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Density Tower Analysis To Achieve Easy And Fast Separation Of Recyclable Materials From An Eco Friendly Company In Tijuana, Baja California, Mexico

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Abstract – An evaluation was made to use the density tower, also called a liquid tower. Its function is to analyze immiscible mixtures made up of liquids with different densities, and it can determine how they cannot mix, allowing the liquids to separate. This type of experimentation is very relevant when you want to separate materials with different densities, to achieve a quick and easy separation of the materials you want to set apart and, in that way, be able to handle them simply and quickly. This arose because an industrial company was having problems separating metallic and plastic materials from industrial equipment that was no longer in service. The process of separating these types of materials was difficult and time-consuming. By using this physical experimental process, savings are generated because it did not require having workers, just containers with the immiscible mixtures to achieve the separation of materials recyclable. The investigation was conducted in 2025.

Keywords: Density tower, recyclable materials, productivity and quality, cost savings, economic gains.

1. INTRODUCTION

The combination of immiscible liquids with different density levels, which cannot be mixed, is very important both as an experimental process and especially in the activity of separating materials that are intended to be recycled[1]. This is because these materials need to be separated, and usually it is difficult and time-consuming to do so. Additionally, sometimes when there is a large amount of recyclable materials to separate, multiple people are required, which generates labor costs[2]. This labor must be skilled to avoid any type of accidents or harm to workers in eco-industrial companies whose job is to recycle different types of materials. With the use of the density tower, this eco-industrial company made progress, improving the separation levels of the materials mentioned above, and thus increasing productivity and quality, leading to better economic gains in this industry[3]. This helps to reduce costs, because you can have containers with the immiscible liquids that form the mixtures separated, in order to set aside recyclable materials, and there is no need to have workers, saving costs. Figure 1 shows the stages of the process of separating recyclable materials with the density tower[4].

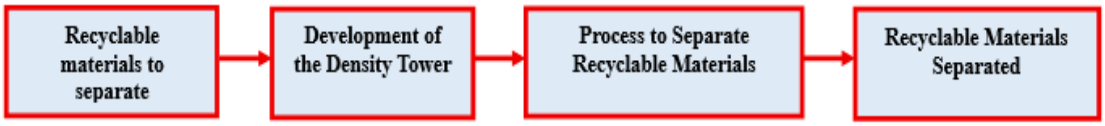


Fig -1: Stages of the recyclable materials separation process
Source: Analysis of the investigation

1.1 Industrial Ecology

They are very important in every city or suburb, where materials that people, businesses, government, and industries no longer need are collected; thinking they no longer have any kind of use, but in reality, they can be used for another type of activity that had been used before[5]. This is very important because it helps reduce large amounts of waste, and in doing so, it helps preserve ecosystems for future generations. Figure 2 shows an industrial ecology company, with the reduce-recycle-reuse logo[6].



Fig -2: Industrial Eco-Friendly Company
Source: Analysis of the investigation

1.2 The Density Tower For Recyclable Material Separation

The density tower is developed using immiscible liquids that cannot mix, forming layers of different types of liquids, which arrange themselves according to the density of each liquid, combining with another immiscible liquid[7]. Figure 3 shows a tower of liquids or a density tower with various liquids of different densities, creating several layers, and thus allowing functionality, as in this research for separating recyclable materials[8].

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Fig -3: Immiscible Liquid Density Tower
Source: Analysis of the investigation

1.3 Recyclable Materials

These are materials that have been used in various activities, but some of them can be reused for functions with lower capacity or requirements[9]. This type of material is recycled by small, medium, or large companies that are responsible for sorting them because sometimes materials from industrial or commercial equipment and machines, or those used by government centers, are joined together[10]. These include metal materials, plastics, fabrics, wood, or composites, which have been manufactured since just before the 21st century. In this scientific study, mainly metal and plastic materials derived from industrial equipment and machinery discarded by industrial plants in the city of Tijuana are analyzed. Figure 4 shows the types of materials evaluated in this scientific study[4].



Fig -4: Metallic materials (steel and aluminum) and plastics for recycling
Source: Analysis of the investigation

2. METHODOLOGY

Various activities were carried out to determine the specialized functions that helped develop the recycling process with the density tower, thereby improving this type of action to make recycling simpler and faster. The activities are outlined below.

a) Development of a density tower using immiscible liquids such as water, ethyl alcohol, and vegetable oil.

b) Analysis of the percentage of recycled materials compared to productivity and quality rates in an eco-friendly industrial company.

c) Evaluation of comparative costs of having workers versus using the recycling system with the density tower.

3. RESULTS

The numerical and percentage information on the recycling process of the mentioned recycled materials, with the presence of workers and with the support of a recyclable system based on the operation of the density tower. The results are shown below.

3.1 Percentage Evaluation Of Material Recycling Production Parameters

In this part of the research, an analysis of the recyclable process of the mentioned materials was carried out, focusing on understanding productivity and quality, performing comparative actions between having operational staff separating the recyclable materials and using a system based on the development principle of the density tower. The percentage levels of this evaluation are shown in Table 1, where increases are represented both with the operation of staff separating the previously mentioned recyclable materials, and a comparison of using a system according to the density tower with various.

Table -1: Percentage Analysis of Recycling, Productivity, and Quality Levels of Tijuana's Eco-Industry (2025)

Relevant Information	Recycled Material, %		Productivity, %		Quality, %	
Months	UW	UDT	UW	UDT	UW	UDT
January	32	34	46	44	42	48
February	36	39	49	48	46	53
March	40	45	52	53	47	57
April	43	48	55	57	51	63
May	47	55	57	59	54	67
June	50	60	60	64	58	70
July	52	63	61	69	62	74
August	56	67	64	74	65	77
September	58	70	66	78	67	80
October	60	74	69	83	68	84
November	63	79	73	85	72	86
December	70	84	75	88	76	89

UW. Using Workers, UDT. Using the density tower system

3.2 Comparative Cost Analysis

The cost section was very relevant because having a system based on the density tower to separate the metal and plastic materials evaluated in this research shows that using a system like this is profitable and helps preserve ecosystems around the world. Table 2 illustrates this, as a comparative cost evaluation of having workers versus having the density tower system. In this table, you can see that on average, the costs with workers are about half of what it costs to use the system with the density tower.

Table -2: Percentage evaluation of costs with operational staff and system with density tower (2025)

Financial Resources	Costs, %		Costs, %		
Months	**UW**	**UDT**	**Months**	**UW**	**UDT**
January	132,000	75,500	July	136,700	67,500
February	134,500	73,700	August	132,800	65,300
March	137,800	72,300	September	130,100	63,600
April	139,600	70,300	October	134,200	62,400
May	141,200	68,600	November	136,300	61,300
June	142,800	69,300	December	138,500	63,700

UW. Using Workers, UDT. Using the density tower system

4. CONCLUSIONS

The development of this research shows the great relevance of using the density tower as a system for recycling recyclable materials from equipment and industrial machinery or from household and commercial activities in this large industrial and commercial city of Tijuana. This is a strong support for helping to conserve ecosystems in this region of northwest Mexico and in any area of Mexico and the world. This indicates that the use of this simple process is very important in the recycling process of the metallic and plastic materials evaluated in this scientific study. Additionally, it generates savings in costs and time by separating the recyclable materials with the immiscible liquids evaluated.

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