Operation ballast water of commercial vessels in Port of Tanjung Emas Semarang

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Abstract. The commercial vessel uses sea water to stabilize a vessel when the vessel is not loading a cargo. The water stabilized for the vessel is known as ballast water. The activity of loading the ballast water for the ship from origin port and disposal to the destination port has caused impact on spreading the unidentified organism to the local port. Aim of the study to determine disposal value of water ballast either from a foreign merchant vessel or domestic merchant vessel so that Port of Tanjung Emas Semarang (PTES) is able to determine a policy on ballast administration from merchant vessel include a data of Arrival and Departure Report of the Vessels (ADRV) documents for the last five years (2009-2014). Disposal ballast water of domestic vessel to PTES is average about 37,036 m³ and increased by 76.68% in a year. Yearly ballast water disposed from the foreign commercial vessels has reached 576.045 m³ for the last 5 years. The increasing of ballast water is about 122.19%. Level of vulnerability on the PTES waters is due to ballast water disposal caused mainly from foreign commercial vessels. The PTES administration should provide water reservoir and water ballast treatment of commercial vessels which has 51,090 m³/per month or 81,744 kl/month.

1 Introduction

A commercial vessel, its operation uses sea water which is kept in ballast tank to maintain vessel's stability. When the cargo is empty, a commercial vessel will suck sea water from port area and it will discharge sea water in ballast tank after reaching the next port.

Ballast water system in commercial vessel uses Ballast pump to unload or load sea water in ballast tank. In addition to increase ship's stability, sea water in ballast tank is used to get the desirable draft of a vessel, increase speed, change trim, decrease bending moment, control list during loading and unloading the cargoes and increase the vessel's maneuver [1].

Water ballast which is discharged by the commercial vessels to destination port has an effect on aquatic environment, the effect at the east coast of Rhode Island has expanded invasion sea weed, migration of jellyfish, *Turritopsis dohrnii* at seashores in Atlantic and Pacific in Panama, Florida. Origin of far away land, Italia, Mallorca, Spain, Okinawa,

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Panama Coast, have spreaded VHSV virus in 55 fish species in fish at Great Lake waters [2-4].

The impact of ballast water discharge is also found Asian shrimp *Palaemon macrodactylus* at east coast of US and New York estuaries in 2001. Moreover a female shrimps which is carry the eggs is found (2001-2002, and 2008) showing the shrimps her doubled [5].

International Maritime Organization (IMO) has legalised a rule of ballast water of commercial vessel via Ballast Water Management Convention in 2004. One of the preliminary requirement is D 1 standard or first standard. It stated that vessel must exchange ballast water in the mid sea ocean range 200 mil before entering distination port or at a depth of at least 200 m in order to minimize spread of the hazard organisms in waters [6, 7].

There are three methods of ballast water exchange as follows the sequential method (the process with the emptying of the ballast water and recharged to obtain at least 95% volumetric exchange), the flow-through method (the process of replacing the ballast water so that water out through overflow or other arrangement), the dilution method (the process of replacing the ballast water filled through the top of the ballast tank with the simultaneous discharge from the bottom of the tank) [7].

The purpose of this study is to analyze the volume of the ballast water of commercial vessels disposal coming to PTES waters for a period of five years and to provide data to PTES administrator to formulate the volume of supply and storage of ballast water from commercial vessels at PTES as the cheapest option in the management of ballast water from commercial vessels.

2 Material and methods

Ballast water capacities are calculated for each commercial vessel with Dead Weight Ton (DWT) more than 400 Gross Tonnage (GT) arrived at PTES waters according to the result from IMO for general cargo vessel 36,5%, bulk cargo 35%, liquid cargo 35%, container 30%, mixed cargo 33%, and Roll on Roll off (Ro-Ro) 33% from DWT [8-10]. Source of incoming and out going commercial vessels from PTES waters used source of Arrival and Departure Report of the Vessels (ADRV) from port harbour administration and harbour otority (KSOP) Tanjung Emas Semarang for the last five years from 2009 to 2014 [11]. PTES is managed by PT. Pelindo III at central Surabaya, and has a management area covering ports of Banjarmasin, Benoa, Samarinda, Cilacap, Padang Bai, Lembar [12]

The discharge of ballast water from a commercial vessel is known from the vessel to unload or load the cargo. If the vessel unload all cargoes in a port then to arrange the draft, either the bow or stern, the vessel has to ballasting of sea water at the port to compensate for the vessel even keel event (there is no big difference between the bow and stern draft) . Whereas if the vessel loads to the entire hatch or existing cargo space, the vessel must deballast the seawater (from the port of origin to the loading port) to compensate for the cargoes.

3 Results and discussion

The domestic commercial vessel berth at PTES in 2009, DWT is about 693,470 MT, maximum DWT accumulation was on October whereas the minimum was on November. It's appropriate to its capacities of ballast tank there at the same month has experienced the maximum and minimum condition. Discharge ballast for each month reached 4,089.75 m³ with the minimum dispossal on February (1,286 m³), maximum on October (8,121 m³).

There have been any increased disposal ballast water as 60.64% in 2009. The arrival commercial vessels at PTES on November are at minimum (70 vessels) which is the smallest vessel is about (533,990 MT) and the smallest capacities are (186,080 MT), because there were vessel loading the cargoes, there was more ballast water disposal (6,088 m³) (Figure 1 a.)

Fig. 1. DWT, ballast tank capacities and ballast water discharge of commercial vessels from a) domestic b) foreign in 2009 (DWT> 400 MT, exclude barge and tug boat)

The foreign commercial vessels coming to PTES have fewer numbers than domestic vessels, where the number of foreign commercial vessels are a maximum of 69 compared to 112 vessels. However, the average foreign vessels’s DWT is 884,293.67 MT compared to domestic vessels of 693,470 MT. It also has implications for larger vessel ballast capacities at an average of 274,870 MT. The average monthly ballast water discharged per month is 29,9915 m3, a minimum of 23,978 m3 in January, and a maximum of 38,070 m3 in October which shows the vessels the most loading cargoes compared to unload.During the year there was no increase in ballast water discharges to PTES (Figure1 b.).

The monthly average of vessels entering PTES weigth 852,900 MT with the minimum month of February (599,398 MT) and the maximum in September (1,072,708 MT), it is proportional to the number of ships coming to PTES where in February there were only 74 and September 114 vessels. The implications of the number of ship DWT to PTES are the vessels’s ballast capacities, minimum 206,779 MT (February) and maximum 370,448 MT (September), with monthly average ballast capacities of 295,184 MT. The discharge of ballast water to PTES is different from DWT condition and vessels’s ballast tank capacities, which in May experienced maximum discharge (8,862 m3) and January minimum (802 m3) with monthly discharge of 3,291 m3. For domestic vessels in 2010, an increase in DWT and vessels’s ballast tank capacities came in at 21.80% while for the discharge of ballast water to PTES there was an increase of 139.53% starting from the beginning of the month until December (Figure 2 a) .

Fig.2. DWT, ballast tank capacities and ballast water discharge of commercial vessels from a) domestic b) foreign in 2010 (DWT> 400 MT, exclude barge and tug boat)

In April 2010, foreign’s commerciaal vessel DWT and ballast tank capacities coming to PTES experienced a maximum condition of 1,130,451 MT and 353,430 MT respectively, minimum in September with DWT vessels of 677,596 MT and ballast tank capacities of 212,693 MT. The vessel that discharges the ballast water experienced a maximum condition in December of 41,590 m3, the minimum month of May of 29,917 m3 and the monthly average of ballast water discharge of 34,776 m3. Foreign vessels coming to PTES in 2010 are decreasing, it can be seen from DWT and its ballast tank capacities are 3.71% and 6.08% respectively. However, for the discharge of ballast water from foreign vessels increased by 37.36%, it was due to an increase in the loading of cargoes for export (Figure 2 b.).

Domestic vessels entering the PTES in 2011 amounted to 1227 vessels, a maximum of 121 in December and a minimum of 84 vessels in February. The average domestic’s vessels DWT for the entire year are 982,561 MT, with maximum conditions in August (1,114,851 MT), the minimum month of February being 865,342 MT. DWT and domestic’s vessel ballast tank capacities are increased by 10%. It is proportional to the ballast tank capacities of 385,152 MT and 299,554 MT. Ballast water discharged to PTES on average is 2,367 m3/month, with maximum conditions in October and March of 4,605 m3 and 1,518 m3. Ballast water discharges by domestic commercial vessels to PTES increased by 44.62% (Figure 3 a.)

Fig. 3. DWT, ballast tank capacities and ballast water discharge of commercial vessels from a) domestic b) foreign in 2011(DWT> 400 MT, exclude barge and tug boat)

Foreign commercial vessels coming to PTES with DWT average of 1,265,368 MT in 2011, with maximum and minimum conditions in October (2,126,581 MT) and July (734,683 MT), DWT of the arrival vessels increased by 3, 94%. The average capacities of the ballast water during the entire year amounted to 395,082 MT with maximum and minimum conditions of 667,499 MT and 225,446 MT respectively. Ballast water discharge to PTES waters increased by 64.26%, with maximum and minimum conditions of 95,619 m3 and 30,561 m3 occurring in November and January. Average monthly ballast water disposal during the year by foreign vessels are 55,914 m3 (Figure 3 b.).

Domestic commercial vessels with an average DWT of 872,448 MT while maximum and minimum DWT conditions in May and June of 966,248 MT and 784,227 MT. This is in line with the ballast tank capacity of 333,989 MT and 270,489 MT. Ballast water discharges from domestic vessels in the average of 4,113 m3/month with an increase of 7.84% (Figure 4 a.).

Fig. 4. DWT, ballast tank capacities and ballast water discharge of commercial vessels from a) domestic b) foreign in 2012(DWT> 400 MT, exclude barge and tug boat)

The average DWT and ballast tank capacities of foreign vessels coming to PTES amounted to 978,757 MT with maximum and minimum DWT in October and April. There was decrease of foreign vessels arrival these year is indicated by the decrease of average vessels’s DWT by 3.9%. In line with this, the ballast water discharged by foreign vessels also decreased 6.68%. Average ballast water disposed of 44,783 m3, with maximum discharge conditions in January and minimum in August (Figure 4 b.)

Domestic commercial vessels berthing on PTES with average DWT of 934,149 MT/month with an increase of DWT from the beginning of the month of 20.32%. The arrival of the vessels reached a maximum number of 143 vessels in September with DWT 1,119,560 MT with the ballast tank capacities of 385,250 MT. While the minimum conditions occurred in February, where there were vessels visits of 103 vessels with DWT 738,975 MT and ballast tank capacities of 251,028 MT. Increased ballast water discharged by domestic vessels is small at 1.33%, with maximum disposal in February and a minimum in June (Figure 5 a.).

Fig. 5. DWT, ballast tank capacities and ballast water discharge of commercial vessels from a) domestic b) foreign in 2013(DWT> 400 MT, exclude barge and tug boat)

Foreign commercial vessels coming to PTES totaling 676 vessels with a mean dead weight of 1,011,526 MT, with April experiencing maximum conditions and the minimum September of 1,589,247 MT and 813,035 MT respectively. In line with the dead weight of the vessel, the tank capacities of the ballast water also follows where it has experienced maximum and minimum conditions in the same month. Ballast discharges from foreign vessels average 56,165 m3, maximum in April (105,338 m3) and August (34,479 m3). Increased discharge of ballast water from the beginning of the month was small at value 3.34% (Figure 5 b.).

The dead weight of domestic commercialvessels coming to PTES with an average of 934,149 MT, an increase in ship arrival by 20% from the beginning to the end of the month. The domestic’s vessels arrival of totaling 143 vessels, the deadweight and ballast water

capacities in September became the maximum (1,119,560 MT and 385,250 MT). However, this condition does not apply to ballast water discharges, due to the most loaded vessels, experiencing maximum conditions in February with a value of 4,044 m3, and a minimum in May (990 m3). The discharge of ballast water into PTES waters was a relatively small increase of only 1.33% (Figure 6 a.).

Fig. 6. DWT, ballast tank capacities and ballast water discharge of commercial vessels from a) domestic b) foreign in 2014(DWT> 400 MT, exclude barge and tug boat)

DWT of foreign vessels ranging from 830,170-1,564,907 MT with maximum and minimum conditions occurring in April and February, the vessels’s dead weight coming to PTES increased 23.7% from the beginning of the month. While the vessels’s ballast capacities are also proportional to the dead weight of foreign vessels ranging from 261,111-482,097 MT. The ballast water discharge experienced an increase of 9.63% with the maximum and minimum conditions occurring in April and February, where the average of ballast water discharged into PTES was 66,467 m3/month (Figure 6 b.).

The number of domestic and foreign commercial vessels arriving to PTES from 2009-2014 where for domestic merchant vessels ranges from 1043 to 1408 vessels, with the average of 1236 vessels/year. The foreign vessels coming to PTES are smaller, ranging from 676-1045 vessels with an annual average of 768 vessels. The arrival of domestic and foreign vessels to PTES during 5 years increased where for domestic ships 35% while overseas ships were 54.6% (Figure 7.).

Fig. 7. Recapitulation the numbers of commercial vessels from domestic and foreign at PTES

DWT of domestic vessels coming to PTES for 5 years ranged from 8,321,640-11,790,736 MT with an increase of 41.69%. This is proportional to the number of domestic vessels arrivals which increased by 35%. The average ballast water discharge of domestic

vessels in PTES is 37,036 m³/year, ranging from 27,937 m³ to 49,360 m³ during the same time period which has increased by 76.68% (Figure 8.)

Fig. 8. Recapitulation of DWT, ballast tank capacities and ballast water discharge of domestic vessels at PTES (2009-2014)

The dead weight of foreign vessels coming to PTES ranges from 10,611,524 MT-15,184,422 MT with an average DWT of 12,257,847 MT/year. There was an increase during 5 years period of 5 years in foreign vessels arrival and dead weight in PTES amounting to 54.59% and 43.09%, respectively. In line with this, the capacities of the ballast water also increased with the same value. The average annual ballast water discharge of the foreign vessels within that period reached 576,045 m³, with the maximum and minimum discharges in 2014 and 2009. There was a significant increase of ballast water discharge by foreign vessels by 122.19%. This shows that foreign vessels coming to PTES are more cargo loading for export (Figure 9.).

Fig 9. Recapitulation of DWT, ballast tank capacities and ballast water discharged of foreign vessels at PTES (2009-2014)

Effectiveness level of mid ocean ballast water exchange rates shows a decrease in *Skeletonema costatum* abundance on container vessels entering to Hong Kong port from California waters, a decrease in abundance of diatoms and dinoflagellates on commercial vessels originating from Mexico [13, 14].

The strategy undertaken by the European shipping community in response to the Ballast Water Management (BWM) Convention is to enforce this Convention as a temporary

solution despite its limited effectiveness, in collaboration with agencies developing BWM Convention in Europe to help harmonize BWM requirements across Europe [15]. The study of the effectiveness of mid ocean ballast water exchange shows the greatest exchange occurs when the source of sea water comes from the port with a low salinity and the exchange will be effective when it occurs in deeper waters than the land, so the ballast water exchange does not discharge all taxa from the port of origin and unsuitable in a regional ballast water setting [16].

4 Conclusion

DWT of domestic's commercial vessels coming to PTES for 5 years ranges from 8,321,640 to 11,790,736 MT with an increase of 41.69%. The average of ballast water discharge to PTES is 37,036 m³/year, an increase of 76.68%. Arrival of domestic and foreign vessels to PTES during 5 years has increased where for domestic ships 35% while overseas ship 54.6%. The weight of foreign commercial vessels coming to PTES are about 10,611,524 MT-15,184,422 MT. The average ballast water discharge of foreign vessels within 5 years reaches 576,045 m³/year. The significant increase of ballast water disposal by foreign vessels are 122.19%.

The vulnerability level of PTES waters due to ballast water disposal is mostly caused by foreign vessels compared to domestic vessels due to the foreign vessels more load cargoes compared to domestic vessels.

The administrator of PTES should provide a reception and ballast water treatment facilities from a commercial vessel with a capacity of 51,090 m³/month or 81,744 kl/month.

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