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Significant steps in ship recycling vis-a-vis wastes generated in a cluster of yards in Alang: a case study

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ABSTRACT

Dismantling and recycling of end-of-life vessels in the so-called environmentally friendly manner has been a major challenge faced by ship owners, ship dismantling yard owners as well as government agencies worldwide today. On one-hand, this paper intends to provide the knowledge-base needed by individual yard owners for planning their short term and long term activities. On the other hand it is hoped that this paper will serve as an essential part of the management information system which will help in governance of cluster of ship dismantling yards. The emission factors estimated in this study using field sample survey of 241 ships dismantled during 2011–2013 in the cluster at Alang Port could be put to use while predicting the quantities of wastes generated from dismantling of six types of ships (bulk carrier, general cargo, container, refrigerator and passenger) which further can be used in preparing environmental management plan to handle the same. The % ships and % cumulative LDT of ships in a given category could also be predicted for the cluster using the validated results reported in this study. Finally, on the basis of primary data collected from over 100 yards in Alang Port and with the help of face-to-face interactions with several field personnel; a "typical ship dismantling and recycling procedure" was articulated.

It is argued that the in-depth understanding of the prevailing "know-how" alone can help in development and diffusion of cleaner technologies for benefit of this sector and facilitate in instituting the integrated waste management system that will eventually ensure safe and environmentally friendly ship recycling - especially in the context of "Ship Recycling Regulation" recently passed by the European Parliament as well as the draft of "Hong Kong Convention", being negotiated at the International Maritime Organization.

1. Introduction

Ships are an integral part of international trade and mainly because of their cost efficiency, nearly 95% of commercial goods are transported by sea routes (Demaria, 2010; Chang et al., 2010). As per the estimation of International Maritime Organization, as on 2010, nearly 150 nations contributed to total 104,304 world fleet of merchant ships; which were involved in international trading activity. Vessels are typically disposed off after a life span of 22–25 years (Deshpande et al., 2012). The end-of-life vessels are being dismantled today in India, Bangladesh, Pakistan and China.

Ships typically contain more than 90% of steel. It has been recognized in the recent past that "recycling" of sheet metal and metal scrap as well as "reusing" of engines, winches, power generators, air-conditioners, refrigerators, gadgets, furniture, construction materials and several other refurbishable objects recovered from ships at the end of useful life should in fact be the focus of ship dismantling (i.e. ship breaking) sector. Ships that are recycled today were built when the environmental laws were not stringent. As a result, at the end of a ships useful life, the vessels not only contains various recyclable materials but also a range of hazardous and toxic substance including asbestos, glasswool, thermocol, oily rags, oily sludge, oily sand, polychlorinated biphenyl (PCB), polyaromatic hydrocarbons (PAH), and organotins like tributyltin (TBT) *etc.*, (Reddy et al., 2005; Gökdeniz et al., 2008; Mahindrakar et al., 2008; Asolekar, 2006; Demaria, 2010; Chang et al., 2010; Deshpande et al., 2012, 2013).

The tonnages of recycled ships have grown three fold during the past years, owing to the rise in supply of end-of-life vessels due to global slowdown in the market. As per the ship recycling statistics,

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it is clear that the world's maritime community will have to scrap 10 to 15 million tons obsolete vessels every year for at least coming 10 years (Asolekar, 2012; Deshpande et al., 2012).

The world community has focused their attention over the past decade on the issues surrounding dismantling of end-of-life vessels and the associated pollution of marine and terrestrial environments. For example, under the aegis of the UNO-institutions, namely, the International Maritime Organization (IMO) and International Labor Organization (ILO); the international convention popularly referred to as "Hong-Kong Convention" was drafted in May 2009 and the negotiations are at advanced stage at the IMO. The convention covers design, construction, operation and recycling of ships. The main aim of this convention is to ensure that ships being recycled do not pose any unnecessary risks to human health and surrounding environment. This convention addresses issues of environmentally hazardous substances like asbestos, hydrocarbons, ozone-depleting substances *etc*., to ensure safe and environmentally sound recycling of ships. Guidelines for inventorization of hazardous materials, development of ship recycling plan, authorization of ship recycling facilities and safe and environmentally sound recycling of ship are included in the convention.

Recently, the European Commission, too, has passed a new legislation entitled "Ship Recycling Regulation" – which was published in an Official Journal of the European Union on 10 December, 2013. According to this regulation, an inventory of hazardous materials (IHM) will be required for all ships entering EU ports, as well as for EU-flagged ships. New builds will have to prepare an IHM not later than 31 December, 2018. Ships going for recycling will need an IHM as soon as the EU list is published, but not before 31 December, 2014. The requirements for an IHM are expected to be detailed than for the Hong Kong Convention's IHM, specifically concerning accuracy and comprehensiveness.

There could be many approaches to quantifying the impact of a given industrial sector including life cycle assessment, environmental impact assessment, environmental audit, inventorization and prioritization as the integral part of environmental management system, ISO-14000 and ISO-30000 series as well as environmental or carbon footprint estimation (Asolekar and Gopichandran, 2005). To be able to apply any such tools, it is necessary to understand the prevailing "know-how" of the ship dismantling sector - which will also help in improving the process conditions and generate the information that can be useful for reducing risks to humans and surrounding environment. Also, the spirit embedded in European Legislation entitled "Ship Recycling Regulation" as well as the draft of "Hong Kong Convention" can be gainfully implemented in the light of clear understanding of steps and processes involved in ship dismantling and recycling sector.

Thus, in the context of escalating pressure from the tonnages of obsolete ships to be dismantled anticipated in the immediate future on one hand and in response to the increased regulatory pressure resulting from the national and international regulations and conventions on the other hand; the ship dismantling sector has to upgrade itself in multiple ways. Clearly, the field interventions and research agenda need to be aimed at developing more thorough understanding of number and types of ship broken and corresponding waste generation and its management plan based on extensive field data and "reality of the sector". To be able to manage the hazardous wastes generated during ship recycling activity, there is a need to articulate the tacit know-how being practiced in ship dismantling so that those insights can influence the preventive environmental strategies to be implemented in the dismantling yards.

Therefore, the specific objectives set forth for this study are:

1. Estimation and comparison of number and weight distribution of different types of ships,
2. Estimation and comparison of emission factors of landfillable and incinerable wastes as well as bilge water corresponding to different types of ships,
3. Validation of the 2011–2012 data obtained on number and cumulative LDT in a given category of ships by projecting it to 2012–2013 scenario and comparing with the actual 2012–2013 data and,
4. Articulation of typical ship recycling procedure to identify key areas of waste generation during ship recycling.

2. Literature review

United Nations Environment Programme (UNEP, 2013) published a case study of Gadani ship breaking yards in Pakistan highlighting the Basel Convention and the Hong Kong Convention models for compliant ship recycling facilities requirements. Also, the short, medium and long term plans for yards to achieve compliance with the two Conventions, keeping in view the environmentally sound management of hazardous wastes is provided. Subsequently, the Secretariat of the Basel Convention published a feasibility report in 2013, providing models for alternative, environmentally sound ship recycling operations. Study was also carried by NGO ship breaking platform on the global economic and legal framework in which the ship breaking industry in Pakistan is embedded and provided the availability of technology, infrastructure and procedures to protect human health and the environment in Gadani ship recycling yards.

Similarly, very few scientific studies have been reported in literature addressing the environmental issues of Chittagong ship recycling yards in Bangladesh. For example, an environmental study was conducted by *Young Power in Social Action* (YPSA), an NGO based in Chittagong, to know the impact of ship recycling on the coastal zone of Chittagong, Bangladesh. It was concluded that the coastal area, mainly sea water, was found to be polluted from Fauzdarhat to Kumira in Chittagong (YPSA, 2005; Kumar, 2009).

In addition, certain publications put out by NGOs, regulatory agencies and progress reports from pilot-projects initiated by stakeholders as well as news reports and propaganda materials are also available on the risks and pollution caused by ship dismantling sector. Unfortunately, these publications do not provide adequate information, reliable data or insights into the sector – especially the processes of dismantling vis-a-vis their environmental and work safety related implications.

It was highlighted in the work of Deshpande et al. (2012) that more than 70% of work-force in Alang ship recycling yards in India are involved in cutting and scrapping of plates as well as on scraping of painted metal surfaces. In their scientific study it was concluded that the pollutants released from a typical plate-cutting operation can potentially either affect workers directly since it can contaminate the breathing zone (air pollution) or can potentially add pollution load into the intertidal zone and contaminate sediments when and if the pollutants get emitted in the secondary working zone and gets subjected to tidal forces.

Also, the cumulative maximum concentration of heavy metals that can potentially occur in ambient atmosphere of a given yard is estimated and the cumulative maximum heavy metal concentration was predicted by the model was between 113 $\mu g/Nm^3$ and 428 $\mu g/Nm^3$ (corresponding to the near-ground wind speeds of 4 and 1 m/s, respectively). For example, centerline concentrations of lead (Pb) in the yard was between 8 and 30 $\mu g/Nm^3$. These estimates are much higher than the Indian National Ambient Air Quality Standards (NAAQS) for Pb (0.5 $\mu g/Nm^3$).

Further, Deshpande et al. (2013) has developed and reported a novel time-motion based methodology through extensive field

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