Report

On

Assessment of the efficiency of the Electro-chlorination unit supplied by Harambh Chemicals Pvt Ltd.

Prepared by

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1. Background

Harambh Chemicals Pvt. Ltd approached IIT Madras to evaluate the performance of their salt-based electro-chlorination system. IIT Madras agreed to undertake the work. The 20-liter capacity electro chlorination unit was installed at the Sewage Treatment Plant (STP, IITM) on 16 November 2023.

2. Objective

To evaluate the performance of hypochlorite generated through the electrolysis process in the electro-chlorination unit supplied by Harambh Chemicals Pvt. Ltd, and its efficacy on water treatment.

3. Methodology

3.1. General specifications of the supplied unit

The electro chlorination unit (Fig. 1(a)) installed in IITM-STP consists of a reactor tank with an operational capacity of 20 L (Total capacity of tank = 25 L), a DC power supply unit, and carbon-based electrodes arranged in a plate type configuration (Fig. 1(b)). The system was supplied with an input voltage of 9V.

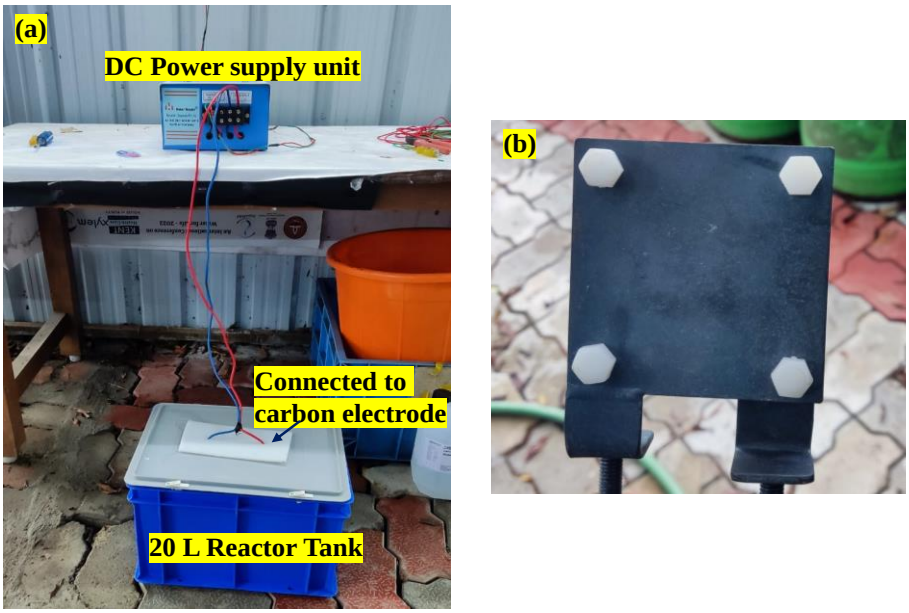


Fig. 1 (a) Overall set-up for 20-L electro chlorination unit (b) Plate type electrode.

3.2. Operational protocol

The chlorine generation in the 20-L capacity unit was initially measured in the batch mode (Fig. 1) with an 8-hour operational cycle. In this experiment, a brine solution was prepared by mixing 0.8 kg of edible salt in 20 L of tap water. The electrode was immersed in the brine solution, and an input voltage of 9V was applied through the electrode to facilitate the electro chlorination process.

3.3. Analytical procedure

The samples were collected at regular intervals and were analyzed for total chlorine and free chlorine using a chlorine test kit procured by HACH (Model- CN66F).

The leaching of the electrode was checked in terms of Iron content in the effluent, by using atomic absorption spectroscopy (Agilent, 280FS).

4. Results and discussion

4.1. Chlorine generation in 20 L capacity unit

The chlorine generation in the 20-L unit was measured in batch mode with an 8-hour cycle for 7 days. The total chlorine generation was measured daily, and free chlorine was measured on alternate days. In the kinetic investigation, the chlorine generation rate was assessed hourly and illustrated in the kinetic plot (Fig. 2).

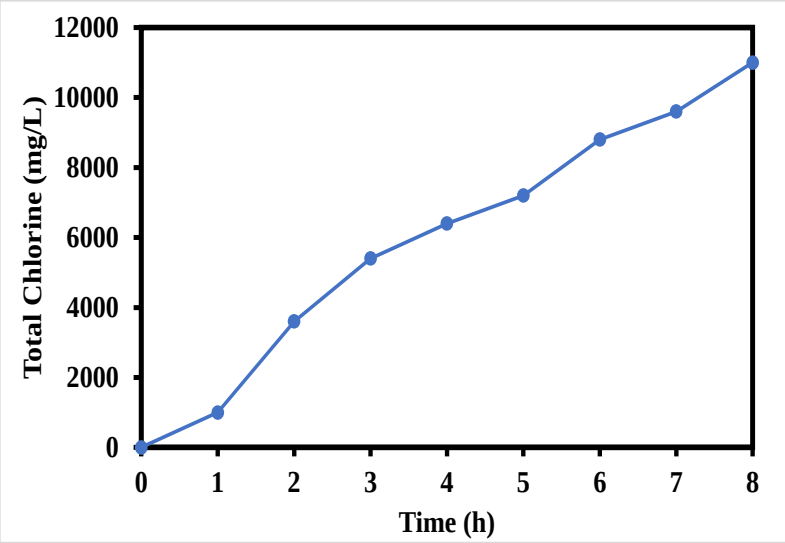


Fig 2. Kinetic study: hourly total chlorine concentration for 20 L unit

It was observed that, during the 8-hour operation over a period of 7 days, the total chlorine generated exhibited a range of 4000-11600 mg/L, with an average of 7575 mg/L.

Simultaneously, the average free chlorine ranged with an average of 7500 mg/L. The detailed results are presented in Fig. 3.

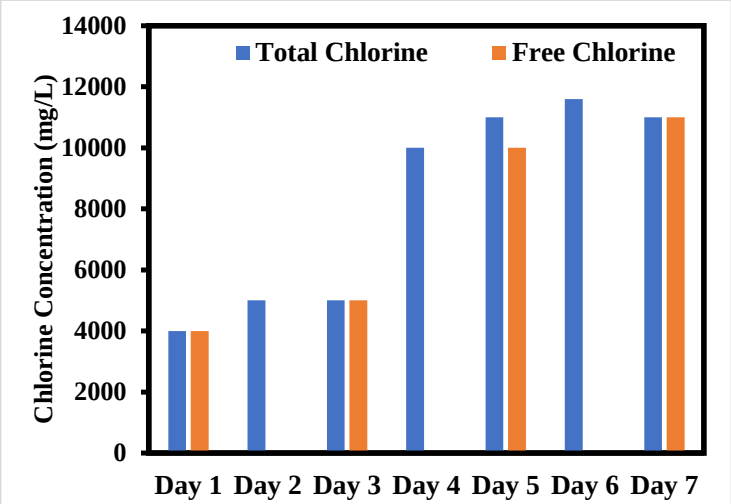


Fig 3. Chlorine concentration after 8h of operation for 20 L unit

4.2. Electrode leaching investigation

During the initial 8-hour electro chlorination process on the first day, electrode leaching was observed in the 60-L unit, resulting in the water turning completely black after operating for 8 hours (Fig. 4(a)). On this first day of electro chlorination, the iron content in the solution was measured at 0.114 ± 0.02 mg/L. In the subsequent days of operation, the final effluent remained clear (Fig. 4(b)). Furthermore, the electrode exhibited no scaling or contamination on its surface (Fig. 4(c)).

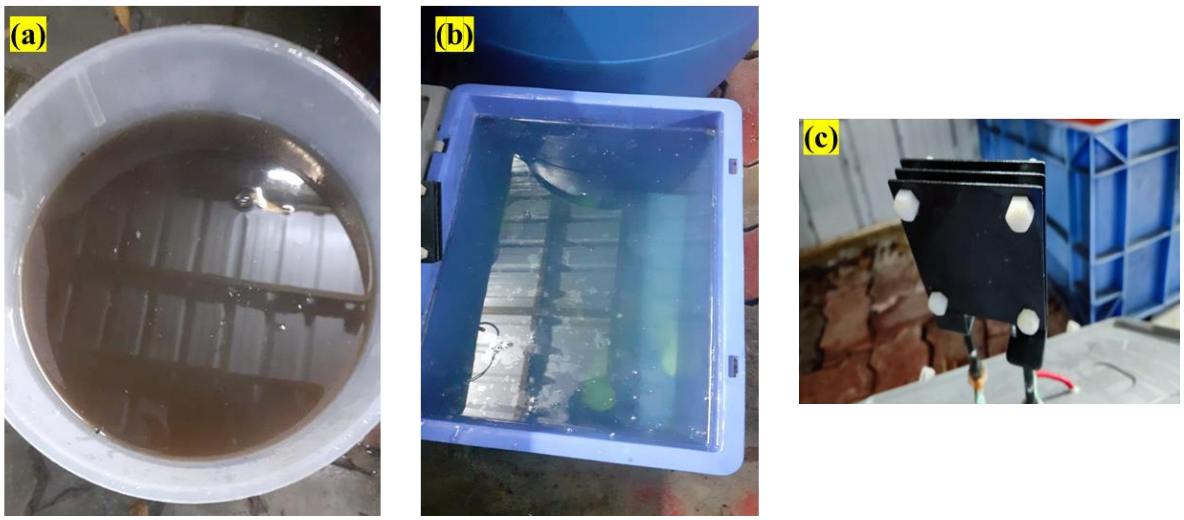


Fig 4. (a) Brown color final effluent observed after Day 1 operation (b) Clear effluent observed from Day 2 operation (c) Electrode after 2 days of operation for 20 L unit.

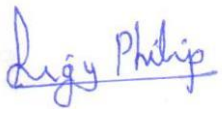
5. Inferences

a) The average chlorine generation for the 20 L unit was 7575 mg/L, and the chlorine generation ranging from 4000 to 11600 mg/L after an 8 h operational cycle.
b) The electrode showed leaching on the first day of operation. This might be due to the excess material coating or improper curing of the electrode. For further days of operation, there was no leaching and the final solution was clear.
c) The efficiency of hypochlorite production was maintained at 11000 ppm at 7^{th} day of operation.

Summary and Recommendations

- **The salt based electro-chlorination system generates about 4000-11,000 mg/L with an average of 7575 mg/L (Tested as per APHA guidelines) after 8 hours of electrolysis of a brine solution containing 0.8 kg of edible salt in 20 L of water.**
- **Initially the chlorine generation was less, and electrode leaching was observed. However, after one- or two-days operation, the leaching was stopped, and the chlorine generation increased. The chlorine concentration reached above 10000 mg/L, after 8 h. Beyond 8 hours of electrolysis, there is no significant increase in chlorine concentration.**
- **The tested system is capable of generating chlorine sufficient to treat 70,000 L of water per day with a chlorine dose of 2 mg/L (7000 x20/2). When the electrodes are fresh, or just after cleaning, it will be generating chlorine sufficient to treat 1,00,000 L/day.**
- **Care should be taken to see that the salt based electro-chlorination system is in operation at least 8 h before the intended chlorination of the water. Otherwise, enough chlorine will not be available,**
- **Daily fresh salt addition is mandatory for generating enough chlorine.**

- **It is recommended to have sensors to monitor the duration of electrolysis, electrical conductivity of the feed water and free chlorine concentration.**
- **The developed model is not suitable for continuous operation.**



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