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Tel. +33 1 53 93 05 00 - Fax +33 1 53 93 05 45/47 - ifa@fertilizer.org - www.fertilizer.org

# CAN LOCAL ADAPTATION WORK WELL TO PUSH TECHNOLOGY ADVANCEMENT ?

Fang Xueyun,
Sinopec Zhenhai Refining & Chemical Co. Ltd., China.

Zhenhai Refining & Chemical Company Limited is a large-scale enterprise with a total processing capacity of 16,000,000 tpa. Its residue oil type fertilizer plant, with a capacity of 300,000 tpa ammonia, 520,000 tpa urea, is the first of its kind in China, and has been in operation since the early 1980s. The ammonia plant was imported wholly from UBE, a Japanese company. The design of the urea plant was made with the co-operation of foreign companies while its equipment were fabricated locally. It was a successful model for local adaptation of key equipment and received a national prize for local fabrication of a key equipment in December 1987. For years, we have been insisting on the technology advancement, continuously exploring ways for local fabrication, bravely innovating and revamping old facilities with domestic technology. We succeeded in the technical revamping with capacity expansion over 20% and adaptation of poor feedstocks through enforcing the use of local spare parts and fabrication of supply materials. It played an important role in reducing cost, expanding production capacity, and controlling material consumption.

In this regard, we took the following measures:

## 1. SUBSTITUTION OF FOREIGN PRODUCTS BY DOMESTIC ONES AND LOCAL ADAPTION OF SPARE PARTS AND MATERIAL

Since complete ammonia plant was wholly imported adopting foreign technology, from the very beginning, water stabilizers, CO-shift catalysts, synthesis catalysts (so-called "three agents") and spare parts all had to be imported from abroad. As estimated, the value for the imported "three agents" and two-year spare parts amounted to more than RMB 20 million (circa USD 2.5 million). In order to reduce the cost and expenditure of foreign exchange, we placed fabrication work on top priority and conducted the work mainly through the following three ways.

### 1.1 Conduct R & D with our own initiative

As our company is situated at coastal area, the chloride ion in the water is high. In the original design, imported HP-303 Mo series water stabilizers were applied. Their prices were high and performance was not as good as what we expected. In order to reduce the cost and improve the performance of corrosion inhibition, the research center of the company took the development of water stabilizers as an important research subject. As the result, the Z981 phosphorous series water stabilizer was successfully developed after repeated experiments and produced by our Industrial & Trade Company. Not only

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Address: ZhengHai District, NingBo City, ZheJiang Province, China
Tel: +86-574-6456425

its performance was superior than that of the imported material, but also the production cost was reduced by one third.

## 1.2 Make full use of the successful experience of domestic analogous plants to substitute the imported catalyst

For example, from the market research, the price of imported CO-shift catalyst K-8-11 was RMB 300,000 per ton while the price of domestic QCS-01 was only half of the imported product. After analysis and demonstration, we not only put it in high and middle temperature conversion, but also in low temperature conversion for the first time. Therefore nearly RMB 10 million could be saved for each catalyst replacement.

Similarly, though successful experience already existed in using domestic ammonia synthesis catalyst $A_{110\text{-}H}$, there was no precedent for the whole converter catalyst using pre-reduction at that time. We first made the whole converter catalysts pre-reduction to assure good activity of catalysts. Meanwhile, we intensified process control, increased harsh conditions in operation and extended the service life of catalysts. Up to now, the service life of catalysts has amounted to thirteen years and with good activity. Today, the "three agents" of large scale fertilizer plant are produced locally.

## 1.3 Assimilate and innovate the advanced technology of foreign countries

As wrapped tubular heat exchangers have the advantages of compact structure, large heat transfer area and heat transfer for multi-media at the same time, it is widely used in the large-sized nitrogenous air separation unit and methanol washing unit at low temperature in the large-sized fertilizer plants. Since this imported equipment was very expensive, we began to do the local adaptation work in the fabrication of wrapped heat exchanger in 1999. Through R & D on the engineering aspects, such as, process calculation, design software development, standard formulation, manufacture and debugging for the wrapped heat exchanger, etc., we determined the flow characteristic parameters for the shell side of wrapped heat exchanger, set up the related equation, established the first national enterprise standard for wrapped heat exchanger, passed the review and approval of the National Pressure Vessel Technical Committee, and took this as the basis for the manufacture, inspection and acceptance. We also completed the wrapped tools of international advanced level, and at the same time developed Cr-Mo steel wrapped heat exchanger to replace two pieces of shell and tube heat exchangers with huge volume in the original design of methanation unit, thus opening up the new application field for this type of heat exchanger. These passed the feasibility evaluation of the national key equipment project for local adaptation of large-sized complete chemical fertilizer plant in the tenth five-year plan. The local adaption of multi-stream wrapped heat exchanger, possesses completely local intellectual property right. Currently, the wrapped heat exchanger has already successfully entered into the domestic market.

Gasifier burner is the core equipment of the gasification process of Texaco Company, USA. Due to its high price and short service life, the burner has long been the bottleneck, affecting the normal operation of plant. In order to solve this problem, we made great effort to develop the locally fabricated burner, focusing on the structure and material to improve the burner. As the result, the service life of locally fabricated burner reached 13 800 hours against the 8 157 hours for imported ones and many technical

performances were superior than that of Texaco Company as well. Evident achievements have also been made in other sections of the gasification system. In 1999, the Global Gas & Power Department of Texaco Company awarded us as the best oil gasification consumer. Today the local adaption of our spare parts has reached over 95%.

## 2. ADOPT LOCAL EQUIPMENT, REVAMP IMPORTED PLANT TO EXPAND CAPACITY

With the maturity of the urea process technology, the competition of urea market is in essence of the cost and profit. Therefore, to remove the bottlenecking restriction, expand production capacity, explore the potential for energy saving and, above all, reduce the cost and increase profitability has become the crucial factor for competitiveness. As we have gradually developed our own core technology based on the assimilation of imported technology for years, we are able to modernize the imported equipment. Therefore, we decided to revamp the plant and expand its capacity by using domestic equipment.

In the modernization of the plant with capacity expansion, the vital part of the revamp for air separation unit was focused on the renewal of plate heat exchanger. We rearranged the process flow diagram, that is, change the original plate switch-over, self-cleaning process to the molecular sieve purification process. With the revamp of the upper tower of air cooling, tower in air separation unit, the gas purification system and heat exchanger process, we enhanced the safety reliability of the air separation unit by simplifying operation procedure, while increasing the cooling effect and decreasing the loss of temperature. With comparison to the former process, the yield of oxygen and nitrogen increased by 3.2% and 5.48% respectively under the condition of 100% designed processing air volume.

As for the air separation capacity, we increased the shaft power of nitrogen compressor from original designed 13 465KW to 15 130KW, resulting in an additional 10% capacity expansion that create the precondition for providing high-pressure nitrogen to refinery. According to the successful experiences on nitrogen compressor revamp, during the construction of the new CFB (Circulating Fluidized Bed) boiler, we revamped the turbines of two boiler feed water pumps in the old system, increased steam flow area to raise the turbine output power, and furthermore, met the need of water supply for recycling fluid bed boiler.

The revamp of the 4115-C5 methanol water-separation tower of methanol washing unit: The tower body shall remain unchanged but the former Linde bubble cap trays were replaced by domestic high efficiency complex trays. Thanks to the evident increase of capacity and apparent drop of water content in products leaving from the top of the tower, the water content in methanol dropped from 1.6-2.1% to 0.5-0.7%. With such achievements, the equipment corrosion was brought under control; the operation cycle of heat exchangers within the system was extended; the chemical washing frequency for heat exchanger was extended from original once a year to once every two years. As the result of dropping of water content in methanol, the circulation volume of methanol decreased by nearly $3m^3/h$, so the power consumption of various pumps also decreased, thus promoting the improvement of operating performance. Owing to the

reconstruction of the methanol-water separation tower, the methanol content at the bottom of the tower decreased, the methanol consumption per ton of ammonia product also witnessed a marked drop, which played a very important role in the stable operation of the whole unit.

The gasifier is the key part of the ammonia synthesis unit. During the revamping for capacity expanding, local adaptation of the gasifier was a symbol of the whole modernization project. We insisted on local technology: domestically designing and manufacturing the equipment. After the unit was put into operation, significant economic benefits and social benefits were obtained. Various economic and technical indexes were changed for the better remarkably. Urea output reached $682x10^3$ tpa, setting the best record of annual output of domestic single large fertilizer unit.

## 3. CONDUCT MODIFICATION ON PROCESS FLOW AND ADJUST FEEDSTOCK AND PRODUCT STRUCTURE

In recent years, due to domestic oil price decontrol, urea production enterprises based on oil as feedstock were generally faced with losses. In order to break away from this difficult position, we carried out process flow modification targeting at the adjustment of feedstock and product structure in the following two aspects: first was to build new methanation unit producing hydrogen product. Thus the product structure was turned from producing single urea product to diversified production pattern, that is keeping the urea production as our main line, we also supply hydrogen, nitrogen and compressed air to refinery, and selling liquid nitrogen and liquid ammonia. Therefore, the fertilizer product chain was extended properly, so the ability to resist against market risk was greatly improved. Secondly, the development of adopting poor feedstock. The renovation of carbon black recovery system was the associate project of the above with the process flow fully developed by our corporation. Its successful development created conditions for the stable operation of the gasifier. So we could directly use oil-free asphalt with high ash content and viscosity as feedstock of the gasifier to achieve the target to use the poorest feedstocks.

The success of the renovation of carbon black recovery system established a precedent for raw oil deficiency among domestic enterprises of the same kind, its economic benefit was apparent and production costs were dramatically reduced compared with that of using residue as feedstock. And at the same time, the outlet of oil-free asphalt was also solved. In so doing we were lifted out of this difficult situation and improved our ability for survival in the market.

The deep deficiency of the feedstock of the gasifier has also far reaching social benefit. According to present experience of international petrochemical industry, the most effective equipment dealing with toxic, harmful and sulfur containing wastes is the gasifier, its sulfur recovery ratio is nearly 100%, and is higher than that of other equipments. Its environmental benefits are also very obvious. Our work of feedstock deficiency of gasifier paved the road of adopting this technology in our country. Although we have made some achievements, in the work of local adaptation, our level is not high enough compared with our international colleagues. There is still a long way to go, and we must build our confidence, redouble our efforts and make contribution to further increase the home-made ratio of the unit.