

# China's Pesticide Industry Must Strengthen Pollution Control

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A Pesticide industry must be transformed and upgraded.

## 1. High output and low net profit

In 2011 China produced 2.65 million tons of pesticides, however, the total sales value (including the sales value of pesticides and other chemicals) accrued by domestic pesticide enterprises was only RMB200 billion (around US\$31.7 billion). China had more than 3 000 pesticide plants, and their total sales value of pesticides was only US\$10.1 billion in 2011, less than the sales value achieved by a single multinational corporation like Syngenta. The sales profit rate of the domestic pesticide industry is far below that in the developed countries. Profit per ton of product in China lags especially far behind that of advanced multinational corporations.

## 2. Low technical level

The pesticide technical level includes the quality of pesticide technical, processing technology and automation level of pesticides as well as the technical level of waste treatment (waste gas, wastewater and industrial residue). Especially in R & D capability and discovery level of pesticides, China still lags far behind the developed countries. China's pesticide industry still remains in the stage of combining imitation and innovation, relying mainly on imitation. Pesticides belong to the fine chemical industry, but China's pesticide makers are not very refined.

## 3. Development of the pesticide industry has a negative effect on the environment

According to the estimate of the pollutant generation and discharge coefficient in the pesticide industry obtained from the national census of pollution sources organized by the Ministry of Environmental Protection of China (MEP) and others in 2007, producing one ton of pesticide can discharge around 50 tons of sewage. The pesticide industry has great impact on the environment, and solving the problems of pesticide pollution has become the primary task in transforming and upgrading the industry.

## B Pollution control tasks cannot be delayed

The transformation and upgrading of the pesticide industry includes the following aspects. First, adjust the pesticide industry structure, expand the scale of pesticide enterprises and improve their competitive edge through mergers and acquisitions and through their development. Second, adjust the product portfolio of pesticide makers, renovate varieties, strengthen product innovation and process innovation, improve the overall technical level of the pesticide industry, improve the added value and the profit per ton of product, and strengthen enterprises. Third, strengthen environmental protection and fundamentally solve the pesticide-related environmental problems.

After over 60 years of development, China's pesticide industry has not only built a relatively complete system, but has also developed and trained a number of high-end sci-tech talents, a precondition for improving the overall technical level of the pesticide industry and fundamentally solving the pollution problems.

To overcome the environmental problems of pesticides, the industry must reduce or eliminate waste gas, water and residue from the source of production and treat the pollutants.

The keys to achieving clean production of pesticides through reducing or eliminating wastes at the source are innovation in the synthesis process, improving the atom economy of the reaction, and integrated innovation in treatment processes.

## 1. Innovation process for imidacloprid production

Imidacloprid is the biggest selling insecticide in the world. In 2011 the global sales value of imidacloprid exceeded US\$1.5 billion. Imidacloprid, which was the first nicotine insecticide developed and commercially produced by Bayer CropScience, went on sale in 1991, and now its patent has expired. At present, China's output of imidacloprid has reached around 30 thousand tons, and China has become the largest producer and exporter of imidacloprid in the world.

2-Chloro-5-chloromethyl pyridine is one of the key intermediates for imidacloprid production. In the course of imidacloprid development, with the constant improvement for the technical level of intermediates and the improvement of the overall process technology, the quality of imidacloprid technical has improved constantly and the production cost has been reduced continually. The price of imidacloprid technical in China reduced from RMB1.2 million per ton in the early 21st century to RMB100 thousand-120 thousand per ton in 2011, and rebounded to RMB150 thousand per ton in 2012.

China has already developed six 2-chloro-5-chloromethyl pyridine industrial processes, three of which start from pyridine derivatives, and the remaining three are cyclization routes. At present, more than 95% of the imidacloprid production units in China use cyclopentadiene-acrolein production process of cyclization routes. The process discharges much waste gas, water and residue, and the wastewater has a high content of COD and inorganic salts, and contains complex organic components. Producing one ton of imidacloprid (100% active ingredient) can produce around 20 tons of high concentration wastewater that is very difficult to treat and seriously pollutes the environment. The survival of imidacloprid depends on fundamentally solving the related environmental problems.

Zou Xiaomao, professor of the Research Institute of Elemento-Organic Chemistry and the State Key Laboratory of Elemento-Organic Chemistry at Nankai University and his team undertook the 863 Plan research project "Research of Imidacloprid Innovation Process and Development of Wastewater Treatment Technology," with support of the Ministry of Science and Technology of China. Guided by the principle of sustainable development, they have developed innovative and clean processes that hardly generate any waste, have already realized large-scale industrial production and have applied for international and Chinese invention patents. The most important technology involved is an innovative synthesis technology for the key intermediate 2-chloro-5-chloromethyl pyridine. The core of the technology is to improve the atom economy of the reaction while solving the problem of wastes at the source.

At present, most of the cyclization processes for the production of key imidacloprid intermediate 2-chloro-5-chloromethyl pyridine in China use phosphorus oxychloride, and producing one ton of this intermediate currently generates nearly 10 tons of wastewater containing a high concentration of phosphorus. Based on the current annual output of around 30 thousand tons, around 200 thousand tons of wastewater is being generated each year. Besides, the wastewater contains a large amount of DMF (20 thousand-30 thousand tons of DMF is discharged to the environment each year) or its decomposition products, phosphoric acid and other organic impurities, and the COD of the wastewater exceeds 200 thousand mg/L. Using the conventional wastewater treatment methods, the treatment cost is very high and it is difficult to achieve the desired effect. So these treatment methods do not meet the sustainability requirements and have become a kind of bottleneck in the production and application of imidacloprid. At present, treated wastewater does not meet the discharge standard. In addition, the yield in this step of the reaction is relatively low, being only 65%-70%.

The final step for imidacloprid production is a condensation reaction. The yield of the most advanced imidacloprid units in China is 78%-85%. In this reaction, producing one ton of imidacloprid generates 3-5 tons of wastewater, and based on the current domestic output, 90 thousand-150 thousand tons of wastewater is produced each year.

Four domestic enterprises use the new imidacloprid clean production process, promoted by the Pesticide Innovation Industrial Alliance, and those four firms' combined imidacloprid capacity has reached 12 thousand t/a. The application of new process will annually generate RMB100 million-200 million of direct economic benefits for domestic imidacloprid enterprises, reduce the discharge of high-phosphorus wastewater into the environment by RMB200 thousand-300 thousand tons, and decrease DMF discharge by 20 thousand-30 thousand tons.

## 2. Sewage treatment in the course of glyphosate production

Improving the atom economy of a chemical reaction can reduce or eliminate waste. However, some wastes like methyl chloride being produced in the course of glyphosate production cannot be reduced or eliminated.

"Chloride Cycle Patented Technology" developed by Zhejiang Wynca Chemical Industrial Group Co., Ltd (SH: 600596) has realized the cyclic utilization of methyl chloride-hydrochloric acid in the glyphosate-silicone cogeneration unit. The advanced technology has been recognized at home and abroad. In recent years, Zhejiang Wynca Chemical Industrial Group Co., Ltd has also developed "Phosphorus Cycle Patented Technology" to completely solve the sewage treatment problem of glyphosate production.

In recent years, there have been many successes in waste treatment at China's pesticide plants. All of these examples show that by relying on science and technology, China's pesticide industry can develop sustainably, and transform and upgrade itself.