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Shipyards and Ship breaking: Opportunities for utilization of steel under the prism of Circular Economy

Pournara A.[1], Sakkas V.[2]

1Department of Maritime Studies, University of Piraeus
[2]Department of Chemistry, University of Ioannina

*corresponding author:

e-mail: anthpour@gmail.com

Abstract Among the activities that constitute the process of dismantling a ship is the obligation of proper management of hazardous materials. As almost the entire ship can be recycled, reused or even resold, the ship dismantling industry can also be considered a "green" industry. The steel used by the maritime industry complies with the quality standards of shipbuilding, presents high durability and is a valuable raw material for reuse by the industrial sector. Following the Circular Economy principles, the ship's steel parts that haven't lost their material value, might re-entry the supply chain and be reclaimed as raw material by the steel industry after being processed. In the present work, a Circular Economy model based on the operation of a hybrid shipyard is proposed. Taking advantage of the facilities and the equipment of a moderate shipyard, it is proposed to include the dismantling activities of specific vessels, focusing on the abandoned ones. The advantages that result with the operation of this hybrid plant include: the reduction of the environmental footprint of ship breaking, assurance of steel tracking in the industry, saving of natural resources and energy, the use of recycled raw materials adopting circular economy practices, cost reduction and more.

Keywords: Ship breaking, Steel, Circular Economy, Industry, Shipyard

1. Introduction

Ship recycling is an important and complex activity, necessary for the constant renewal of the shipping fleet. The term "ship breaking" describes the activity of total or partial dismantling of a vessel in a ship dismantling facility in order to recover parts and components (IMO, 2012). The main goal of the process is to achieve the highest level of recovery and reuse of materials found on a ship (Deshpande et al., 2012). Unfortunately, the practices and prevailing conditions in the ship dismantling facilities make this process dangerous both for the environment and for the human health and safety of workers (Jain et al., 2013). Regulations governing the ship breaking industry are framed by the Basel Convention, the Hong Kong Convention and the European Ship Recycling Directive, the mandatory implementation of which has increased the burden on shipping companies and for additional design and management work on shipyards and ship breaking yards (Kurt et al., 2015). The dismantling of a ship automatically means the end of it's life cycle. However, no importance is given to this final stage, despite the fact that it's construction materials remain in the vessel and are usable even when it's life cycle is closed. The ship recycling industry contributes substantially to the achievement of the goals of sustainable development, as it helps to avoid the negative environmental impact of virgin iron ore mining, a process that requires a high inflow of energy and destroys the local ecosystem (Weisz et al., 2015).

1.1 Circular Economy and steel

Circular economy is described as a process in which waste is considered to be reused or recycled for the purpose of further consumption (Ellen MacArthur Foundation, 2015). The shipbuilding industry provides the potential for exploitation of recoverable, reusable and recyclable materials, restoring them in the financial flow and reducing the environmental problems associated with it (Barua et al., 2018). A typical ship consists of more than 95% steel, which is a highly recyclable material. This necessitates the discovery of technological methods to reduce the negative environmental impact of the steel industry, promoting the need to move to a circular economy model, where scrap will be used as a raw material (Nechifor et al., 2020). The steel used by the maritime industry complies with the quality standards of shipbuilding and is a valuable raw material for reuse by the industrial sector (Mikelis, 2013).

1.2 The case of the abandoned ships

In shipyards often exist ships at the end of their life cycle, that according to the legislation should be led to an approved ship recycling facility. Many of them are left abandoned in the shipyards when their repair is inevitable or unprofitable. For their transportation to the dismantling facility, there are two options: the ship to sail alone or to be towed there. However, many of them, are not even able to sail for their "last trip" to the recycling facility, but due to the existing damage they carry, it is not possible to tow them either. Consequently, these ships will remain at the shipyard for a long time in order to be partially repaired, in a way that can be towed to the recycling facility, while the environmental footprint of the towing process is particularly high. In other words, there is a dead-end situation that is followed by high economic and environmental costs.

2. Methodology

There are several shipyards in Greece, the majority of which are located in Perama, Salamis island and Elefsis. Unlike the shipyards, ship recycling facilities are no longer operating in Greece today, as the legal framework for their establishment and operation is not clear, while the costs are characterized as prohibitive. It is estimated that the cost of a new medium sized shipbreaking yard (50000 LDT/yr) is about 50,81 €/LDT (European Commission, 2016). On the premises of a shipyard, activities of new shipbuilding, and repair and maintenance of older ships are performed.

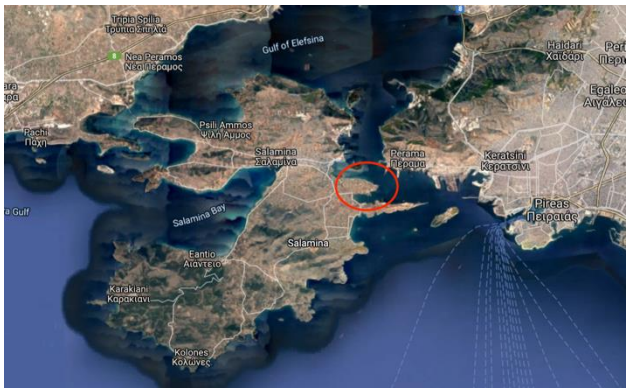

Figure 1. The location of the shipyard on Salamis island

One of the largest shipyards in Greece owned by Spanopoulos Group of Companies is located in Salamis island, in the Ampelakia - Kato Pounta region at the northeastern part of the island and was used as a case study. The specific shipyard as the largest shipyard of the company can serve all types of vessels, even the biggest ones.

After the in situ visit at the premises of the shipyard and discussion with the plant's managers the following issues have been reported and concluded: Firstly, the problem of the abandoned ships has beset the shipyard for many years and still does, followed by waste of energy, time and money. Secondly, the issue of the traceability of steel scrap after it leaves the shipyard. Steel scrap that is no longer used by the shipyard and is received by waste disposal and transfer companies, can't be further traced after the shipyard and their final use is unknown.

Figure 2: Temporary repair of an abandoned ship in order to be towed to a shipbreaking yard miles away

Since the common element between shipyards and ship breaking yards is the procedure of cutting, which is and the main part of the ship dismantling process, a new hybrid model of a shipyard is proposed, which according to Spanopoulos Shipyard could solve the existing issues.

3. Results

The proposed model of a hybrid shipyard facility has as its core a very productive idea concerning the problem of the abandoned and old vessels: the execution of the basic cutting activities inside the shipyard facilities. This is made possible by the fact that shipyards have both the equipment and the license to perform cutting of steel and metals, and also meet all the environmental and safety standards. It is strongly emphasized that this is not about a substitute of the shipbreaking yards. Practically it is proposed to operate a ship dismantling unit within the shipyard.

3.1 The route of steel scrap

A key point is the utilization of steel scrap with the least possible processing, to ensure a low environmental footprint. This is the reason why the steel scrap will be available in very specific industries, with which the hybrid yard will be in close cooperation and contact, ensuring the proper utilization of steel. Among the demanded standards will be a green certificate of material disposal that will ensure the way by which the steel will be processed and what will its final use and form be. The shipment of steel to the industry will be done under the responsibility of the shipyard and with a privately owned fleet of vehicles, in order to ensure the traceability of steel scrap.

3.2 The operation of the Hybrid Shipyard

Upon entering the shipyard facilities, the vessel will pass through the inspection phase where it will be assessed whether it will be driven for repair or dismantling. In the dismantling phase, the ship will be inspected again, for evaluation and material sorting. That phase is followed by the removal of the useful and easily removable parts of the ship and the cutting of the rest of the ship. The hazardous materials will be carefully removed and will be collected and temporary stored apart from all the other materials in specific storage within the premises of the shipyard, according to the ship breaking legislation. Going forward, the cutting stage is followed by the sorting of materials, divided into three categories: materials that can be used within the installation for repairing etc., steel scrap and other materials.

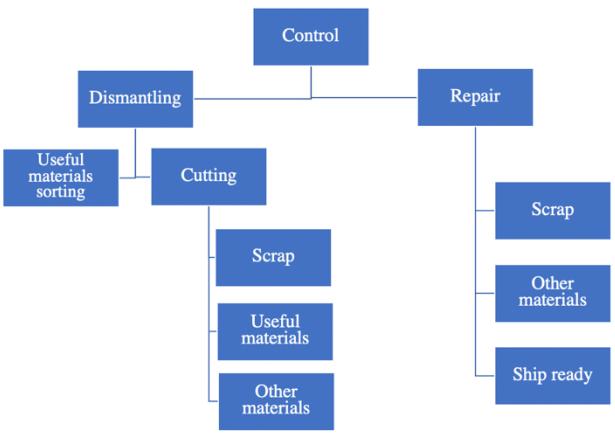

Figure 3. Flow diagram of the hybrid shipyard

As for the route of the repair phase, three currents arise: scrap, other materials and the ship ready for delivery. The steel scrap will be collected and transported under the responsibility of the shipyard. Respectively, the stream of other materials will be collected and stored properly.

4. Conclusions

With this operating structure of the proposed facility, the reduction of the environmental impact of ship dismantling and the operation of shipbuilding and dismantling in under the principles of the Circular Economy are achieved. Traceability of steel scrap will be finally possible through the hybrid facility, resulting in savings and certified utilization of valuable materials. The long-standing problem of the management of the abandoned ships can now be solved, leading to a series of environmental and economic benefits. Consequently, there is a reduction in the environmental footprint of the ship breaking industry and the steel industry, as well as of the related processes.

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