CHINA'S NUCLEAR TECHNOLOGY FOR ECONOMY GROWTH

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ABSTRACT

The transfer of nuclear technology to practical applications in energy, agriculture, food, industries and others has made important contributions to the prosperity of the national economy and the improvement of living standard of Chinese people in the past 40 years. Facing the great challenges in upcoming years, sustained efforts are needed to promote industrialization, commercialization and internationalization of nuclear technology. Rapid economic growth is providing the golden opportunities for the development of nuclear technology in China. With the trends to globalization of economic development, civilian applications of nuclear technology will have to be involved in international co-operation and competitive world markets to narrow the gap between China and other developed countries in the world in the next century.

INTRODUCTION

Since the first nuclear reactor and the first charged particle accelerator were put into operation in China, nuclear technology has passed over 40 years. As is commonly known, nuclear technology has both military and civilian utilitarian values and serves both peaceful and national defence purposes. The early program was successfully carried out by Chinese nuclear experts under the planned economy focusing on developing atomic and hydrogen bombs and nuclear-powered submarines. Up to the 1980's, the strategic objective of the nuclear technology began to make structural adjustments towards the service for national economic construction and improvement of people's life through cultivating new industries, upgrading traditional industries, and rising scientific and technological levels in compliance with the market economy in the new era of reform and opening up to the outside world.

In recent years, China has experienced an annual economic growth rate of about 10 percent, which brought a sharp increase in the demand for access to the benefits of modern technologies, including nuclear technology. Therefore, Chinese nuclear experts are facing great challenges and golden opportunities in the upcoming years.

Nuclear technology has focused on energy supply for electric power and sustainable development for agriculture, including farming, forestry, animal husbandry, sideline production and fishery. It is well known that China stands at population of 1.2 billion now and is still increasing at an average of 13 million annually.

Apart from energy and agriculture, the practical applications of nuclear technology are comprised of such aspects as radiation processing, sterilization of medical products, radioisotope instrument and nucleonic control system (NCS), non-destructive testing (NDT), application of isotope tracing, nuclear medicine and radiotherapy, radiopharmaceuticals, radioimmunoassay kits and so on. All of them have been developed by Chinese experts and are being considered as adapting military technology to the production of civilian products to provide many new technologies, techniques and new products for national economy and becoming a part of high and new technologies. These are expected to help bring about a shift in the mode of economic growth from labour-intensive to technology-intensive in China. Development of nuclear technology and related industries has a direct bearing on the improvement of the overall quality of Chinese economy and its future development to some extent.

Despite the principle of self-reliance of the applications of nuclear technology with its own characteristics, China needs and welcomes international exchange and cooperation with all countries in the world. In fact China has established co-operation and trade relation with many foreign countries and regions and become an important nuclear import and export country. In the past years introduction of advanced technology, equipment and others was carried out on a selective basis from abroad to improve the vitality and competitiveness of Chinese technology.

With the globalization trend in the economic, scientific, and technological development in the next century, Chinese nuclear experts will more deeply be involved in the international co-operation and competitive world market to promote the applications of nuclear technology for economic growth, while the overseas business partners will benefit from China's potential and huge market for peaceful use of atomic energy.

NUCLEAR TECHNOLOGY FOR ELECTRIC POWER

The most common application of nuclear technology is to provide nuclear energy supply for electric power. To realize its goal of becoming a major economic power, China must improve infrastructure, including energy, transportation, communication and so on. Among them the supply of electric power is one of the prerequisites for maintaining its long-term and sustained economic growth. China is a country with a vast territory and is rich in coal and water power. Therefore the principles for the exploitation of energy resources are as follows: great efforts are to be devoted to the development of coal-fired power in the nearest future; but the country will, in the long run, rely on hydroelectric power; nuclear power is developing as is required and other kinds of energy resources will be appropriately made use of in line with local conditions. However, nuclear power offers an attractive alternative option particularly in the coastal South-east areas, where the economy is relatively well-developed, the demand for electricity is high but the lack of both hydroelectric and coal resources limits the development of power generation. China now has two operational nuclear power stations: the domestically constructed Qingshan plant in Zhejiang Province and the Daya Bay plant in Guangdong Province, bringing the nuclear power (2.1GWe) to less than 1% of the national electricity generation capacity and alleviating a transportation strain, an environmental burden and an energy cost increase due to coal burning in densely populated urban areas along South-east coast of China.

The Qingshan plant has been designed, built and operated by Chinese experts and 70 per cent of its equipment is made by domestic enterprises. It has been working highly efficiently since generating power in 1991. The Daya Bay plant connected to the grid in 1994 was wholly imported from western Europe: the nuclear island from France and the conventional island from Britain. Annual generation of electricity from those two plants is equivalent to three times of the total generated electricity of the whole country in 1952. The successful construction and safe operation of the nuclear power stations have fully demonstrated that China is in a position to carry out design, construction, operation, management and import and export of nuclear power plants. In fact the Chashma Nuclear Power Plant, being constructed in Pakistan, is taking the 300Mwe Qinshan plant as a prototype.

There is an ambitious program of nuclear power to improve the energy supply structure for the economic growth in China. The country plans to build four more plants with eight units or total capacity of 6.6 GW during the Ninth Five Year Plan (1996~2000). These will be the second-phase of Daya Bay, Qinshan's second and third phases, plus a plant at the city Lian yungang in Jiansu Province to meet the urgent power demand in the coastal areas. It is estimated that nuclear power installed capacity will be 9.5 GW by the year 2003, 20~23 GW by the year 2010, and 40~50 GW by the year 2020, accounting for 5~6% of the total installed capacity.

At Qinshan, two 600 MW units of Chinese are under Construction. At Ling'ao close to Daya Bay and 50 kilometers from Hong Kong, two 1000MW units are Sina-France project, which has started and is

scheduled for commissioning in 2002 and 2003. There will be the construction of two 700 MW CANDU reactors from Canada for the third phase of Qinshan. At the city Lian yungang in Jiangsu Province two 1000MW units from Russia are planned. At present many provinces such as Shandong, Fujian, Hainan, Jiangxi, Hunan and Liaoning have expressed their strong desire to build nuclear power plants. As predicated, there will be a great progress in nuclear power development in China in the next century.

NUCLEAR TECHNOLOGY FOR AGRICULTURE AND FOOD PRODUCTION

Agriculture and food have to be placed first in the overall economic plan with the huge population in China. During the past 40 years Chinese experts have done their strenuous endeavours to utilize nuclear technology to help solve agriculture and food problems.

It is worth mentioning that improvement of crop yields is of strategic importance to China. Plant breeding is at the heart of improvements in agricultural production. It is essential for Chinese farmers to use varieties which have a better yield, are more resistant to disease, have better nutritional quality and are better adapted to soil, climate and growing season to sustain and improve output.

The long-term practices of mutation breeding induced by radiation (such as γ ray or neutron beams) in China have proved that it is an effective approach to crop improvement as well as an important supplement to conventional breeding. To meet with success, there has been a collaboration network nationwide for promoting the development of radiation mutation breeding and the release of improved cultivars in various provinces throughout the country. Up to date, accordion to rough statistics, more than 400 mutant cultivars of about 40 different species including cereal crops, fibre crops, oil crops, vegetables, fruit trees, ornamented plants and many other plants of economic value, have been developed and released (or approved) for cultivation and commercial production. Most are directly utilized mutants, covering total area of about 9 million hectares in different parts of the country. The number of mutant varieties and their release area rank the first in the world. The economic return of growing these improved varieties is hundreds and thousands times as much as the funds invested in the research and development in this field. The outstandingly valuable achievements are considered to have made a major contribution to economic growth and farmer's incomes in China with an impact so great that it is impossible to assess their monetary value. It is well known that in China the development of the agriculture is supporting 22 per cent of the world’s population with a mere 7 percent of the earth’s arable land.

Food irradiation is another successful example of nuclear technology used for the preservation of food in China. To promote the commercial application, a nationwide program of food irradiation has been carried out, including technology feasibility, animal toxicity test, human trails of consumption, clearance, legislation, hygienic standard, market testing, public acceptance and others for many years. Among them the human feeding trails with 35 kinds of irradiation foods tested by 439 persons (8 groups) for 7-15 weeks at various cities in the country concluded that there are no significant changes, including polyploidy of peripheral lymphocyte. Decades of practices in China have shown that food irradiation offers a safe and reliable way to help reduce the post-harvest food losses resulting from microbial spoilage and insect infestation and provides a valuable addition to the traditional methods of salting, cooking, smoking, canning, freezing and chemical preservation. At present, Chinese peasants, particularly in the poverty-stricken areas, are strongly interested in low doses of irradiation for sprout inhibition of garlic within about one month after its harvest. They have obtained economic benefits due to the shelf-life extension and long-term storage of irradiated garlic. It is estimated that there are about 50 cobalt-60 gamma-ray facilities for agricultural processing with total amount of irradiated foods (particularly garlic) being more than 40,000 tons per year throughout the country to meet the demands in domestic and overseas markets. Although food irradiation has not yet had any significant economic impact, the technical, legal and trade frameworks are now well established to help play an increasingly important role in disinfestation of stored products,

sprouting inhibition, ensuring the hygienic quality of food without food-borne diseases, quarantine treatment of fresh produce and extension of shelf-life.

The sustainable development of Chinese agriculture and food must rely on modern science and technology, so the need for nuclear technology is likely to increase. Apart from mutation breeding and food preservation, more exact techniques of measurement, analysis and tracing by labelling radioactive and stable isotopes can provide some of most accurate means for the evaluation of fertilizer uptake and agrochemical residuals, especially for the study of molecular genetics and biology in the future. Besides, Chinese nuclear experts is helping the farmers stimulate the growth and development of certain organisms such as silkworm, tussal, carp, prawn, oil-soybean, etc. at very low dose and control insect past. To sum up, it is now difficult to see how agricultural research and development can be successful carried out without nuclear technology.

NUCLEAR TECHNOLOGY FOR REVITALIZATION OF INDUSTRIES

A strategy for the revitalization of industries has been carried out through the latest science and technology to help bring about a shift in the mode of economic growth in China. As a high technology, nuclear technology is making important contributions to upgrading various traditional industries and emerging as new technology-intensive industries on the basis of its research and developments achievements.

- The technological industrialization drive of radiation processing has pushed a lot of new and high performance products, such as cross-linked heat shrinkable materials, wire and cable insulators, battery membrane, printing and dyeing auxiliary agents, disposable medical products, irradiation food and others into the domestic market. There are a nationwide network of 45 electron beam accelerators with a total power of about 2000 kW and more than 50 gamma-ray facilities with total loaded capacity of over 10 M Ci cobalt-60 in operation to support the commercial development of radiation processing.
- Varieties of nuclear detectors and instruments are widely serving for well-logging of oil and coal exploration and exploitation, gauging of industrial processes, radiography for non-destructive testing (NDT), and so on. Nuclear well-logging such as natural gamma logging, spectral natural gamma logging, compensated neutron logging, compensated density logging, litho-density logging and carbon/oxygen logging has become a routine service for oil exploration and development in the big fields throughout the country. Radioactive tracer interwell monitoring for the evaluation of the flooding reservoirs and measurement of residual hydrocarbon saturation in water-injection wells is playing an important role in secondary or tertiary production of domestic oil-fields. Nuclear borehole logging and radiotracer application, combined with sonic and electric logging technologies have made valuable contributions to China's petroleum industry with annual crude oil production of nearly 160 million tons.
- Nuclear measurements and nucleonics control can be made by non-contact processes and with minimum disruption to existing plants to realize the modernization and optimization of traditional industries. In fact, there have been more than 10,000 nuclear gauges installed in various enterprises of traditional industries for measurement of industrial non-electric parameters, such as level, thickness, density, weight, moisture and element composition. Some of them have been an imperative part of nucleonic control system (NCS) for automation control of production processes, especially in large-scale iron steel plants and pulp and paper mills. The industrial gamma radiography has led to the convenience of NDT especially for the panoramic exposition to pressure vessels and pipelines for checking all types of welds with high efficiency and low cost. It is not negligible that more and more ionization smoke alarm detectors with radioisotope have been used for fire-fighting to protect public safety.

– Applications of nuclear technology in medicine benefit at least 20 million of Chinese people every year from clinic diagnosis, therapy of cancer or screening of epidemic diseases. At the same time radio-immunoassay (RIA) kits, in-vivo radiopharmaceuticals, and the related equipment and devices become commercial products in medical market. Regular supply of the local and import products can meet the clinic demands of nuclear medicine at about 2000 hospitals in the cities throughout the country. For example, there are nearly 200 devices of single photo emission computerized topography (SPECT) for clinic imaging regularly consuming in-vivo radiopharmaceuticals from domestic or overseas manufacturers with nuclear reactor or cyclotron.

CONCLUSION

1. Nuclear technology is unique with enormous social and economic benefits in many respects and cannot be replaced by other technologies. Currently well established nuclear technology, as well as more sophisticated innovations and combinations of nuclear and non-nuclear technologies are able to widen the scope of their applications in national economy, especially in the modernization and optimization of energy, agriculture and food and other traditional industries. It is gaining greater recognition that the civilian applications converted from military-oriented nuclear technology should be encouraged to result in a economic return with irreplaceable and environmentally friendly features.
2. China is a developing country with nuclear capability. The transfer of nuclear technology into practical applications has made important contributions to the prosperity of national economy and the improvement of living standard of Chinese people in the past 40 years. Facing the great challenges in upcoming years, sustained efforts are required to narrow the gap between China and other industrially developed countries in the world.
3. Recent rapid economic growth is providing the golden opportunities for the development of nuclear technology in the strategy for industrialization, commercialization and internationalization of new and high technology in China. Despite the principle of self-reliance of the nuclear applications with Chinese characteristics, introduction of advanced technologies and key equipment from abroad are needed to bring about a leap in domestic technological development. International exchange and cooperation are helpful to promote common development on the basis of mutual benefit.
4. China's potential market is huge with 1.2 billion of population. It will create the good economic opportunity for the investment of overseas partners. With the globalization trends in economic, scientific, and technological development, China is opening up more actively to the outside world and Chinese nuclear technology will have to be involved in and take a part in the competitive world market in the next century. Prospects are bright.

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KEY WORDS

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