



The environmental impact analysis of hazardous materials and the development of green technology in the shipbreaking process



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ABSTRACT

This paper introduces the status of the Chinese and international shipbreaking industry, and discusses the hazardous shipbreaking materials and the effects on environment and human. Therefore, this paper explores green shipbreaking technology, and puts forward the application of the abrasive water jet cutting technology to the shipbreaking process, and studies the feasibility of the application from the aspects of its implementation, environmental protection, safety, efficiency, and economy. Moreover, this paper also discusses the deficiencies of this idea.

1. The shipbreaking industry overview

The global economic growth has promoted the global maritime trade, thus greatly promoting the development of the shipbuilding industry. In general, the life of a ship is usually 20–30 years; the ships built at the end of the last century have ended or will end their services, and the dismantling of these ships has become a worthy consideration. In recent years, the recovery of the global economic is slow. The situation of excess transportation capacity continues, and energy efficiency design index (EEDI) has officially entered into force (IMO, 2011). These factors have led to an obvious trend that ships are sent for recycling at an earlier age, for many ship owners, it is more economical to declare a ship unfit for service instead of opting to service or modify the ship. Under the influence of the global financial crisis, the continuous depression of shipping business has resulted in a sharp increase of ships to dismantled (Mao, 2009). Therefore, the shipbreaking industry has a large market around the world (see Fig. 1–6).

Although the shipbreaking process may cause a range of harmful consequences, including air pollution, water pollution, soil pollution and explosion, etc., it is beneficial for the world's environment and resource conservation. Shipbreaking industry, as a green industry, has become a part of the circular economy since dismantling and processing old vessels (Rahman et al., 2016). On the one hand, it provides the shipowner with the disposal service of the old vessels. On the other hand, shipbreaking allows the materials from the ship, especially steel, to be recycled and made into new products. This lowers the demand for mined iron ore and

reduces energy use in the steelmaking process. So it is extremely important to optimize and improve shipbreaking technology and effectively reduce pollution.

This article introduces the status of the Chinese and international shipbreaking industry from the respects of shipbreaking methods, social environment, economic cost, environmental protection measures and so on. It analyses and studies the hazardous materials during shipbreaking process such as asbestos, PCBs, solid foam, fiberglass, etc. and their negative impacts on environment and human. For conventional hot cutting technology, this article puts forward the application of a greener technology—abrasive water jet cutting method in the shipbreaking process, and studies the feasibility of the application from the aspects of implementation, environmental protection, safety, efficiency and economy.

2. The present status of shipbreaking industry

The shipbreaking yards mainly located in Bangladesh, India, China and Pakistan. The annual shipbreaking tonnage of these four Asian countries accounts for 85 percent of the global total (OCN, 2017); and other shipbreaking shipyards located in the Mediterranean area and Turkey. More than 700 ships are sent for recycling every year (Galley, 2014), and in 2009, the shipbreaking market hit a 13-year high (Sarraf et al., 2010). According to Clarkson's institute (Clarkson, 2017), the latest statistics on the trend of shipbreaking shows that in 2016, 933 ships, a total tonnage of 44.4 million dwt, were dismantled in total, an increase of

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Fig. 1. Traditional beaching method pollutes the environment seriously (Hettwer, 2014).



Fig. 2. Dock shipbreaking method pollutes the environment less.



Fig. 3. The cabin containing asbestos.



Fig. 4. The pipes containing asbestos.

14% over the same period last year. In 2016, the shipbreaking activities of bulk cargo ship and container ship played an important role: 65% and 18% of the total tonnage, respectively. The shipbreaking tonnage of the four Asian countries: Bangladesh, China, India and Pakistan, accounts for

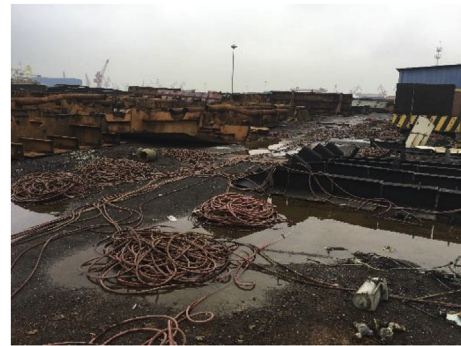


Fig. 5. Shipboard cable often contains PCBs.



Fig. 6. The position requiring heat insulation often uses solid foam in the ship.

90 percent of the global total in 2016. By this token, the development momentum of the shipbreaking industry is still strong at this stage, and the recovery of shipping industry still has a long way to go.

The shipbreaking yards in South Asia often use beaching method to dismantle ships—taking the ship onto beach and then dismantling the ship there, in which case the process and related equipment are simple. So the cost of site and fixed equipment is low. Moreover, the labor of shipbreaking markets is abundant, cheap and skilled. The direct and indirect utilization of dismantled goods is high, and the developed secondary market can offer a recycling way for dismantled goods (CNSA, 2017). But it is clear that during the shipbreaking process, environmental pollution and workers' safety problems are worrisome in these areas.

The shipbreaking yards in China mainly use the dock or wharf method to dismantle ships, which can effectively reduce the pollution caused by hazardous materials. In such way, China has won more shipbreaking orders that requiring environment protection. And due to the advanced technology, Chinese shipbreaking yards tend to dismantle large tankers and Very Large Crude Carriers involving complicated technical difficulty and huge profits (Xu, 2009). In China, the Yangtze River Delta and the Pearl River Delta play the leading role in the shipbreaking industry and some coastal areas develop side by side (Zhu, 2009).

Since 2009, China always occupies the top 3 of the amount on shipbreaking in the world (Wang, 2016), which provides vast regenerated metal resources for circular economy. The shipbreaking capacity of China has been widely recognized around the world. China has greatly promoted the safe and green shipbreaking industry and improved energy saving and emission reduction, which has made active contribution and obtained the good social efficiency.

In China, the scrap steel price at home and abroad has hung upside down for a long time, and the scrap steel market demand is not prosperous. The tight export restriction on scrap steel and the wharf or dock shipbreaking method increase the environmental protection and safety inputs. Above factors resulted in that the shipbreaking price gap between China and the South Asian countries has become larger and larger. During twelfth five-year, in Bangladesh, India and Pakistan, every light

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