

Fluorescent Tubelight Disposer: A Technique to separate Mercury and Phosphorous

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ABSTRACT: A fluorescent tube is a low-pressure mercury-vapour lamp that uses fluorescence to produce visible light. Mercury is essential to a fluorescent bulb's ability to emit light; no other element has proved as efficient. As effective as it is at enabling white light, however, it is also highly toxic. It is especially harmful to the brains of both foetuses and children even though mercury is present in an amount of 3 – 4 mg, when released to the environment. By 2021, the production of tubelight in India will be stopped, as a part of shifting into sustainable energy. The enormous amount of T12 and T8 tubelights are in the urge of disposal since it contains toxic elements. The main aim of the project is to dispose these tubelights in a safe way which includes the extraction and collection of these toxic materials – mercury and phosphorous. The disposer contains a chamber which crushes the tube. The glass material is collected in a collector and the mercury and phosphorous is collected separately. The residue will be stored and used for further application.

KEYWORDS: Fluorescent tubelight disposing, Mercury separation, Mercury lamp disposal, Tubelight crushing.

I. INTRODUCTION

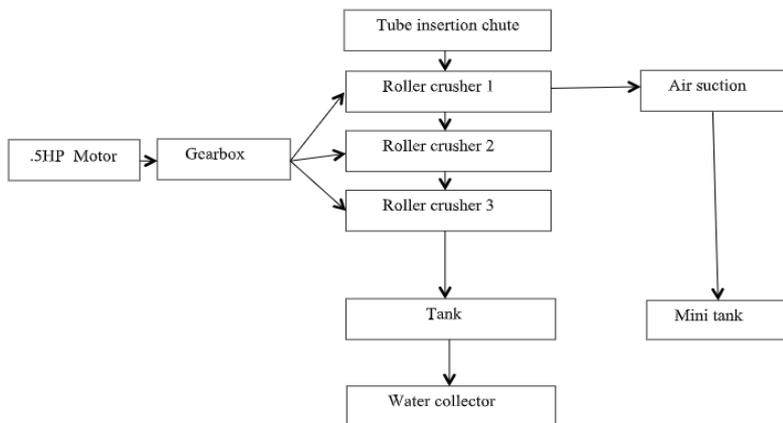
Fluorescent Tubelight Disposer, is a equipment developed for the disposal of fluorescent tubelights. Disposer consists of a glass crushing unit, mercury extraction unit, and phosphorous is also extracted separately. Rollers are used for crushing. And mercury is extracted using vacuum suction principle from the crushing chamber. The finely crushed glass powder is collected as the residue. The glass powder is mixed with water to separate the phosphorous content. The purpose of this project is to effectively extract mercury and phosphorous from the tubelight, in the hope of determining a viable and profitable procedure that can be scaled up to an industrial process. The product eliminates environmental pollution due to tubelight disposal and is also socially relevant.

Paper is organized as follows. Section II describes the components used in fluorescent tubelight disposer. The block diagram explains the working. Methodology is given in Section III. Section IV presents experimental results. Finally, Section V presents conclusion.

II. MATERIALS AND METHODS

Fig(a) is the block diagram of fluorescent tubelight disposer. From the block diagram it is clear that the whole process is divided into 2 units mainly. There is a motor and a gear box to distribute the power to the main units. The gear box is connected to three rollers using a belt drive. The power from the motor is given to the gear box and this gear box distributes the power to the rollers. Three rollers are provided to facilitate fine crushing of the glasstube. The portion in chamber, where the crushing initiates, is the place from where the mercury is extracted. This portion is kept closed using a chamber which is operated manually. Vacuum suction principle is applied to collect the mercury vapour to the mercury collection unit. The glass material after undergoing crushing is collected in a tank partially filled with water. From this tank phosphorous content is separated and stored. The work in this paper is divided in two stages. 1) Glass Crushing Unit 2) Mercury Collection Unit. Glass crushing unit starts from GI pipe of diameter 10mm is used as the tube insertion chute. This is welded to the main frame. The main frame of the apparatus is setup using sheet metal. The pieces are welded together. There is an opening and closing lid at the point of insertion to the inside of chamber. The purpose of lid is to provide a closed atmosphere to the first layer. The first layer needs to be airtight in order to stop the escaping of mercury vapour to the outside environment. The layer includes the pair of roller crushers of diameter 100mm. The gap between the two rollers is adjusted to a value slightly less than the diameter of the tubelight. Here we have setup a gap of length 14mm. A funnel (slanted metal sheets) is fixed at the

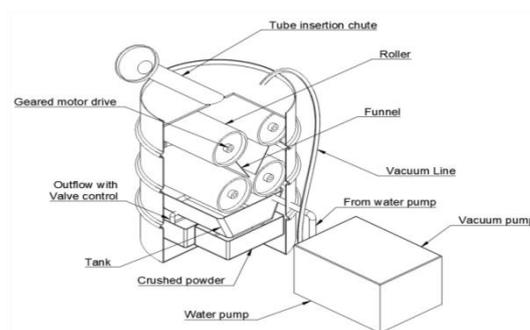
bottom of the rollers, to guide the crushed glass into the next roller. In order to maintain the air tightness we provided a metal sheet after the funnel. The sheet is manually operated. Mercury collection process is happening in the first layer. A vacuum suction principle is applied to the collection of mercury vapour from the first chamber. The Hg is carried to the collection unit which is partially filled with water. Since the Hg is denser it settles down. The second layer of the main chamber consists of 2 pairs of roller crushers with diameter 50mm. The gap between the rollers is reduced to 5mm and 3mm respectively. This adjustment is to facilitate the crushing of gas particles to fine powder. A funnel is provided at the end of each crusher. The rollers are rotated with a 220V, 1/2 hp, Single phase Motor. The rollers are connected to the motor with the help of two gear drives and six pulleys. The gears and pulleys are connected using belt drives. The pulleys are fixed to the end of the rollers. The motor is connected to the gear drive using belt. The two gears placed at the top, distribute power to the pulleys. The pulleys in turn rotate the rollers.



Fig(a) Block diagram of Fluorescent Tubelight Disposer

III. METHODOLOGY

Fluorescent Tubelight is put into the crushing unit through the tube insertion chute and motor is turned on simultaneously. The first pair of roller initiates the crushing. The low pressure mercury vapour inside the tubelight rushes out as soon as the occurs a crack. A vacuum suction principle is applied to get the vapour and collect it to the Mercury collection unit which contains water. Mercury condenses and get settled at the bottom. After the completion of Mercury collection, the lid of the first chamber is opened manually. The remaining two pairs of rollers crushes the glass into fine powder. These fine powder is made fallen into the tank which is partially filled with water. After making sure that the powder has completely fallen into the tank, water is pumped into it. Due the pressure and force of the incoming water, it get mixed with the glass powder. After the settling time, the glass particles due to its high density gets settled down at the bottom. The water and phosphorous mixture at the top level is removed through water outlet pipe and is collected.



Fig(b) CAD draft of disposer



Fig(c) Fluorescent Tubelight Disposer

IV. EXPERIMENTAL RESULTS

T12 and T8 tubelights were used for the disposal purpose.

Tubelights contain 3-4 mg of Mercury content.

Small amount of mercury is found in the mercury collection tank in the form of small spheres.

Water collected after the crushing of glass is tested and found the presence of Phosphorous.

Fine glass powder have the properties of sand. Hence, it is useful for many purposes.

All the residues can sent to the laboratories for the further chemical tests.

V. CONCLUSION

A new product is developed for the extraction of mercury from the fluorescent tubelights. This project has some social relevance, since mercury is toxic substance when exposed to environment. The government of India has banned T5 and T8 tubelights and soon going to ban T12 tubelights. Recently, Kerala government has made a announcement that the state will impose a ban on the sale of fluorescent lamps starting November this year as a part of sustainable energy policy. The problem thus going to face is the disposal of these huge amount of lamps. Each lamp contains a minimum of 3 mg of mercury in it. Since the numbers of lamps are considerably huge, so will be its hazardous impact on the environment. The scope of this project is hence applied there. Instead of throwing the lamps to the landfill, lamps can be disposed safely using the fluorescent tubelight disposer. As a future scope, the product can be developed to dispose the compact fluorescent lamps

REFERENCES

- [1] Cristian Tunsu ,Teodora Retegan Christian Ekberg, Sustainable processes development for recycling of fluorescent phosphorous powders – rare earths and mercury separation, literature report , Department of Chemical and Biological Engineering Industrial Material Recycling and Nuclear Chemistry Chalmers University of Technology Gothenburg, Sweden, 2011 35
- [2] Yadong Li and Li Jin, Environmental Release of Mercury from Broken Compact Fluorescent Lamps, environmental engineering science, Volume 28, Number 10, 2011; 1-5.
- [3] Haridasan KP, Aswin R, Bharat KB, Bipindas KK, Jayadev K and Prasobh MA, Extraction of the mercury from compact fluorescent lamp waste, Vol.3, Issue.1, pp:1315-1319, 2016
- [4] Shyamsujan; Information on CFL and its safe disposal, elcoma india, <http://www.elcomaindia.com> on 25/1/2015.