

**IFA PRODUCTION AND INTERNATIONAL TRADE CONFERENCE**

**Fairmont Le Château Frontenac – Quebec City (Canada)  
13-14 September 2001**

**OUTLOOK FOR FERTILIZER PRODUCTION  
BY MEDIUM AND SMALL NITROGEN AND PHOSPHATE  
PLANTS IN CHINA**

**by**

**LI Zhijian  
China National Chemical Planning Institute  
CHINA**

# OUTLOOK FOR FERTILIZER PRODUCTION BY MEDIUM AND SMALL

## NITROGEN AND PHOSPHATE PLANTS IN CHINA

by

LI Zhijian

China National Chemical Planning Institute

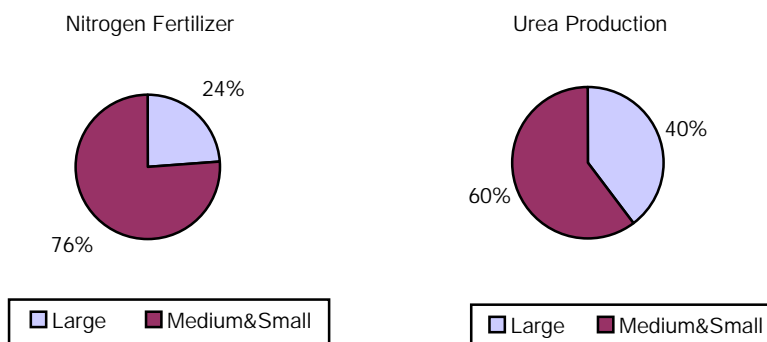
CHINA

### 1. What are medium and small scale plants ?

Fertilizer production from medium and small scale plants is a very special field in Chinese fertilizer industry. The medium and small plants include : 1) medium nitrogen plants : the plants with ammonia capacity between 80~200 kt/a ; 2) small nitrogen plants: the plants with ammonia capacity below 80 kt/a ; 3) medium phosphate plants : the plants with capacity of 30~60 kt/a  $P_2O_5$  ; 4) small phosphate plants : the plants with capacity below 30 kt/a.

The number of medium nitrogen plants has totaled more than 90 and their overall capacity has reached 25% of total capacity in China. These plants mainly produce urea and ammonium nitrate.

The small nitrogen plants, who mainly produce ABC (ammonium bicarbonate), as well as urea and ammonium chlorate, taking 50% of the total nitrogen fertilizer capacity.

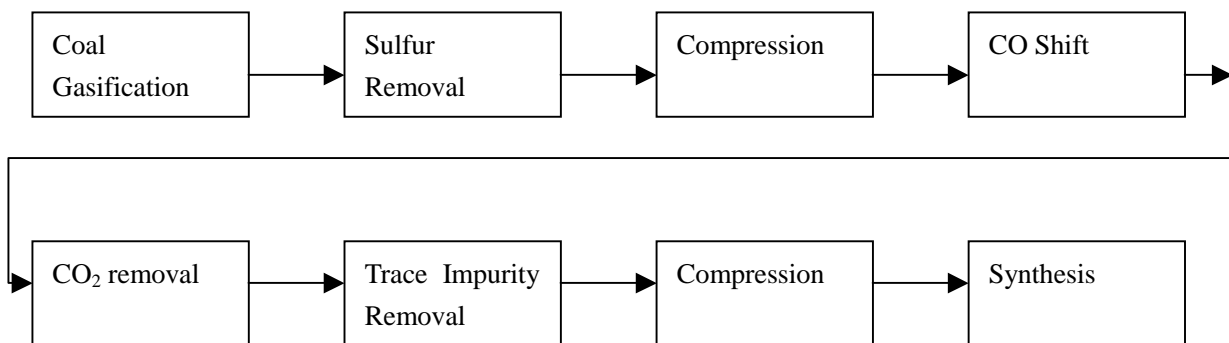


Medium and small phosphate fertilizer plants refer the plants that 1) use domestic technologies and 2) producing SSP or FMP or that converted to MAP/NPK. There are only 10 large phosphate fertilizer plants in China while there are 400 small and medium-phosphate ones. In the year 2000, the medium and small plants produced 790 kt of MAP, 590 kt of NPK and 4,280 kt of SSP and FMP. The production of medium and small plants amounted to 5,630 kt and took 85% of the total phosphate fertilizer production.

## 2. Technologies

The medium and small plants originated from 1950's, when the gate of the China was closed and foreign technology and equipment were not available. So that Chinese engineers designed the process based on their experience. These plants all use domestic equipment. The medium and small plants are naturally backward compared with the large plants imported from western countries since 1970's. However, the medium and small plants has been developing continuously in past decades and their technologies are greatly improved. Especially, the products of small plants converted from ABC and SSP to urea and MAP since the end of 1980's. The wide-scale change affects more than 200 small plant and enlarges the scale of medium and small plants to a higher level, even 10 times than original for some plants.

Now the typical process for a medium and small nitrogen plants is :

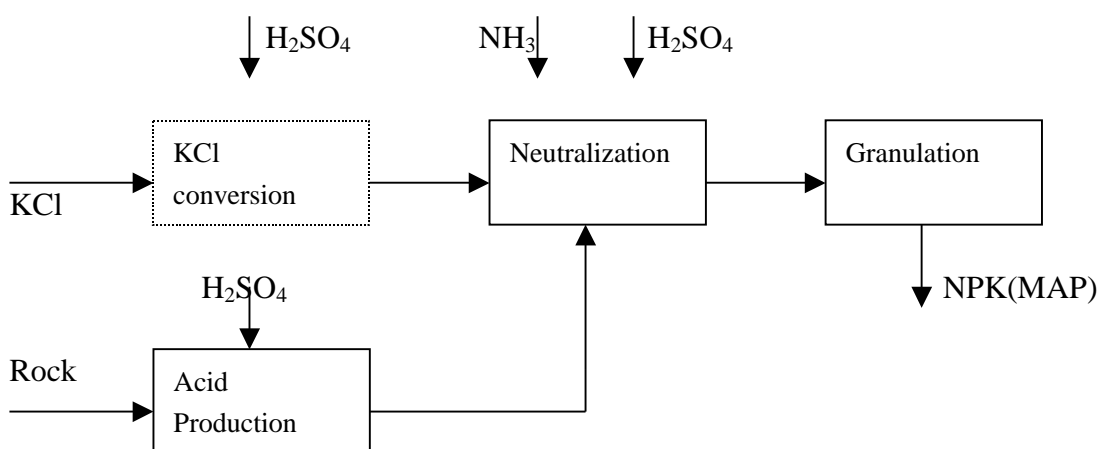


The coal gasification mostly based on lump anthracite or coke which is gasified at atmospheric pressure with air. The compressors are driven by electric motors. So the coal and electricity are two most important factors in the total production cost. Some new gasification technologies are developing in China but seldom used due to technical risks or high cost of these technologies.

The urea technology for small and medium plants is typically total solution recycle process of 1960's, except for several plants, constructed after 1980's, using imported technologies such as CO<sub>2</sub> stripping or NH<sub>3</sub> stripping process.

The ABC production is rather simple compared with urea. In ABC process, the CO<sub>2</sub> removal is integrated with ABC production.

A typical medium and small MAP/NPK process is as follows :



The small and medium MAP plants mostly use lower grade rock as material, and produces 11-44-0 as final product.

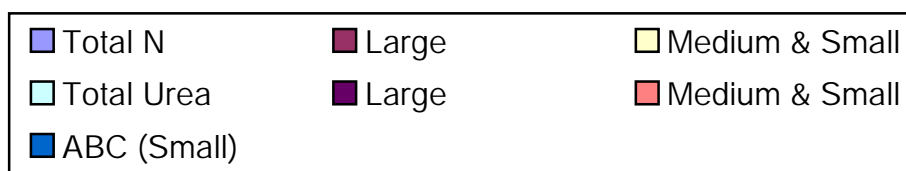
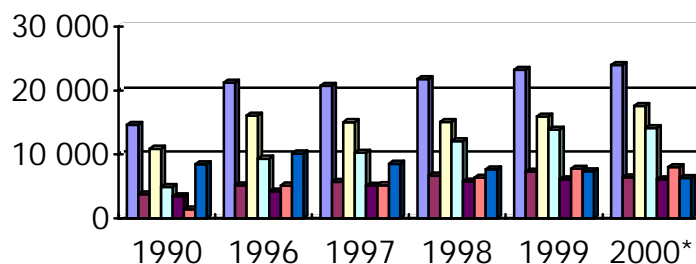
Some MAP plants have been changed to NPK (chlorine-free) production by adding a KCl conversion section, where the KCl is dissolved by sulfuric acid to obtain potassium hydrosulfate and hydrogen chloride. The product has a good market in China and has been an important compound fertilizer.

For the technology and equipment of medium and small plants are from domestic market, the investment of new plants and renovation plants is rather low. These plants also use cheaper energy and materials. They are key reasons that these plants still exists and compete with world-scale plants in China.

### 3. Production

The production of small and medium plants is the most active and potential part in the fertilizer production in China. Now it is still takes a lion's share in the total production in China.

In the last five years, the total production of nitrogen fertilizer and the production of small and medium plants are as follows : (kt)

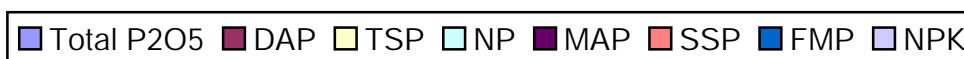
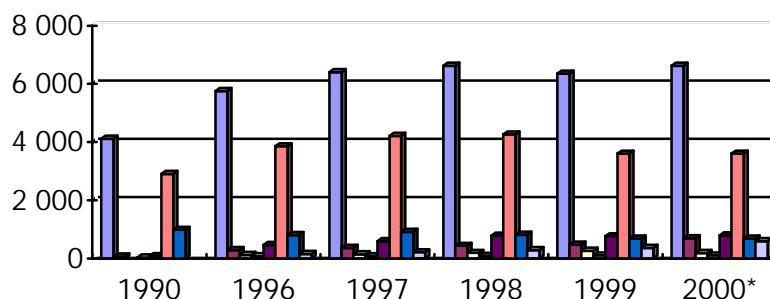


In the last decade, the total nitrogen fertilizer production increased by 60%, or an growth rate of 4.8% per annum. During last decade, 13 new large scale plants were commissioned but other 3 large ones were closed. Thus the total nitrogen production of large plants increase by 2,658 thousand tons.

However, the nitrogen fertilizer production of small and medium plants increased by 6,683 thousand tons, accounting for 72% of the total increment. Especially for urea, the total production of small and medium plants increased by 6,604 thousand tons while that of large plants only increased by 2,630 thousand tons.

The rapid growth of medium and small nitrogen fertilizer plants is due to two reasons : first, the small urea plants has a large design margin and they are very easy for de-bottle-necking, and second, the free market price policy (without control for a ceiling price) for small plants brought a lot of profit for further capacity expansion. A typical example is that the 120 small urea plants, converted from ABC, with designed capacity of 40 kt/a is now operating at 100~120 kt/a.

For phosphate fertilizer, there are similar stories, which could be reflected by the following table. (kt)



2000\* Preliminary

The production from large phosphate fertilizer plant, mainly produce DAP, TSP, NP and some NPK is undergoing rapid increase in recent years, reflecting by more than doubled DAP production in last 5 years. But the high analysis fertilizer from medium and small fertilizer plants also increased sharply, for example, the two products mainly from small and medium plants--MAP production nearly doubled and NPK production nearly tripled in the last 5 years.

However, the production of low-analysis fertilizer – SSP and FMP, was quite flat even decreased gradually in last years, reflecting the demand and re-structuring in the fertilizer market.

#### **4. Influential Factors to the Future of Small and Medium Plants**

The future of small and medium plants is very difficult to predict clearly, for there are too many plants with different circumstances and also there are many factors that will influence the competitiveness and survival of them. The following factors may be the key factors that will play an important role in the production of medium and small plants.

##### **4.1 Governmental Policies**

The small fertilizer plants enjoy value-added tax (VAT) exemption. Due to WTO rules, the policy will not exist for a long time upon China joins WTO. The VAT reduction on urea and DAP will phase out before the year of 2004. That will affect a lot of small and medium plants by increasing the production cost by around 5%. Although the bleak domestic market in last five years has proved that domestic competition may be stronger than that from abroad, some small and medium plants will be more difficult to survive in market competition if policies change.

But generally speaking, the government will still support the modernization and renovation of small and medium plants, may through other ways, for medium and small plants are so important to keep the fertilizer market stable. The support may be from investment support, research and development support and etc.

##### **4.2 Technology Upgrades**

Imported technologies, suitable for large-scale plants, are normally expensive for medium and small plants. So traditionally, the medium and small plants mainly rely on domestic technologies. The technologies of small and medium-sized plants are under progressing and even breakthrough in last years, and may develop further in the future. The development of new technologies will be key factors that affect the medium and small fertilizer industry.

The coal gasification technology is the most important factor for medium and small ammonia plants. Now the gasifier for medium and small ammonia plants is a very old one and in which only lump anthracite coal can be used. The anthracite is produced at several limited areas in China but other coals such as bituminous is widely distributed in China. Due to transportation and mining problems, the prices of anthracite coal is increasing year by year and the advantage of cheap material is gradually eroded.

Advanced coal gasification technologies have been sought for a long time since 1980's, but the imported technologies such as TEXACO and LURGI gasification proved to be expensive and are not suitable to small plants. Some Chinese researchers are developing new gasification technologies, especially suitable for small and medium plants. Breakthroughs are possible to be obtained recently. If these technologies are widely adopted by small fertilizer producers and the material for them could be changed from expensive anthracite to cheaper coals, the production cost of small and medium plants could be reduced drastically.

In small and medium phosphate plants, new technologies for acid attacking of phosphate rock have been developed by Chinese engineers. Through the technology, the phosphate acid capacity could be easily doubled or even tripled with low investment. The extra acid produced could be used as feedstock for NPK or MAP. If cheap sulfuric acid or sulfur is available, the capacity of small and medium plants has a large potential to increase.

Another technology should be mentioned is that the feedstock of sulfuric acid production of small and medium plants have been changed from totally pyrite to sulfur or mixture of sulfur and pyrite, for the domestic technology for burning sulfur and sulfur/pyrite mixture is mature in last years. When the international sulfur prices are low, the sulfuric acid produced shall be cheaper than that from pyrite.

The urea-based NPK is another technological breakthrough that affects the medium and small plants. Formerly, urea is difficult or impossible to be used as material for NPK production for its physical properties. Even when NPK market is very strong, fertilizer producer could only use ammonium chloride or other nitrogen fertilizer as nitrogen source. Through year's endeavor, the urea-based NPK technology has been mature and it is now promoted in China. Through this technology, a lot of small nitrogen fertilizer plants converted part of their urea production to NPK, whose nutrients could be adjusted to the demand of local market. That will also enhance the competitiveness of small and medium plants.

#### 4.3 Construction of Large Plants

Production of large plant is another competitive factors for small and medium sized plants. Fortunately for small and medium plants, only a few plants is estimated to be constructed in the near future. On the contrary, some large nitrogen plants has been converted to hydrogen plants or closed.

Up to now, three large plants has been closed :

#### Large Plants Closed

Name of plants	Capacity (N)	Year of Stopped
Wujing Chemical Plant, Shanghai	240 kt	1997
Guangzhou Petrochemical Plant, Guangdong	240 kt	1999 (converted to hydrogen)
Qilu Petrochemical Plant, Shandong	240 kt	2000 (converted to hydrogen)

For the future of other naphtha-based plants, uncertainties still exist, although plans to shifted materials to cheaper coal have been announced.

And the construction of new large plants is very limited :

#### Large Nitrogen Fertilizer Plants Under Construction

Name of plants	Capacity (N)	Year of Start-up
Fudao II Plant, Hainan Island	370 kt	2003
Lutianhua Group, Sichuan	320 kt	IDF

In the near future, we could predict that the large nitrogen plants will not the main contributor for fertilizer production and the surplus on nitrogen fertilizer could be eased. Small and medium plant will have a larger room to survive.

The construction of large phosphate fertilizer projects is better than that of nitrogen projects.

The large projects to be commissioned in near future are :

#### Large Phosphate Plants Under Construction

Name of plants	Capacity (P <sub>2</sub> O <sub>5</sub> )	Year of Star-up
Yunnan Phosphate Fertilizer Factory, Yunnan	300 kt	2002
Yunnan Honghezhou Phosphate Co.	150 kt	2005
Tongling Chemical Industry Co.	120 kt	2001

For the strong phosphate market demand, the small and medium plants also have possibilities to increase their capacity and will also play as an important role in MAP and NPK supplier. The large plants are not necessarily economic than small and medium plants, the small and medium plants will compete with them in the market.

#### 4.4 Competitiveness of Imported Fertilizer

After China join the WTO, the fertilizer quota system will be phased out and replaced by the tariff quota system. It is reported that the tariff quota for urea and DAP would be 1,300 kt and 5,400 kt, and enlarges gradually to 3,300 kt and 6,900 kt at 6<sup>th</sup> year. The tariff quota for NPK would be 2,700 kt and also enlarges at 5% annually.

People worried that the opening of the gate to imported fertilizer would bring strong impact to domestic producer, especially to small and medium plants. The fact in recent years is that, not imported product but the domestic competition dropped the market price to historic level and consequently forbid some producers to closure. Compared the market price of domestic and imported fertilizer, the domestic products are competitive in market price but not famous in brand.

Spot prices of some fertilizer in China (Aug,2001)

Name of product	Market Price Yuan/ton	Yuan per nutrient
Imported DAP (18-46)	1900	29.68
Domestic MAP(11-44)	1350	24.55
Imported NPK (17-17-17)	1900	37.25
Domestic NPK(15-15-15)	1450	32.22

According to the market situation, we estimate joining WTO will bring impact to some plants with high production cost, but not to the whole industry. The small and medium plants survived at low market prices in the last years will mostly still survive.

### 5. Future

The future of small and medium plants will be focused on restructuring, de-bottle-necking and expansion at the sites with cheaper materials. The overall production will continue to grow while the production of large plants will be flat or slow increase. The production of small and medium plants will be from the change of the following :

#### 5.1 Technological Reforming

As mentioned above, the technological break-through may evolve a revolution in small and medium plants. It could happen at three aspects :

Firstly, if the domestic coal gasification technologies are mature, the chief feedstock of small and medium plants will be converted from expensive anthracite to cheaper bituminous coal. This change will drastically drop the production cost of small and medium urea plants.

Secondly, new technologies will double the capacity of existing small and medium plants at low expenses. For example, a 100,000 t/a urea plant with total solution recycle process could be reformed to 200,000 t/a through stripping process. A 30,000 t/a P<sub>2</sub>O<sub>5</sub> phosphoric acid plant could be increased to 60,000 t/a even 90,000 t/a by new acid attacking technology.

Due to there are so many plants, how many of them will be reformed and the total potential capacity increased is very difficult to predict.

Thirdly, the product structure of small and medium plant will change from single-nutrient fertilizer to complex fertilizer, and also from low-analysis fertilizer to high-analysis fertilizer in general. For the NPK from urea and from MAP production are mature now, it is possible for small and medium plants to convert some urea or MAP to NPK according to local market situation. Actually, this change has happened and will continue in the future. The NPK produced from small and medium plants is also a competitive factor to Urea or DAP.

### 5.2 Plant Number and Single Plant Capacity

Due to the severe market competition, a lot of small and medium fertilizer plants have been closed in last five years, especially in nitrogen fertilizer sector.

We estimate at the beginning of 2001, the small and medium nitrogen plants in normal operation shall be less than 400, shrinking from 700 in 1996. The number of small phosphate fertilizer plant is more stable than nitrogen plants, although some SSP plants operate periodically.

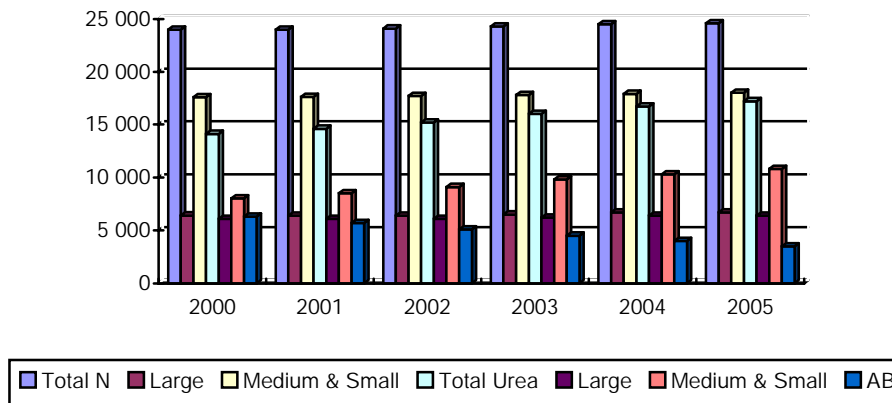
We predict that the number of small and medium nitrogen plants will be reduced to 350 and that of small and medium phosphate plants will be 400. The closure capacity of small and medium plants will be compensated by the expansion of small and medium plants of high-efficient and low-cost production.

In fact, a lot of small and medium plants have reached the capacity of more than 200 kt/a of nitrogen or 100 kt/a of phosphate. Even with a hat of small or medium, the actual capacity is similar to large plants. The difference of small and medium plants with large plants is becoming smaller and smaller. Maybe in far future, the small and medium plants will be just a so-called name without clear definition.

### 5.3 Forecast of Production

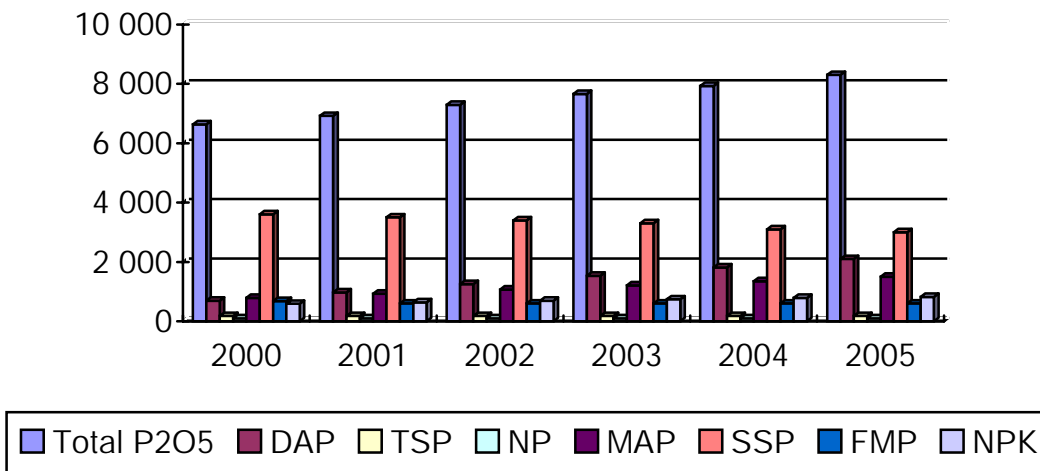
The medium and small plants may meet a lot of challenges in the future; the challenges may come from the opening to the imported product, the increase in feedstock prices, or the decrease in product prices. But as the lessons they have learned before, the production from small and medium plants will still grow, although some may be closed at fierce competition.

The small and medium nitrogen plants' fertilizer production is estimated as follows ( kt/a ) :



The small and medium fertilizer production will be the main contributor for the increase of urea production. And the total production will be stable while the ABC production keep downward to lower level.

The phosphate production in the next five years is estimated as follows : (kt/a).



The total phosphate fertilizer production may grow to 8,300 kt/a at 2005 or a 5.7% per annum growth rate, mainly from DAP, MAP or NPK production. Production of other phosphate fertilizer will be flat or slightly down ward. Of course, the large DAP production will increase at a rapid speed ; but the small and medium MAP/NPK plants also plays an important role in the growth.

## 6. Conclusions

- Small and medium plants are not advantage in technology, but not necessarily less competitive in production cost, for they can use cheaper materials and their fixed cost is low.
- Small and medium plants plays an important role in fertilizer production in China ; their production will be affected by governmental policies, technology upgrades, construction of large plants, and imported products.
- The future of small and medium plants is optimistic ; the production is expected to increase in urea, MAP and NPK.

Thank you for your attention.