conditions and direct landfill will cause secondary pollution. Therefore, in order to meet the land disposal standards, ash must be treated to

harmless materials strictly under the concentration limitation of dioxin-like and leached pollutants shown in Table.

Technical Trend

In the performance of hazardous waste treatment, the valued composites such as solvent and metals can be recovered and reused, while the hazardous wastes with low reuse value should be detoxified and/or neutralized using pre-treatment and final disposal processes which include landfill, incineration, etc. During the last decade, developed countries usually applied landfill as a disposal method. However, due to the shortage of land resource and its potential risk for the pollution of groundwater, the trend of hazardous waste disposal methods gradually turned to incineration.

Incineration Technologies

Rotary kiln incineration is currently the dominate technology of hazardous waste incineration, which is able to incinerate several types of solid, semi-solid, aqueous and gaseous wastes. There are three main incineration technologies including slagging incineration (~1000 ℃), ash incineration (~850 ℃) and pyrolysis (~650 ℃). The flame temperature in slagging incinerators is around 1100 ℃ which can make the organic matters in hazardous wastes sufficiently degraded. The slag of incineration can be converted into viscous state and embed the heavy metals in it.

Fluidized bed incineration can only be applied in some specific waste treatment such as sludge. It can be classified into bubbling bed and circle bed incineration. The former one is mainly used for low heating value sludge and the latter one is usually used in other waste incineration.

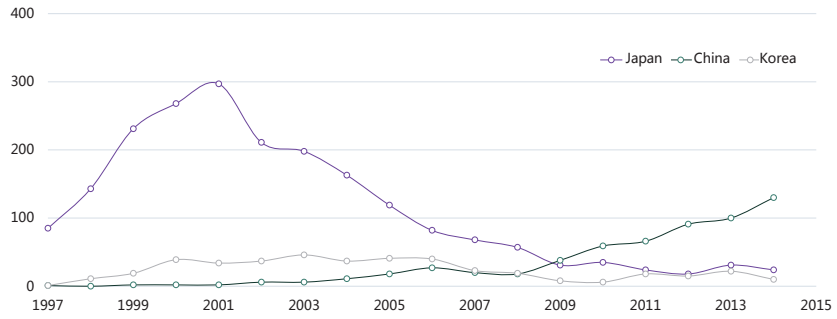
Liquid waste incinerators can destroy all sorts of liquid wastes, with highly variable loading rate, faster temperature adjustment, lower CAPEX and OPEX. But this technology has two major disadvantages. First, it is impossible to dispose liquid waste which is hard to atomize. Second, it must be equipped with different atomization combustors and sprayers to deal with the various liquid wastes with different viscosity and suspended solid content.

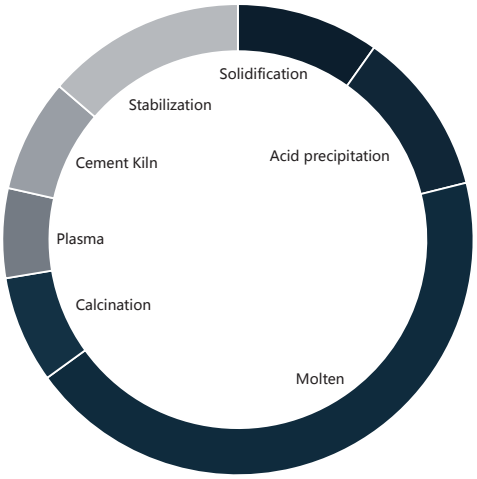
Plasma gasification utilizes energy to form plasma field. Hazardous wastes are heated, melted and finally vaporized with central temperature of 6000 ℃ and edge temperature of 1200 ℃ . The advantage of this technology is that wastes can be completely cremated, while the disadvantages include high capital and operational costs and high energy consumption. Therefore, this technology is usually employed to destroy biochemical weapons and extreme hazardous wastes, rather than normal hazardous wastes incineration.

2.1 Patented Technology Distribution

In the past 20 years, China, Japan and Korea have the largest number of ash treatment patents in the world. After the period of rapidly increasing from 1990s to 2000s, Japan achieved the technology outbreak and the number of ash treatment patents has recently been stable. On the other hand, China's waste incineration ash treatment started late, indicating that the fly ash problems did not gain sufficient attention at that time. However, in recent years, the number of patents about this technology has presented an increasing trend, which is related to a series of waste regulations issued by the government.

According to the patent database, in addition to the main fly ash melting methods, the number of other waste incineration ash treatment technology patents are considerate. Chemical stabilization is usually used to deal with heavy metal wastes both domestically and globally, especially heavy metal chelating stabilization. Plasma gasification is believed as a potential technology to dispose incineration fly ash. Cement solidification is a method to stabilize



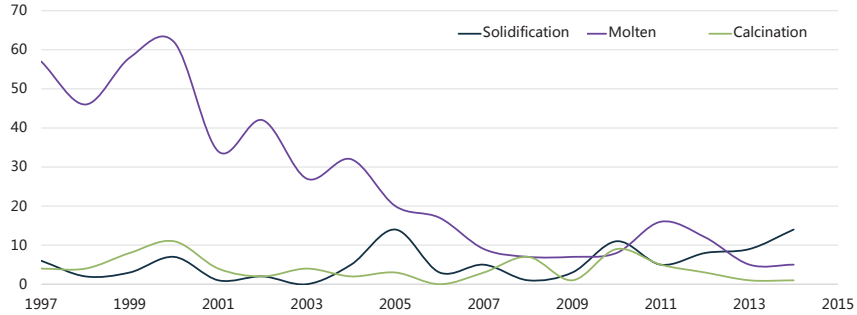


the fly ash by adding Portland cement in it; then high-strength mass is produced and the heavy metal in the ash can be converted into hydroxide matters, which can be solidified. This technology can reuse incineration ash as recycling material applying for asphalt pavement. From the development of technologies, the number of solidification and calcification changed a little in a small range, while the number of melting methods shows a decreasing trend due to high cost and energy consumption.

Conclusion

In 2015, there was 42.2 million tons of industrial hazardous wastes produced in China. However, there are no more than 2000 companies having qualification for hazardous waste treatment. Among these qualified companies, additionally, the operational certification of Tianjin Yiming Environmental Technology Co, Ltd. was cancelled in 2016, which implies not only the large market of hazardous wastes disposal but also the high industrial restriction and standard.

In the future, incineration fly ash can be directly landfilled or used as cement raw materials through treatment due to the development of incineration ash treatment technologies and the successful breakthrough of dioxin pollution control technologies. The amount of hazardous waste treated will increase a lot within the compliance of the national policy.



The companies of incineration ash treatment technology in China

Name	Technology/project	Introduction
BMEI	Stabilization	Ash disposal
Xin Zhongtian Environment Protection Co., Ltd.	Incineration	Convert to harmless slag
Grandblue	Rotary spray semi-dry desulfurization +Activated carbon adsorption + Bag dust collector	Removal of heavy metal, toxic gas and dust
Longgang Dongjiang Environment	Plasma gasification system	Incineration fly ash disposal
Dongjiang Environment	Stabilization technologies	Stabilization to meet the toxicity requirement of leaching at landfill
Beijing China Sciences General Energy and Environment Co., Ltd.	Activated carbon adsorption	Removal of heavy metal and dioxin in the dust
IESUN	Microwave system	Thermal treatment of dioxin in ash
Wuxi Xuelang Environmental Technology Co., Ltd.	SNCR+ Semi-dry deacidification + Activated carbon sparging + Bag dust collector	Ash treatment
Shenyang Academy Environmental Sciences	plasma detoxification treatment	Ash treatment
Shanghai Solid Waste Disposal Center	Plasma gasification integrated technologies	Ash treatment
GTS Energy Technology (Shanghai) Co., Ltd	Plasma gasification	Conversion to harmless glass-type end products
Everbright International	Chelating agents solidification	Dioxin control
Hangzhou Jinjiang Group	Doping coal co-firing	Dioxin control
Chongqing Sanfeng Environment Industry Group Co., Ltd.	Activated carbon sparging+Semi-dry+Bag dust collector	Semi-dry dust cleaning technology from Germany
Wanqiang Science Development Co.,Ltd.	Low temperature carbonization technology	Incomplete incineration to gas complete combustion process, greatly reducing dioxin and solid particulate matter emission

3. Industrial Wastewater Treatment

About Industrial Wastewater In China

According to Environmental Statistic Data 2016, total wastewater discharge in China in 2015 was 73.53 billion tons and 19.95 billion tons comes from industrial sources, which is 27.13% of the total discharge.

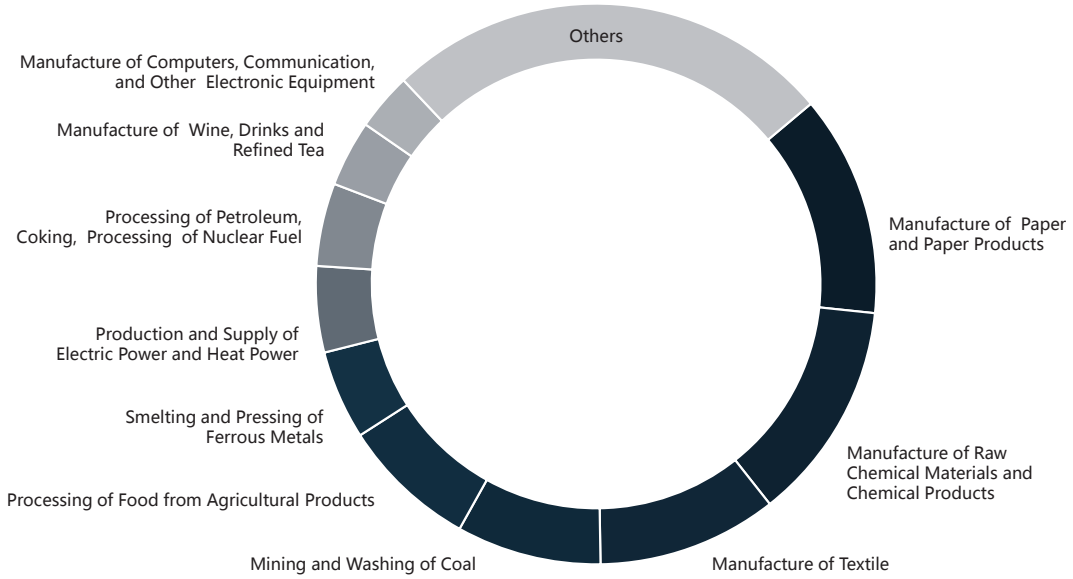
From the figure 1, it can be clearly seen that top 5 discharge industries are manufacture of paper and paper products , manufacture of raw chemical materials and chemical products, manufacture of textile, mining and washing of coal and processing of food from agricultural products. The respective portions of the top 5 industries are 12.77%, 12.70%, 10.38%, 8.35% and 7.83%, the summation of top 5 would be over 52% of total wastewater discharge. Moreover, combing the information in Table 1 above, top 5 industries, except processing of food from agricultural products, are all severe contaminated industries. Half of the wastewater comes from these sources, so reducing their discharge and applying proper treatment on them should be the top priority.

Trend Of Industrial Wastewater Discharge In Industrial Sectors

According to environmental statistic data from 2012-2015, the total industrial wastewater discharge continuously decreased. The discharge in 2015 was 13.60% less than the number in 2011.

From Figure 2, it can be clearly withnessed that the total wastewater treatment amount keeps slowly increasing, but the industrial discharge has been continuously decreased. The discharge control on industries is approved to be effective. Judging from the trend, during 13th FYP, the decrease is likely to continue.

Although the total industrial discharge decreased, in the detailed industries, the trend from 2014 to 2015 was not the same. Figure 3



below shows the changed amount and changed percentage in different industries during 2014 to 2015.

Water Ten

Water Ten is the most important specialized plan about water related issues in the future 5 to 15 years, especially for 13th FYP period. The final objectives of the Water Ten are to improve national water environment quality, and recover the water ecosystem. Water Ten has set its scope with the entire water environment. To achieve these ultimate objectives, a good control and treatment on the industrial wastewater is essential. All items in Water Ten about industrial wastewater treatment are listed below:

- comprehensive control on industrial wastewater pollution: shut down small industrial corporations with poor environmental protection facilities, especially in heavy polluting sectors, such as papermaking, textile, etc.; renovate with cleaner technology on ten key industries, which are paper production, coking processing, non-ferrous metal, fertilizer, printing and dyeing, agricultural products processing, active pharmaceutical ingredients production, tanning,

pesticide and electroplating; centralized treat for wastewater from industrial parks and industrial agglomerations;

- economic structure transforming and upgrading: adjust industry structure, eliminate low level equipment and technology according to related standards and guidelines; enhance industrial water reuse and encourage seawater direct use as industrial water;

- water saving: encourage industrial water saving with water consumption indicators;

- technology backup: develop advanced technology on desalination with industrial high-saline-concentration wastewater; promote third-party treatment on wastewater and industrial parks;

- full use of market mechanism: set proper scheme for non-residential water use; complete charge scheme on wastewater discharge fee involving water saving and tax discount scheme; complete encouraging scheme to increase industrial water efficiency;

- environmental enforcement: complete the systems of regulations and standards on industrial wastewater; enhance the supervision and enforcement; complete pollutants measuring system;

- water environment management: strictly control environmental risk on industrial corporations and agglomerations, set proper control measure to manage therisk;

- water ecosystem safety: give proper treatment on industrial wastewater to prevent underground water from pollution;

- clear division on responsibility: set clear responsibility on wastewater discharge corporations; set proper scheme to verify the targets regularly;

- public participation and supervision: publish pollution indicators; announce the situation regularly;

Water Ten is the milestone of wastewater management. The reason is not only for its high administrative level, but also the breakthroughs in many aspects. It set the tone of wastewater treatment in China. As stated in the previous, the revision draft of *Water Pollution Prevention and Treatment Law* also absorbed highlights from Water Ten. Moreover, as an action plan, Water Ten is more feasible in tackling the key problems of the wastewater management in China.

Technologies Encouraged By Policies

As stated in the previous chapter, environmental industry is policy driven, which means the policies would guide the development of the technologies and innovations. This part will list the designated wastewater treatment areas in the legislations and plans, which have called for the technology innovations.

Radioactive wastewater treatment. In the latest Water Pollution Prevention and Control Law, it emphases that the high and medium radioactive wastewater is prohibited to discharge, and low radioactive wastewater should be properly treated. In 12th FYP, nuclear power industry in China saw a rapid growth, 17 nuclear power units have been operated, and 13 were under construction. In the latest 13th Five-Year Plan for Nuclear Industry Development, it raised even higher objectives on nuclear power development. According to the joint estimation on the nuclear power development by OECD and IEA, nuclear power in China would double by 2050. The rapid development of nuclear power industry would offer a growing wastewater treatment market. Moreover, the 13th FYP for Nuclear Industry Development and 13th FYP and Vision 2025 for *Nuclear Safety and Radioactive Pollution Prevention and Treatment*, all underline the proper treatment for radioactive wastewater treatment. Radioactive wastewater treatment need special technologies, and the enhanced supervision and stricker discharge standards would all be the motivations for developing advanced treatment technology for radioactive wastewater. The entry barriers for radioactive wastewater treatment is relatively high, but they are not insurmountable. Because of these barriers, only limited player can enter the market, and once in, the market potential would be very attractive.

Online monitoring, remote control system and smart water. Water Ten and Water Pollution Prevention and Control Law all stated the importance of supervision and monitoring, and they all underline that the industrial enterprises should be equipped with online monitoring facilities for supervision departments and the enterprises should have an in-time control on the wastewater discharge. In the plans, third-party treatment is also a hotspot. The remote control system would be one of the core factors for third-party treatment, especially for small-scale enterprises. It would increase the management efficiency with the least input. Smart water is also the new trend. Smart water would provide a comprehensive control on the water situation, which would help to manage the entire workflow and optimize the wastewater reuse and wastewater treatment.

Wastewater reuse and utilization. Water Ten and *13th FYP for Green Industry Development* both encouraged the industrial wastewater reuse. *13th FYP for National Environmental Protection Technology Development* pointed out the wastewater utilization in petrochemical industry and coal-chemical industry. It also emphasized the development of membrane bioreactor, which would be applied in both wastewater reuse and utilization. Zero liquid discharge technology is the typical example of wastewater reuse and utilization in this area.

High concentration wastewater treatment. Water Ten and 1*3th FYP for Green Industry Development* have underlined wastewater treatment for high concentration pollutants, such as ammonia nitrogen, saline, etc.

List of Top 30 Companies in East China Region (Shanghai, Zhejiang, Jiangsu and Anhui)

Company Name	Headquarter Location	Total Assets*	Total Revenue	Net Profit	Specialized Businesses
Welle Envir.	Jiangsu	2780	960	120.6	Treatment of Landfill Leachate
Safbon Water	Shanghai	1770	680	77.1	PPP Model
Cec Envir.	Jiangsu	1510	610	100.9	Condensate Polishing
Atk Holding	Jiangsu	822.5	253.7	24.8	Water treatment agent
Shanghai Senon	Shanghai	579.7	333.1	31.7	Evaporation, concentration and separation equipment
Shanghai Denovo Envir.	Shanghai	365.8	330.0	28.8	MBR technology
Hangzhou Tianchuang	Zhejiang	321.1	185.9	10.1	Membrane separation technology
Haiyan Power System	Zhejiang	272.5	180.4	16.8	Condensate water treatment system equipment
Deqi Envir.	Anhui	191.3	21.1	-24.7	Concentrated treatment of heavy metal sludge
Liaoyuan Envir.	Jiangsu	151.1	145.1	18.3	Professional manufacturer of thiocyanate
Kewei Tianshi Envir	Jiangsu	148.4	74.8	0.04	Sewage treatment chemicals
Jiangsu Sinosuper Envir.	Jiangsu	110.4	64.4	7.1	Complete Set Equipment for Sewage Treatment
Hangzhou Huishui Tech.	Zhejiang	104.4	53.2	9.1	Electrochemical water treatment technology
SND H&H Envir.	Jiangsu	95.6	65.7	44.8	Treatment of industrial waste water and other hazardous waste
Zhejiang Kaichuang Envir.	Zhejiang	91.5	84.3	0.6	membrane separation technique
Suzhou Dihill Green Tech.	Jiangsu	90.1	12.3	-5.0	Recycling of industrial waste liquid
Auhui Jiaming Envir.	Anhui	84.3	14.2	-5.6	Landfill leachate treatment
Shanghai Weilai	Shanghai	83.8	73.5	12.7	Water treatment chemicals
Jingyu Envir.	Shanghai	78.2	60.0	1.4	Landfill leachate treatment
Shanghai Tongji Construction Sci.&Tech.	Shanghai	77.7	29.7	0.8	Advanced oxidation and phosphorus recovery technology
Enpr Envir.	Zhejiang	76.9	65.9	11.8	Research and development of Water treatment chemicals
Jinyuan Envir.	Jiangsu	74.9	59.3	12.1	Industrial waste water treatment system and equipment
Peier Membrane	Jiangsu	71.1	15.4	4.7	MBR system treatment
Ingreentree Envir.	Jiangsu	61.7	50.5	5.7	Heavy metal waste water pollution treatment system and equipment
Lason Chemical Envir.	Jiangsu	58.6	32.7	3.0	Composite microbial inoculants
Jiangsu Bada Sci&Tech.	Jiangsu	55.8	45.6	1.8	Design and development of water treatment equipment system
Zhongsheng Envir. Remed.	Jiangsu	50.2	27.8	6.9	Organic wastewater treatment
Anhui Huanghe Water	Anhui	49.0	20.3	0.1	EPC service
Aqua Worth (Suzhou) Envir.	Jiangsu	43.0	68.9	10.9	activated carbon filter
Jiangsu Nanzi Envir.	Jiangsu	35.4	68.4	17.3	biological agent

4. Soil Remediation Industry in China

The long-awaited *Action Plan for Prevention and Control of Soil Pollution*, so-called Soil Ten, was finally issued by the China State Council in May 2016. It is the last piece of China's ambitious action-plan trilogy to tackle air, water and soil pollution problems in China.

The main objectives of Soil Ten include improving soil quality, ensuring safe agricultural products and creating a healthy living environment for people in China. There are 231 detailed action measures involved dealing with pollution prevention, monitoring, restoration and etc.

The key objectives include:

- By 2020 to curb the nation's increasing soil pollution, by 2030 thoroughly control environmental risks of soil, and by 2050 improve the environmental quality of soil completely;
- To ensure approx. 90% of contaminated farmland and sites can be used safely by 2020, and increase this proportion to 95% by 2030;
- By 2017, to set up national-level soil environmental quality monitoring points and establish the monitoring networks;
- By 2020 arable land and agricultural products shall be concurrently monitored and evaluated based on detailed survey of soil contamination.

Technologies In Huge Demand

This Soil Ten is opening up ample opportunities for land remediation specialists of UK, US, Japan or some leading European countries.

The current gap between China's core technological capabilities of soil remediation and those of advanced economies offers foreign companies exciting opportunities, especially those possessing the proprietary technologies and know-how for in-situ immobilization, bioremediation, safe disposal and resource recovery.

According to Umore Intelligence, the Chinese government will spend 'tens of billions of yuan' each year on 'demonstration projects of heavy metal contaminated soil restoration and over-exploited groundwater comprehensive treatment' in the coming five years. Much of the polluted areas are located in the eastern & central China, the developed regions, such as the Yangtze River Delta, Pearl River Delta and etc.

The government's determination to tackle the soil pollution is not only driven by the urgent environmental deterioration but also the social and economic reasons. The contaminated land may cause a domino effect in the China's society involving the food safety, water safety and even depreciation of commercial property.

With the strong market demand and governmental support, there are enough incentives for the foreign technology companies to take this lucrative chance in China.

Where Is The Money From?

However, to profit by importing their technologies and know-how into China, these technology or solution providers need to be well prepared for a certain degree of risk.

Soil remediation is usually invisible and entangled with other environmental issues such as the underground water pollution. Its effects have such a long latent period that in many cases the original polluter is gone when the problem becomes apparent. It is thornier than other environmental issues like water or air pollution.

China needs RMB 5-7 trillion ($1 = 6.5836 Chinese yuan) to clean up the contaminated soil, according to the figure from Financial Times, equivalent to one-third of its entire foreign exchange reserves. This figure exceeds the funds already planned for water and air pollution. But different from the latters, which the investors can charge for, soil remediation has little return.
An unresolved question remains: who will play this huge bill?

In the period between 2006 and 2013, there were 48 projects with open information over the source of funding, according to the Soil Remediation Market Report 2014-2020 by Jiangsu Institute of Environmental Industry (JIEI) in 2014. The total investment was over 2 billion yuan. Around 28% was from the governmental funding, while approx. 47% was self-financed by the companies. In addition, 22% was in the form of public-private partnership (PPP). The rest 3.5% was from the donation of GEF, the Global Environmental Facility.

The government, EPC contractors, and mainstream media, although have all tried to answer this pending problem of financing, alas none of them has found the silver bullet. But for the foreign technology companies, the good news is that this is not the major question they should worry about. Instead, the very first challenge they face is what Chinese companies they should approach and partner with.
In other words, who are the indigenous big players now in the soil remediation in China?

Who Should You Partner With?
In 2015 *Umore Insights* conducted a thorough research and summarized the Big Seven as the top players in the current soil remediation sector in China:

- BCEG Environmental Remediation Co., Ltd. (BCEER)
- China Energy Conservation DADI Environmental Remediation Co., Ltd (CECDADI)
- Yonker Environmental Protection Co., Ltd. (Yonker)
- Beijing GeoEnviron Engineering and Technology, Inc. (BGE)
- Zhongke Dingshi Environmental Engineering CO., Ltd (Dingshi)

- Suntime Environmental Remediation Co., Ltd. (Suntime)
- Shenzhen Techand Ecology & Environment Co.,ltd. (Techand)

As shown in the figure above, over half of the major competitors are from Beijing. It reflects the nature of environmental protection projects in China: a close and strong tie with the government is half success. Many foreign companies, especially the SMEs, usually start off their China entry on the wrong foot as they barely have any local network. This is especially true in the soil remediation market. All of these top players were originally made by their strong network in the industry rather than any excellence in technology. It is necessary to develop an accountable local partner or middle-man to introduce your technology or products to these big players. This is a wise and proven channel for the foreign technology companies to break into this ‘established’ market.

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