



On the future of Chinese cement industry



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ABSTRACT

The Chinese cement industry is now facing several problems, including increasing environment pressure and serious overcapacity. In this paper, the Chinese cement and cement industry are re-examined in the light of aiming for low CO₂ emissions in cement manufacturing, development of recycling and integration with related industries. Progress towards a smart cement industry is advocated for the manufacturing of environmentally friendly cement products. The green degree (GD), low CO₂ emission degree (LCD) cycling degree (CD) and smart degree (SD) of different industries are quantitatively characterized based on material flow, energy flow and information flow. Moreover, comparisons are made among industries of cement, steel, nonferrous metallurgy, glass, and ceramics in different historical periods and this shows that cement and steel, traditional still modern as building materials, are not replaceable. It is demonstrated that ecology, lowering CO₂ emissions, recycling and integration, and smart development are the four requisites for transformation in the Chinese cement industry, and the main path of transformation is presented as well. It is stressed that success of the transformation will largely depend on innovation in science and technology.

Originality: In this paper, the cement and cement industry are re-examined by combining “oriental philosophy” and “western philosophy”. Based on the in-depth analysis of material flow, energy flow and information flow during cement manufacture and usage processes, the green degree (GD), low CO₂ emission degree (LCD), cycling degree (CD) and smart degree (SD) were creatively put forward, accordingly, the ecological performance, low carbon, cycling and intelligence degree were quantitatively characterized. The future direction of development of the cement industry was presented from the technical innovation point.

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1. Introduction

The basic needs for human survival are clothing, food, shelter and transportation, among which “shelter” and “transportation” greatly rely upon construction and building materials. Among the many building materials, cement is seen as the “food” for building and plays an irreplaceable role in the process of human civilization.

Modern cement was born [1,2] in 1824 with the patent awarded to the British engineer J. Aspdin, for “Portland cement”. Modern cement is a kind of traditional and yet modern building material based on ancient cementitious materials. As is shown in Fig. 1, cement and steel, with a brief history of 190 years, represent some of the greatest achievements of human endeavor and the milestones of civilization in the history.

The Chinese cement industry has been playing a vital role for the rise of China over the past 100 years since its initial growth. Fig. 2 shows the Chinese cement output and its share in the total world cement output over the last 30 years. It can be seen that with the rapid development of the economy and increasing demand for cement, China’s cement output has grown rapidly. It has become the world’s largest cement production country since 1985, and its output has accounted for over half of the total in the world since 2006.

Cement has been the bulk indispensable building material after the foundation of new China. It has been widely used in civil construction, water management, national defense and traffic engineering and plays a very important role in the construction of the national infrastructure. By the end of 2014, the proportion of Chinese living in urban areas had reached 55%, highway is up to 112,000 km, high-speed railway reaches 16,000 km, and the number of water conservancy dams has increased to nearly 90,000 with a total length of dikes of more than 250,000 km.

As a result of the unremitting efforts of several generations of cement workers, Chinese cement manufacturing technology and equipment have reached the world leading level. Based on the new dry cement production technology, the Chinese cement industry is striving for the aims of large scale, high efficiency equipment, high performance, clean process and comprehensive utilization of wastes. The technology and equipment have so far not only satisfied the domestic needs, but have also been exported to overseas.

In the development of cement industry, there are several problems to solve. First, growing pressure on the environment which is unsustainable, and the substantial increase in management cost of enterprises. In July 2013, the Chinese Ministry of Environmental Protection issued new standards with stricter limits on emission of dust particles, SO₂ and NO_x. A considerable number of cement plants cannot meet these limits with existing technology. Second, there is serious overcapacity. Profitability is greatly threatened. In 2014, Chinese cement output was 2.476 billion tons, while the actual capacity is 3.315 billion tons, the capacity utilization rate was only 75%, which is far below the internationally recognized rate of 85%. Third, the rate of development is slowing down. The theoretical thermal consumption of cement per kg is 1800–2165 kJ (including raw material drying, 5–8% water is included). Since the pre-calcination technology has been developed, thermal consumption per unit of cement clinker has decreased from 3100 kJ/kg clinker to 2250 kJ/kg, however, it is difficult to further reduce the calcination thermal consumption further given that there is now a thermal loss of only 200 kJ/kg clinker in the manufacturing process.

What is the future for Chinese cement industry? What are the essentials to the future cement research? We urge researchers to ponder these questions and seek answers.

2. Transformation in Chinese cement industry

There is no other new material that can completely take the place of cement. With the growing pressure on environment, consumption of resources, and the increasing demand of environment protection, significant transformations will continue to take place in cement industry, including more environmentally friendly products, low CO₂ emissions in manufacturing, recycling development and integration with related industries, and smart cement industry.

2.1. Green cement products

The production of materials comes along with material flow and energy flow. Ecological products result from the minimum use of raw materials and energy during the process of manufacturing with minimum

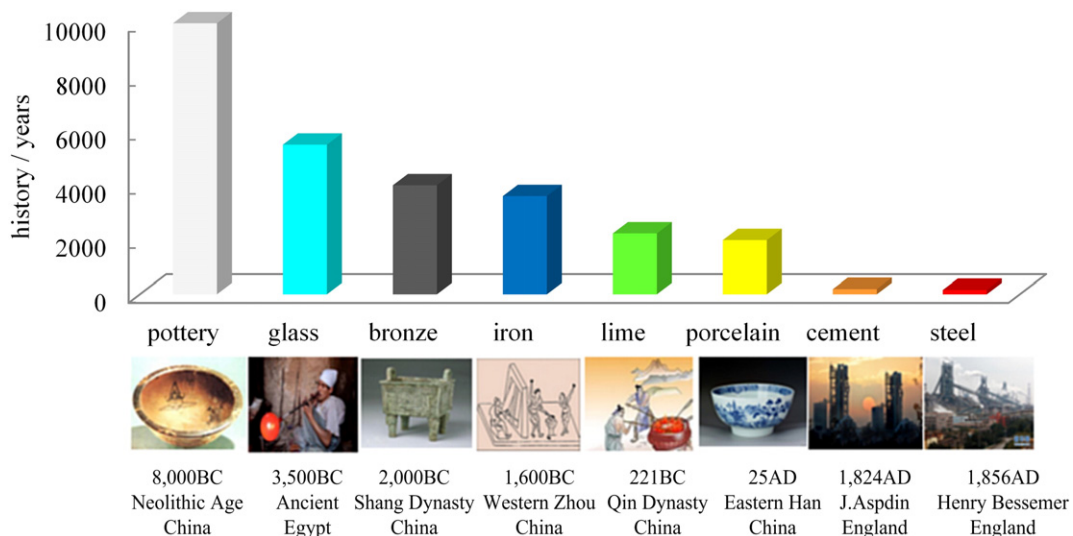


Fig. 1. History of materials [3].

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