International Journal of Applied Research 2016; 2(3): 516-519

ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 5.2
IJAR 2016; 2(3): 516-519
www.allresearchjournal.com
Received: 04-01-2016
Accepted: 06-02-2016

Vimal Kumar Yadav
M.Tech., Department of Chemical Engg. Ujjain Engg. College, Ujjain (M.P.) - 456010, India.

Dr. Kanjan Upadhyay
Associate Professor, Department of Chemical Engg, Ujjain Engg. College, Ujjain (M.P)- 456010, India.

Correspondence
Vimal Kumar Yadav
M.Tech., Department of Chemical Engg. Ujjain Engg. College, Ujjain (M.P.) - 456010, India.

Recovery of plastic from E-waste

Vimal Kumar Yadav, Dr. Kanjan Upadhyay

Abstract
Plastics are among the most dangerous, hazardous, non-biodegradable and least recycled components in the fast-growing worldwide waste stream of electronic and electrical products. It's demand is increasing day to day, because of light weight, highly electrical resistance, easy to shape and long life, more used in electrical and electronic equipment for makeup wire insulator, equipment body, Plates, switches, and many other purposes. E-waste term refers to electrical and electronic products which have multiple components some are toxic and hazardous that can cause serious health and environmental issues if not handled properly. In the first step this work physical separator has been designed to perform sorting activity and has in the treatment of E-waste is collection and sorting. Sorting dismantling is mainly done manually. 1.130 kg E-waste PCB taken for manually dismantled PCB, after dismantling the total weight of PCB is1.100 kg, the separation of the metal, glass, light LDPE films plastic are carried out in the designed separator. The performance of the physical separator at three different rpm like 1200 rpm, 1500 rpm and 1800 rpm were carried out and large separation observed. It has been found that plastic separation efficiency is around 70% at 1800 rpm, 55% at 1500 rpm and 43% at 1200 rpm respectively. Thus separation of PCB E-waste can be performed automatically.

Keywords: E-waste, Physical separation, recovery of plastic from e-waste.

1. Introduction

The electrical and electronic waste (e-waste) is one of the fastest growing waste streams in the world. Electronic waste, E-waste comprises of wastes generated from used electronic devices and house hold appliances which are not fit for their original intended use and are destined for recovery, recycling or disposal (Divya *et al*, 2012) [3]. Activities related to electronic waste (e-waste) is one of the emerging problems of the 21st century. E-waste refers to end of life electronic products such as computers, televisions, and mobile phones made of plastics, metals, other trace elements (TEs), etc (Ngoc *et al*, 2009) [10]. The electronic industry is the world's largest and fastest growing manufacturing industry. During the last decade, it has assumed that role of providing a forceful leverage of the socio-economic and technological growth of a developing society (Dr. Mohite, 2013) [4]. Electronic products are made from valuable resources, including precious and other metals, engineered plastics, glass, and other materials, all of which require energy to source and manufacture (Jain *et al*, 2009). The main components of electronic waste are approximately: 45% ferrous metals, 10% non-ferrous metals (mainly Cu and Al), 22% plastics and 9% glass (Ficeriova *et al*, 2008) [5]. It is observed in recent years that large volume of e-waste is being from western countries to Asian countries like China, India, etc. for disposal. The western countries are, therefore, compelled to find out alternative destinations for disposal, where the labour cost is comparatively low and the environmental laws are not en-forced so strictly(Chatterjee 2012) [2]. Three categories of WEEE account for almost 90% of the total waste generation, which includes 42% large house hold appliances, 34% ICT equipment and 14% consumer electronics (Gupta *et al*, 2009) [6]. When not recycled the e-waste is incinerated and landfilled. These methods involve not only wasting valuable metals, but also creating a potential risk for the environment. One of the most important components in the e-waste are the PCBs (printed circuit boards) where the precious metals concentrations are ten times higher than in rich precious metals bearing ore. A typical PCB composition is: 30% plastics, 30% refractory oxides and 40% metals (Montero *et al*., 2012) [9].

1.1 Effects of E-waste

E-waste is much more hazardous than many other municipal wastes because electronic gadgets contain thousands of components made of deadly chemicals and metals like lead, cadmium, chromium, mercury, polyvinyl chlorides (PVC), brominated flame retardants, beryllium, antimony and phthalates. Long term exposure to these substances damages the nervous systems, kidney and bones, and the reproductive and endocrine systems, and some of them are carcinogenic and neurotoxic. Primitive recycling or disposal of e-waste to landfills and incinerators causes irreversible environmental damage by polluting water and soil, and contaminating air (Saoji 2012) [12]. Because plastics are highly flammable, the printed wiring board and housings of electronic products contain brominated flame retardants, a number of which are clearly damaging to human health and environment (Rani *et al*, 2012) [11]. In India, primarily two types of disposal options based on the composition are in practice. These are Landfilling and Incineration. However, the environmental risks from landfilling of E-waste cannot be neglected because the conditions in a landfill site are different from a native soil, particularly concerning the leaching behaviour of metals (Borthakur and Singh 2012) [1].

1.2 E-waste Indian Scenario

Despite a wide range of environmental legislation in India there are no specific laws or guidelines for electronic waste or computer waste. As per the Hazardous Waste Rules (1989), e-waste is not treated as hazardous unless proved to have higher concentration of certain substances. E-wastes contain over 1000 different substances many of which are toxic and potentially hazardous to environment and human health, if these are not handled in an environmentally sound manner. The growth of E-waste has significant economic and social impacts. The increase of electrical and electronic products, consumption rates and higher obsolescence rate leads to higher generation of E-waste (Jain *et al*, 2011) [8]. As there is no separate collection of E-waste in India, there is no clear data on the quantity generated and disposed of each year and the resulting extent of environmental risk. The total waste generated by obsolete or broken down electronic and electrical equipment in Indian has been estimated to be 146000 tons per year (Dr. Mohite 2013) [4]. The total electronic waste generation in Maharashtra is more than 20,270.6 tonne, out of which Navi Mumbai accounts for 646.48 tonne, Greater Mumbai 11,017.06 tonne, Pune 2,584.21 tonne and Pimpri-Chinchwad 1,032.37 tonne. The estimate includes 50, 000 tonnes of such E-waste imported from developed countries as charity for reuse, which mostly end up in informal recycling yards either immediately or once the re-used product is discarded. The authorized E-waste recycling facilities in India capture only 3% of total E-waste generated; the rest makes its way to informal recycling yards in major cities like Delhi, Mumbai and Bangalore (Saoji 2012) [12]. The current data shows that by 2012 global E-waste will reach 53 million tons from 42 million tons in 2008 thus growing at a CAGR (Compound Annual Growth Rate) of 6 percent. E-Waste is continuously growing in developed countries by 2010 it has grown to 2% in comparison to previous 1%. While in developing countries E-plastic waste contribute 0.01% -1% of total solid waste generation (Gupta *et al.*, 2009) [6].

2. Materials and method

E-waste (PCBs) collected from local electronic shop of Ujjain, Madhya Pradesh, India and taken 1.130 kg PCBs for performing experimental work. First cleaned and manually dismantled the PCBs by using piler and screw driver, after dismantled the total weight of PCBs is 1.110 kg.

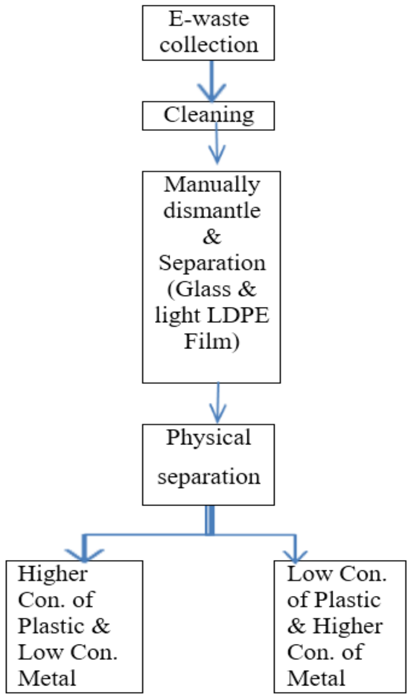

Fig 1: Process flow diagram of separation of plastic and metal from E-waste.

2.1 Physical separation

Physical separation is done by using designed physical separator. Physical separator is a Re-modified mixer grinder, in which charge mixed E-waste plastic and metal and separated according to mass and velocity.

2.2 Physical Separator

Physical separator is a Re-modified mixer grinder; jar universal fixed blade is replaced by circular plate. The physical separator works on 220-240V Ac, 50 Hz and current rating with 6 Amps. 1by1 inch two rectangular holes in the jar in opposite direction made opening lower at 1/3 of jar height from top and charged E-waste mixture plastic, metal etc. is filled in the jar and allowed for separation at three different efficient rpm, then again the physical separator is modified by increasing rectangular size of jar. The new rectangular is 2.5 by 2.5 inch has been made. The experimental work carried out in the three different rpm, observed is efficient in nature. The flour near to the separator is separated with cardboard to separate and collect the material and it has been observed that about 0.250 kg of PCB mixture can be separated with in sort duration. It has been noted that by modifying the rectangular opening of the jar now the separation is efficient and possible. The amount of plastic separated about 122.5 gram whereas metal observed to be 52.5 gram and PCBs mixture observed 75 gram. Based on the above separation result the efficiency of separation comes out to be 43% at 1200 rpm, 55% at 1500 rpm and 70% at 1800 rpm. The design of the separator is based on theoretical calculated relate to the projectile equations. The effective distance is being calculated theoretically and they has observed. The distance of the material plays key role in separation of the material. The following are the design equations take into consideration, based on projectile theory and centrifugal theory.

- $F = \frac{mV^2}{r}$ (1)
- $v = r\omega$ (2)
- $Vx = V \cos\theta$ (3)
- $Vy = V \sin\theta$ (4)
- $R = \frac{U^2 \sin 2\theta}{g}$ (5)
- $H = \frac{U^2 \sin^2\theta}{2g}$ (6)
- $t = \frac{u}{g}[1 + \sqrt{1 + \frac{2gh}{u^2}}]$ (7)

m = is the mass
ω = is the angular velocity in radians per unit time
v = is the velocity
Vx = is the horizontal component velocity
Vy = is vertical component velocity
R = is the horizontal range
H = is the height
g = is the gravitational force
h = is the height of jar

Actual velocity, angle time and range calculated by applying trial and error method in equation (1), (2),(7) and (5) respectively.

Fig 2: Designed physical separator

3. Results and discussion

3.1 Effect of particle size: It is also important factor for separation; if particles have equivalent size then particles are falling at same distance. In the work used 0.4 gm (average wt.) plastic particle for separation.

Table 1: Shows the theoretical calculated data

Rpm	Force (Newto)	Theoretical Angle (Θ^0)	Theoretical Velocity (Vx) (M/S)	Theoretical Distance (Meter)	Theoretical Time (Second)
1800	0.497	45	6.595	2.216	1.01
1500	0.345	45	3.886	1.539	0.9
1200	0.220	45	3.109	0.985	0.716

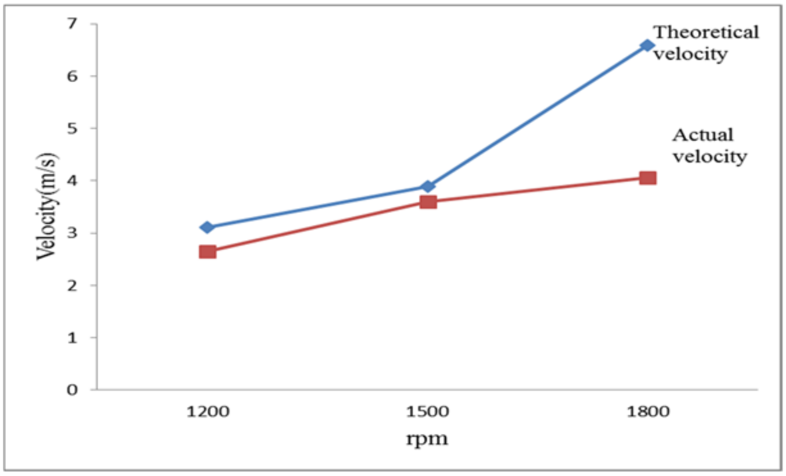

Fig 3: Shows the Comparison between theoretical v/s actual velocity

3.2 Effect of angle: To achieve maximum falling distance of separation angle should be 45 ^{0}C or near it. If falling horizontal distance is high, separation percentage is also increased.

Table 2: Shows the actual calculated data

Rpm	Force (Newton)	Actual Angle (Θ^0)	Actual Velocity (Vx) (M/S)	Actual Distance (Meter)	Actual Time (Second)
1800	0.497	52	4.060	1.63	0.659
1500	0.345	49	3.605	1.31	0.8
1200	0.220	53	2.646	0.68	0.633

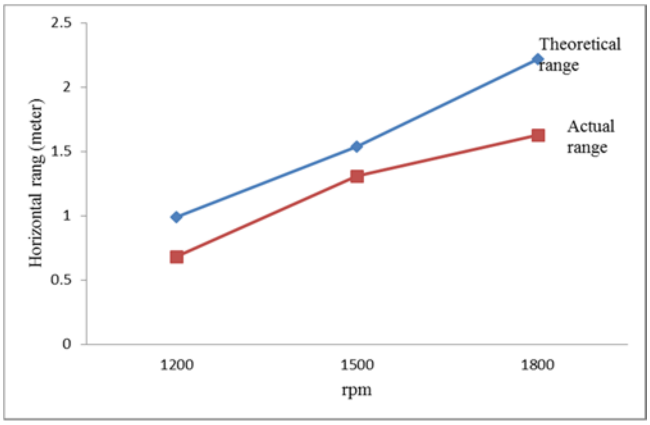

Fig 4: Shows the Comparison between theoretical v/s actual horizontal range

3.3 Effect of rpm: It is important factor for centrifugal force generation, in the separation three rpm is used 1800, 1500 and 1200 and observed that, if rpm is increased, the velocity, horizontal distance cover by the particle and separation of E-waste plastic is increased. Noted the at 1800 rpm 70% plastic separation, at 1500 rpm 55% plastic and 1200 rpm 43% plastic separation.

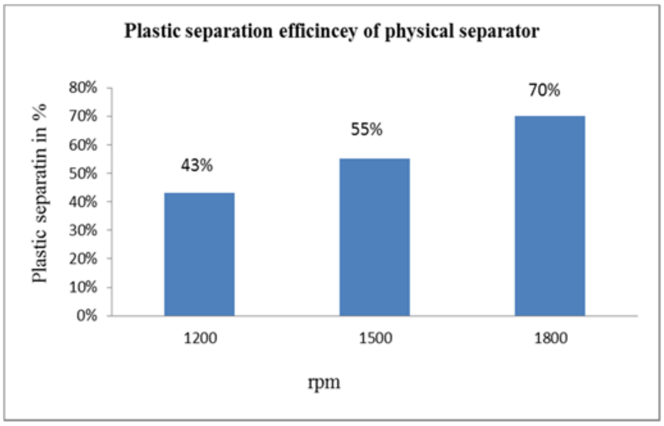

Fig 5: shows the separation efficiency of physical separator

4. Conclusion

E-waste plastics present a major threat to today's society and environment, in the study used physical separation method and 1.130kg E-waste (PCBs) taken and manually dismantled PCB, after dismantling the total weight of PCB is1.100 kg. Performance is noted at three different rpm like 1200 rpm, 1500 rpm and 1800 rpm. It has been observed that plastic separation is 70% at 1800 rpm, 55% at 1500 rpm and 43% at 1200 rpm. This method is cheap and effective, feasible for separation of e-waste plastic and metal automatically. The worker working in this filed can be problem with the toxic materials dust. Inherent safety in this process providing. The separation of E-waste can be made automatically to avoid environmental pollution. For this a physical separator has been designed based on projectile theory and centrifugal force theory.

5. Acknowledgement

The authors are thankful to Department of Chemical Engineering and Ujjain Engineering College, Ujjain (M.P.) for permission to collect literature from the library and their Cooperation.

6. References

1. Borthakur Anwesha, Singh Pradeep. Electronic waste in India: Problems and policies Review article, international journal of environmental sciences. 2012; 3:353-362.
2. Chatterjee S. Sustainable Electronic Waste Management and Recycling Process, American Journal of Environmental Engineering. 2012; 2(1):23-33.
3. Divya Khurana, Singh Tanvir, Kumar Amit. E-waste management: an overview, International Journal of Research in IT & Management. 2012; 2:763-770.
4. Dr. Mohite BJ. Issues and Strategies in Managing E-Waste in India, Indian Journal of Research in Management, Business and Social Sciences. 2013; I:46-51.
5. Ficeriova Jana, Balaz Peter, Dutkova Erika, Gock Eberhard. Leaching of Gold and Silver from Crushed Au-Ag Wastes, the Open Chemical Engineering Journal. 2008; 2:6-9.
6. Gupta Reena, Sangita, Kaur Verinder. Electronic Waste: A Case Study, Research Journal of Chemical Sciences, 2009; 1(9):49-56.
7. Jain Sanjeev, Garg Kapil Mohan. Managing E-Waste in India: Adoption of Need Based Solutions, Journal of Internet Banking and Commerce. 2011; 16:1-11.
8. Jain Sanjeev, Garg Kapil Mohan. Managing E-Waste in India: Adoption of Need Based Solutions, Journal of Internet Banking and Commerce. 2011; 16:1-11.
9. Montero Ricardo. Guevara Alicia and De la Torre Emesto, Recovery of Gold, Silver, Copper and Niobium from Printed Circuit Boards Using Leaching Column Technique, Journal of Earth Science and Engineering. 2012; 2:590-595.
10. Ngoc Ha Nguyen, Agusa Tetsuro, Ramu Karri, Phuc Cam Tu Nguyen, Murata Satoko, Bulbule Keshv A *et al.* Contamination by trace elements at e-waste recycling sites in Bangalore, India, Elsevier, Chemosphere. 2009; 76:9-15.
11. Rani Bina, Singh Upma, Maheshwari Raaz, Chauhan AK. perils of electronic waste: issues and management strategies, Journal of Advanced Scientific Research. 2012; 3(1):17-21.
12. Saoji Ajeet. e-waste management: an emerging environmental and health issue in india national journal of medical research. 2012; 2:107-110.