Ferguson, G.H. 1932. The Chlorination of Ballast Water on Great Lakes Vessels. Public Health Reports (1896-1970), Vol. 47, No. 5 (Jan. 29, 1932), pp. 256-258

(6) Hopkins, F. G., Biochem. Jour., 1921, xv, 286.
(7) Hopkins, F. G., and Dixon, M.: Jour. Biol. Chem., 1922, liv, 529.
(8) Hopkins, F. G.: Biochem. Jour., 1925, xix, 787.
(9) Harris, L. J.: Proc. Roy. Soc. London, 1923, B, xciv, 428.
(10) Abderhalden, and Wertheimer: Arch. f. des ges. Physiol., 1923, cc, 76.
(11) Mirsky, A. E., and Anson, M. L.: Proc. Soc. Exp. Biol. and Med., 1930, xxviii, 170.
(12) Joachimoglu, G.: Arch. f. Exp. Path. u. Pharm. 1916, lxxx, 8.
(13) Kuroda, T.: Arch. f. Exp. Path. u. Pharm., 1927, cxx, 330.
(14) Sullivan, M. X.: Pub. Health Rep., 1926, xli, 1030.
(15) Walker, E.: Biochem. Jour., 1925, xix, 1082.
(16) Meyerhof, O.: Arch. f. des ges. Physiol., 1923, 199, 531.
(17) Levaditi, C., Anderson, T. E., and Manin, Y.: Bull. de la Soc. de Path. exotique, 1928, xxi, 676. *See also* Compte rendu, Soc. de Biol., 1909, lxvi, 33.

THE CHLORINATION OF BALLAST WATER ON GREAT LAKES VESSELS

By G. H. FERGUSON, *Chief Sanitary Engineer, Department of Pensions and National Health of Canada*

In the final report of the International Joint Commission on the Pollution of Boundary Waters issued in 1918, it was recognized that in addition to contamination of Great Lakes waters by vessel sewage there was also a possibility of polluting harbor waters, particularly near municipal intakes, by the unrestricted discharge of vessel ballast water, which is usually seriously contaminated. After a discussion of pollution by vessel sewage, the report continues as follows:

> Pollution by water ballast constitutes a more difficult problem. There has not yet come to the notice of the commission any feasible means of purifying the rather large quantities of water which vessels while in the polluted areas of inner harbors frequently take on board for purposes of ballast, and which they afterwards discharge upon approaching their destination, often while passing water intakes. It will probably be sufficient for the present at least to control this practice by regulations designed to limit or prevent the discharge of ballast water in the neighborhood of intakes. In the event of failure of such control by regulations, more expensive and time-consuming methods of treatment will have to be developed and prescribed.

With a view to investigating the feasibility of such methods as were suggested for chlorinating ballast water, and also to consider other relevant matters, a brief study of this question was made in the latter part of the navigation season of 1930.

The data collected are presented in the accompanying table:

Data regarding ballast water and ballast tanks on certain Great Lakes vessels

Vessel	Total ballast capacity	Time to discharge	Remarks
	Tons	*Hours*	
Huronic			Ballast tanks filled at Sarnia and discharged there on return from Windsor. Ballast water also taken at Fort William prior to trip to Duluth.
Shelton Weed	810	5	
Rahane	730	6	
Ralph Budd	2,000	6	
Algonquins	1,000	5	
Noronic			Ballast tanks filled at Point Edward going westward and emptied at Point Edward on return trip eastward.
Ontadoc	2,000	6	
Penetang	975	4	
Coalhaven	1,250	5	
Lachindoc	760	5	
Hamonic			Ballast tanks filled or emptied at any point that is required and emptied as cargo becomes heavier.
Donnacona	7,852	2	
Royalite	1,000	3	
Aycliffe Hall			Ballast tanks unlined.
Lemoyne	7,000		Ballast tanks unlined and never cleaned.
Soreldoc			Ballast tanks unlined and never cleaned. Variable ballast carried.
Elgin			Ballast tanks never cleaned.
City of Windsor			Ballast water taken from Toronto Harbor and discharged at or near Montreal.
Cement Karrier			Ballast tanks unlined.
City of Toronto			Ballast water obtained in Lake Ontario.
Ashcroft			Ballast tanks not cleaned and unlined.
Maplebay		6	Ballast water obtained in Montreal Harbor and canals is discharged in harbor at Fort William.

While the small number of vessels examined does not warrant the drawing of very specific conclusions, there are, nevertheless, a number of observations to be made. The ballast tank capacity of canal-sized freighters and upper lake vessels ranges from 750 to 7,500 tons, which may be discharged in periods from 2 to 6 hours. In a typical steamship the ballast water is stored in the forepeak, two or three tanks under the cargo hold and engine room, and in the afterpeak. Additional ballast capacity is sometimes obtained by flood valves opening from the tanks into the cargo hold. Each tank is separated not only by a bulkhead but also by a partition running parallel with and over the keel. The pumping arrangement is usually a simple one, suction pipes from each tank leading to a common manifold in the engine room and thence to the pump or pumps.

There are several methods of chlorinating ballast water which might be adopted, using sodium hypochlorite as the medium for transporting the chlorine. One proposal was to add a 2 per cent solution of sodium hypochlorite by means of a chlorinator to the ballast water as it was discharged from the tanks through the chlorinating chamber (pipes or tank) to overboard. As the detention period available would seriously limit the time for the chlorine to complete its action, a high concentration of solution would be necessary and this might lead to possible corrosion of ship plate if a ship tank were used for the retention chamber. For this reason a separate tank would have to be built in the engine room or at some other convenient place. This plan, while it has the merit of being an effective one, might be prohibitive because of the cost entailed.

To lessen this disadvantage and to render effective the long detention period afforded by vessels in plying from port to port, a second proposal was to chlorinate the water on admission to the ballast tanks. This might be done in two ways. A solution chlorinator installed near the ballast water pumps would add a definite amount of chlorine to the water as it was pumped to the tanks, or, dispensing with additional apparatus altogether, proper amounts of the solution could be added to the empty tanks by means of the sounding pipes. Then when the pumps were started, the inrush of fresh ballast water would cause the solution to be thoroughly mixed with the water. This method has the advantage of not only being economical but the thoroughness of the disinfection may be checked by taking ballast water samples from a vessel intercepted at any canal en route from port to port and sailing light. A serious objection is the corrosiveness of chlorine with its damaging effect on steel plate. As the concentration of free chlorine for 100 per cent sterilization of all bacteria would vary with the bacterial counts of different harbor waters, the chlorine dosage for a given case might be far in excess of the amount required, leaving some free chlorine to attack the steel. This might be obviated to a certain extent by dividing the harbor waters into classifications on the basis of plate counts of total bacteria and specifying a chlorine dosage for each class. Thus a ship leaving Montreal Harbor with ballast water would use a certain concentration of free chlorine which would be just sufficient or nearly so for the purpose, while another ship taking ballast in one of the upper lake canals would probably use a lesser amount.

In general, there do not seem to be any real physical difficulties in the way of effectively chlorinating ballast water. It has been shown that ballast water tanks are usually filthy, containing accumulations of rust and other sediment; and when to these tanks is added foul harbor water it is at once apparent that pollution of otherwise uncontaminated water, particularly near municipal intakes, is quite within the realm of possibility.

Further study was discontinued on this problem as it was felt that sufficient data had been gathered for present purposes and that direct pollution of Great Lakes waters by vessel sewage is a far more serious menace and one which should receive first attention, rather than the lesser menace of vessel ballast water.