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STUDIES OF IMPACT ON ENVIRONMENT DUE TO E-WASTE AND REFRIGERATION WASTE DURING SHIP RECYCLING PROCESS IN INDIA- A WAY OUT

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Abstract

In the past few years, it has been observed that the shipbreaking process and its consequences have risen in a huge way. Therefore, it is creating a big challenge for the environment as well as to human health. Currently, the ships which are being dismantled, are manufactured or built-in the 80s which is before the time on banning of several harmful materials that are vulnerable for the environment. Hence it has been discovered that if the shipbreaking process has been carried out in a haphazard way by less technical and scientific process and by taking improper health, environment, and safety precautions they could be exposed to the broader range of hazards and the ship breaking process would leave disproportionate biggest environment footprints. Thus, it is fundamental to carry out the ship dismantling procedure in order to recognize the wastes that have been generated from the ship breaking process. So, this paper will show the different effects on the environment because of refrigeration wastes in the ship recycling process in India and systematic way out.

Key Words: CFC, HCFC, HFC, GWP, ODP

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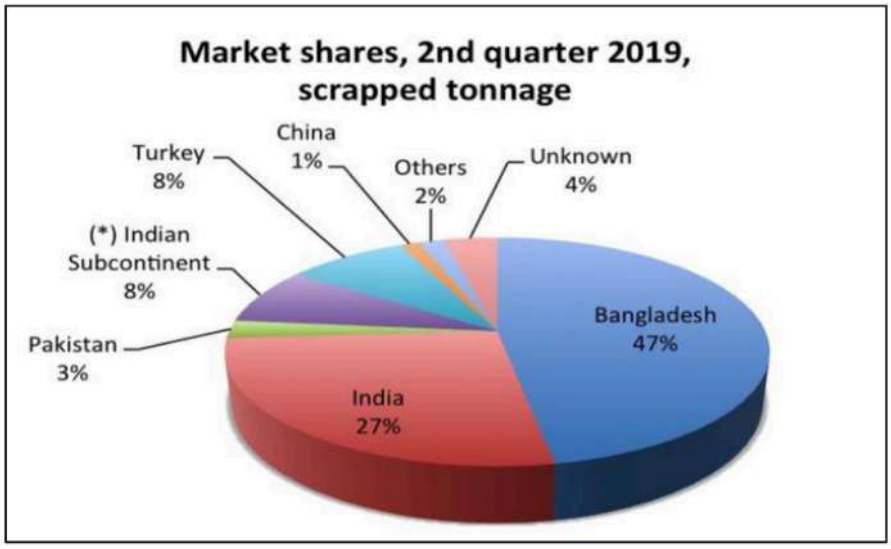
1. INTRODUCTION:

The ship recycling process is an old procedure and the European Union used to refer to this process as the traditional way of taking the old ship that is teaching.

The process is conducted by dismantling the obsolete vessels completely after anchoring down on the shore for recovering the useful components. The shipbreaking process is considered to be the biggest onshore business due to its profitable purpose (Du, Zhang, Zhou, Yuen, and Wong, 2018) Du. Z *et al*. It has been found that India is also in the race in this business. The ship possesses a refrigeration system for carrying loads of goods from one place to another therefore during the time of dismantling the vessel it imparts several refrigeration wastes to the environment.

As per Devault, Beilvert and Winterton (2017), the shipbreaking practices in India are labor-intensive and it is completely based on experienced wise management with no technical organized process. An estimation of around 2 to 8 months is needed for breaking the ship based on the size as well as the type of the vessels. For carrying out this process around 150 to 200 laborers used to employ for the individual ship breaking process in the site. However, it has been also observed that the very less execution of the management guidelines has been followed and of the occupational as well as environmental measures at the site. Therefore, the ship breaking industry in India is far from leading the process by following international standards and environmentally sound practices (Hossain, 2018) Zhang *et al*. Furthermore, owing to the hazardous wastes that are occurring due to the refrigeration wastes which causing subsequent environment pollution the ship breaking site at the Alang has been under the close supervision of the national and international authorities. It has been stated by Hossain, Fakhruddin, Chowdhury and Gan (2016) that the activity carried out in the Indian shipbreaking except for Kolkata is the beaching process. The obsolete vessels are sailed onshore or towed by using the tidal range and then it is broken down manually. However, the guidelines for the precautions and safety of the ship breaking process that should be followed have been laid down by the Gujarat Maritime aboard. While dismantling the ship several wastes materials are generated particularly the refrigeration wastes which used to cause an impact on the environment at a high level. It has been found that compounds such as CFC that is chlorofluorocarbon and methane from the refrigeration wastes are affecting the ozone layer of the Earth in a major way.

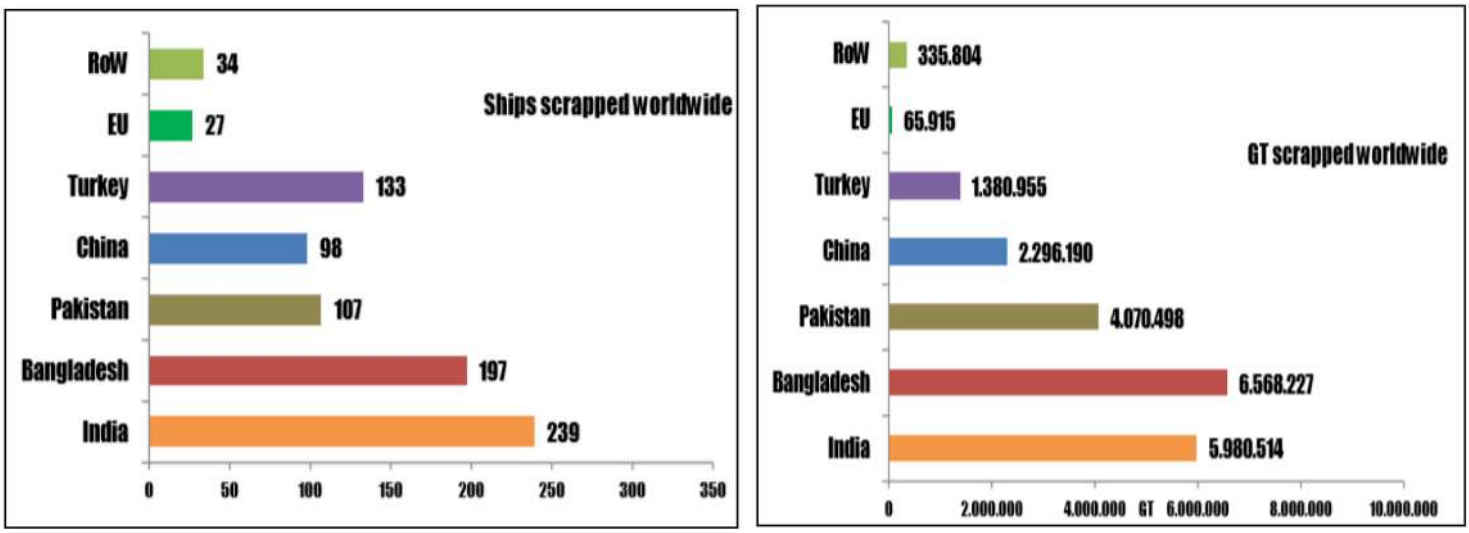
Figure 1.: Market share (Second Quarter 2019)



Source: Bulletin of information and analysis on ship demolition, Shipbreaking # 56, (Robin Des, 2019)

As per Chowdhury, Mili, Akhter and Ahmed (2017), the hazardous wastes also comprise of the polychlorinated biphenyl (PCB), Tributyltin (TBT), polycyclic aromatic hydrocarbons (PAH) and heavy metals. There are also gaseous and solid wastes like CFC, ammonia and the inflammable gases which used to present within the pipeline of the oil tankers and also in the LPG carriers. Therefore, all these wastes make it difficult to handle the process and the locating of these hazardous wastes along with its removal process is tedious because of the complexity of the structure of the vessel.

Figure 2: 2017 Ships scrapped worldwide



Source: NGO-Shipbreaking, Platform-stats Graph, (2017)

2. STUDY OF SHIP RECYCLING YARDS:

The main objective of this study is to estimate the cause of the impacts on the environment by the hazardous refrigeration wastes generated by the ship breaking process in India. For conducting this research study both qualitative and quantitative research method has been used. The qualitative data has been collected with the help of gathering resources from different kinds of literature sources that comprise of journals, articles, various reports of ship recycling process, websites and books. The relevant and accurate data has been taken from the selected sources to maintain authenticity in the study. On the other hand, the quantitative data have been obtained with the help of interviewing the personnel involved in shipbreaking process. The valuable information will then be selected and obtained by thoroughly transcribing the records that have been gathered in the interview process to get the relevant information.

With the 2016 inclusion of a global HFC phase-down, the Montreal Protocol now has two regimes to control: the ODP and GWP substances.

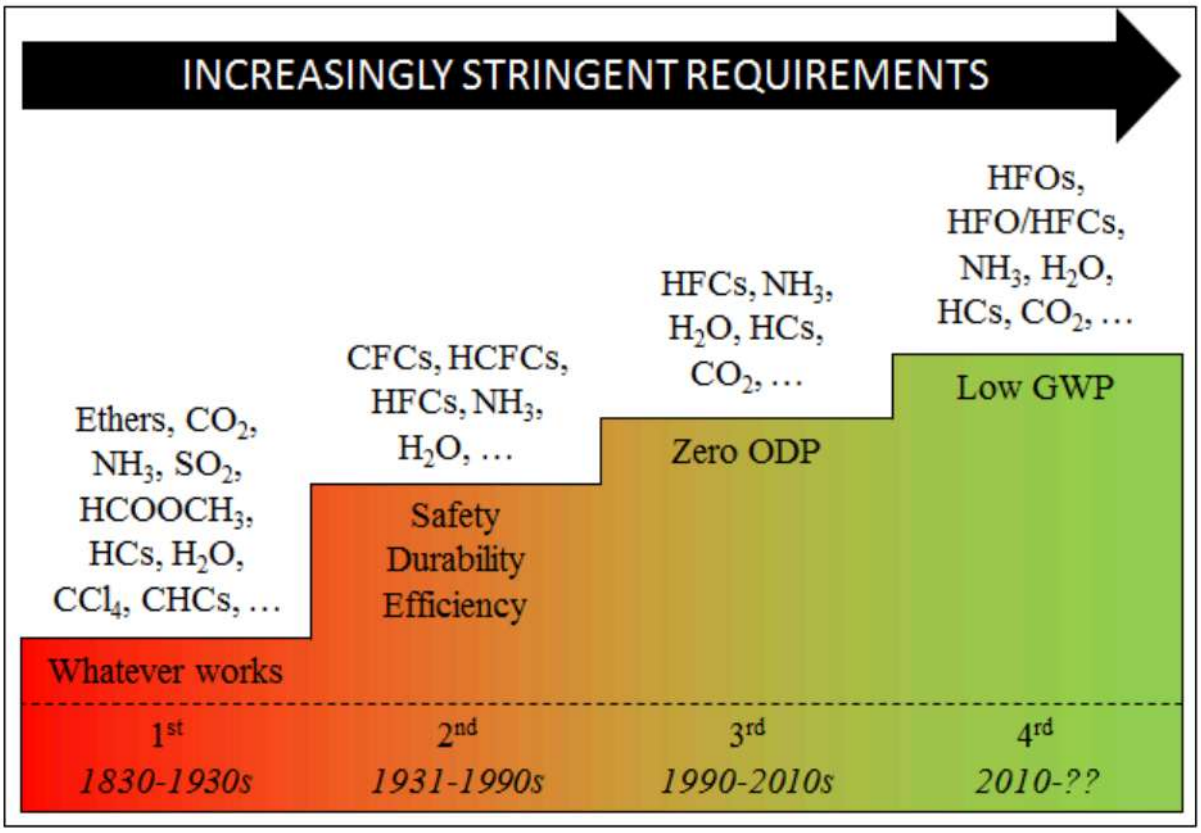
Figure 3: ODP & GWP of Common Refrigerants

Type	Product R-Number	ODP		GWP	
CFC	12	1	High	10900	High
	502	0.33	High	4657	High
HCFC	22	0.055	Medium	1810	Medium
	123	0.060	Medium	77	Low
	401A	0.033	Medium	1182	Medium
	401B	0.036	Medium	1288	Medium
	402A	0.019	Medium	2788	High
	402B	0.030	Medium	2416	Medium
	408A	0.024	Medium	3152	High
	409A	0.046	Medium	1909	Medium

Source: The Air Conditioning, Heating and Refrigeration NEWS

The phase-out schedule for HCFC and the phase-down schedules for HFC can be in Fig.4. Generally average ship's life 30 years and transforms for ship recycling process in shipbreaking yard. Most of these ships used Chlorofluorocarbons (CFCs), Hydrochlorofluorocarbons (HCFCs), Hydrofluorocarbons (HFCs) *etc*. which have GWP and ODP. During ship recycling process these gases are released into the environment due to uncontrolled way of handling and scrapping of refrigerant units and components. Other than this, the process involved labors with lack of training and environmental awareness in line with supervising and management personnel.

Figure 4: Evaluation of Refrigerants



Source: Calm, J.M., 2008. The next generation of refrigerants e historical review, considerations, and outlook.

The refrigerants commonly found in refrigeration / AC equipment as well as their approximate charge sizes. Actual equipment charge size varies based on equipment type and model. Generally, a household refrigerator typically contains 0.225 kg of refrigerant. While a building chiller may contain over 450 kg. of refrigerant.

Reference Fig.5 ships have (other than refer ship):

Accommodation AC unit

Provisional refrigeration system

Domestic refrigerators

Example:

Approx. total quantity of refrigerant = 100 kg (minimum side) / ship

Figure 5: Average quantity of refrigerants used by ships

Average HFC charge per ship in kg			
Type of vessel	For AC	For Provision	Refrigerator
Passenger	600	120	50
Ro-Ro	200	40	5
Tanker	70	20	5
Bulk Carrier	70	20	5
Vital Statistics of Ship Recycling Yards in Alang: About 80% vessel Container Ships, Oil & Chemical Tankers, Bulk Carriers, General cargo Ships. Average CFC, HCFC, HFC per ship= 100 kg			

Source: Ships manual

For carrying out this research study different shipbreaking sites in India have been visited to obtain the desired data and information that would aid in getting the desired outcomes of the research study. The various shipbreaking sites which are present in India have been distributed along the coastline. The prominent among all the shipbreaking sites that are present in India are the Sewri in Mumbai, Kolkata in West Bengal, Maharashtra and Alang which is situated in Gujarat (Zhang, 2016). Apart from this, the Kakinada, which is present in Andhra Pradesh, Hutbay and the Rungat port in Andaman has been also considered to be the ship dismantling operation sites. About 80% scrapped ships are Container Ships, Tanker, Bulk Carrier, Ro-Ro Ships *etc*. Generally average life cycle of a ship may be considered as 25~30 years. Mainly these ships hold CFC, HCFC, HFCs in their refrigerant plants.

Analyzing all the relevant data and information that has been gathered it has been found that the ship recycling process used to create huge pollution in the environment due to uncontrolled emission of refrigerant waste Fig.6. The refrigeration wastes generate a huge amount of hazardous wastes because of the improper dismantling procedure. The disposal of

this refrigeration wastes is affecting the ozone layer of the Earth and because of that several health issues take place among the individuals due to the exposure of the high ultraviolet rays from the sun (Patel, Singh, Patel, Jain, Amin and Madamwar, 2019). It has been also found that the improper way of handling of the hazardous refrigeration wastes also leads to soil contamination. The gases which are used in the refrigeration process are flammable in nature. It also includes toxic compounds like the PCBs, TBT, heavy metals like that of cadmium, ammonia, zinc, lead, copper and chromium (Manjunath, Sharma, Tyagi and Kaushik, 2018). Therefore, the toxic smokes get released when the dismantling procedure is carried out and it goes to the air thereby causing air pollution. The CFC and the PCB used to affect the Earth's oxygen layer and cause the greenhouse effect which is the main cause of the rise in temperature. It also causes depletion in the ozone layer thereby further causing serious health disorders.

Figure 6: Quantity of refrigerants released during ship recycling in India and its effect

Year		2020 1st, 2nd, and 3rd Quarter Total	FY 2019	FY 2018	FY 2017	FY 2016	FY 2015
Total Nos. of Ship Recycled in India		129	214	453	259	249	275
Total Refrigerant Kg (average) CFCs		12900	21400	45300	25900	24900	27500
50% Release Uncontrolled	Refrigerant Kg	6450	10700	22650	12950	12450	13750
	GWP (CO2 eq.) Ton	70305	116630	246885	141155	135705	149875
	ODP	6.54	10.7	22.6	12.95	12.45	13.75
25% Release Uncontrolled	Refrigerant Kg	3225	5350	11325	6475	6225	6875
	GWP (CO2 eq.)	35152	58315	123442	70577	67852	74937
	ODP	3.225	5.35	1.23	7.05	6.78	7.49
10% Release Uncontrolled	Refrigerant Kg	1290	2140	4530	2590	2490	2750
	GWP (CO2 eq.)	14061	23326	49377	28251	27141	29975
	ODP	1.290	2.140	4.530	2.590	2.490	2.750

3. RESULT AND DISCUSSION:

The shipbreaking industry is found to be the most hazardous industry as it causes tones of different types of wastes that are harming the environment in a bad way. Hence the contention is to make the sustainability of the process and the industry. So, to carry out this ship recycling industry in an eco-friendly way all the necessary safety guidelines should be

followed along with the implementation of the EMP with formulated principles that are provided by the ISO. To reduce the effects of the hazardous substance in the environment the global community must be committed towards sustainable development and also in promoting the eco-friendly process of dismantling the ship in the necessary sites where the operations are carried out. Other than this, locally the policies and regulations should be formulated concerning the ship breaking activities for focusing mainly on the safety of the recycling process. Moreover, the challenges which the ship recycling process is mainly facing nowadays are due to the refrigeration wastes it produces such as CFC, HCFC and other heavy metals. For minimizing the effects of these harmful substances, the action plan should be implemented at the global scale to reduce the wastes onboard and also to handle the wastes in a proper way for safeguarding the workers from the occurrence of any kind of casualties. Apart from this, the global, as well as the local safety measures and waste management guidelines, should be followed to reduce the impact of wastes generated at the time of dismantling.

4. CONCLUSION:

This research has been conducted to obtain relevant data and information on the refrigeration wastes that have been produced at the time of the ship recycling activities. It has been recognized that the ship dismantling industry in India is a part of the global ship recycling process. The industry possesses various opportunities and challenges. Furthermore, in India, this ship breaking industry is considered to be the prime economic activity as most of the steel used to obtain through ship dismantling and recycling procedure. Therefore, maintaining sustainability is needed for this industry. The wastes this industry possesses are high and hence it needed preventive measures to reduce the wastes. The government of India must implement proper guidelines that must be global and local based so that it could be followed to manage and handle the wastes in an effective manner. The government must consider implementing of going green process to handle the bulk wastes which the shipbreaking process used to generate at the site. Proper handling of the refrigeration wastes must be carried out in order to minimize the impact of the air, land and water. It has been found that heavy metals are causing depletion in the marine ecosystem and also causing a high rate of air pollution. Thus, it is essential that the appropriate steps such as Hongkong International Convention, Waste Inventory and Management system, Waste Management and Disposal Risk Analysis, Refrigerant Disposal Facility/Unit in Ship Breaking Yard, Disposal Certification and Records and Regular Training

of Environment Awareness to Personnel involved should be taken to reduce the effects of the refrigeration wastes as much as possible in order to prevent the harmful impacts.

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