RITESH RAMESH PALKAR *

Exploring Circular Economy with an Engineered Approach for Waste to Wealth

Abstract: The ecosystem is facing a significant burden as the population continues to grow rapidly. This has led to a tremendous rise in demands, which in turn has resulted in the generation of waste through various means, primarily due to the adoption of a linear economy approach. Industrialization emerged as an obvious response to the perceived scarcity of natural resources. However, this approach led to a one-way system, resulting in the accumulation of undesirable materials that we now have to confront. Although nature has taught us the value of a circular economy, mankind opted for a linear economy model to improve living standards. Today, we are all concerned about the unpredictable environmental changes and their potential consequences. To address these inevitable challenges, a concrete and comprehensive plan must be presented and implemented across all sectors. Creating awareness is a crucial step in promoting the adoption of a circular economy approach. In light of this, the author wishes to showcase several case studies where what is commonly considered waste is being transformed into valuable resources. This article focuses on areas such as solid waste management and wastewater treatment. It emphasizes the importance of carefully managing industrial waste, which can be harnessed as an energy source. This approach ultimately aims to achieve zero waste generation and zero liquid discharge.
Keywords: Circular Economy; Solid waste; Zero Liquid Discharge; Solid Waste Management; Awareness.

Összefoglalás: Az ökoszisztéma jelentős terhekkel néz szembe, mivel a népesség száma továbbra is gyorsan emelkedik. Ez az igények rendkívüli megnövekedéséhez vezetett, ami viszont – elsősorban a lineáris gazdaságossági szemlélet elfogadásának köszönhetően – a további hulladék-termelést eredményezett, méghozzá annak valamennyi lehetséges fajtájából. Az iparosítás nyilvánvaló válaszként jelent meg a természeti erőforrások vélt szűkösségére.

* *Marwadi University Department of Chemical Engineering, Associate Professor*
Email: ritesh.palkar@marwadi-education.edu.in

Ez a megközelítés azonban egyirányú rendszerhez vezetett, ami a nemkívánatos anyagok felhalmozódását eredményezte, amivel most szembe kell néznünk. Bár a természet megtanított bennünket a körforgásos gazdaság értékeire, az emberiség mégis a lineáris gazdaság modelljét választotta az életszínvonal javítása érdekében. Manapság mindannyiunkat aggasztanak a kiszámíthatatlan környezeti változások és azok lehetséges következményei. Ezen elkerülhetetlen kihívások kezeléséhez konkrét és átfogó tervet kell bemutatni és végrehajtani minden ágazatban. A figyelemfelkeltés kulcsfontosságú lépés a körforgásos gazdasági megközelítés terjesztésében. Ennek fényében a szerző több olyan esettanulmányt kíván bemutatni, ahol a közönséges hulladék értékes erőforrásokká alakul át. A tanulmány olyan területekre összpontosít, mint a szilárdhulladék-, valamint a szennyvízkezelés. Hangsúlyozza az ipari hulladék gondos kezelésének fontosságát, amely energiaforrásként hasznosítható. Ennek a megközelítésnek a célja végső soron a nulla hulladék- és a nulla szennyezőfolyadék-kibocsátás elérése.
Kulcsszavak: Körkörös gazdaság; szilárd hulladék; nulla szennyezőfolyadék-kibocsátás; szilárd hulladék kezelése; tudatosság.

Introduction

Nature has created the resources and it has its lifecycle. The evolution of human beings is very interesting. It has many steps and an equal opportunity has been given in every step to evolve the different phases. This approach has resulted in the enrichment of the lifestyle. Nowadays, we are considering this a luxury. Nature has its capacity to indulge the varying situations. A simple example is the life of a tree, it passes through different stages. *Figure 1.* depicts the lifecycle of an apple tree from the initial phase i.e. germination to the harvesting of the juicy fruit as well as its regermination. The same scenario has been presented with the help of leaves in *Figure 2.* The major point that we can highlight here is an appropriate way of the process and its natural way to dispose of it.

Figure 1. The life cycle of an apple tree

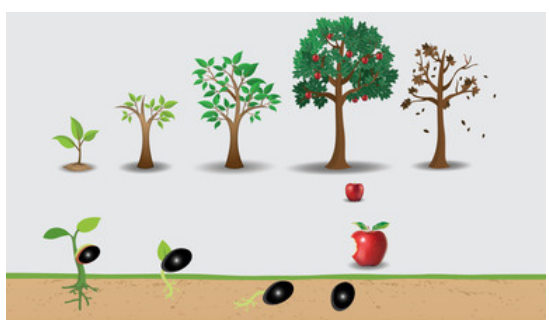
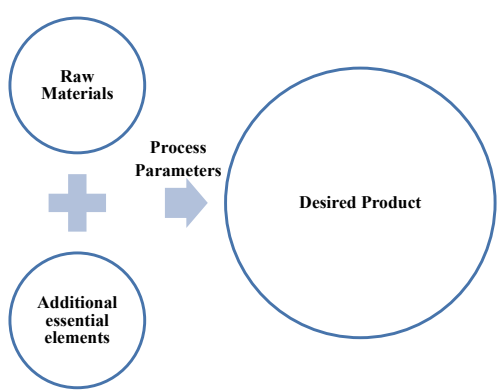


Figure 2. The life cycle of leaves

The term we will refer to this process will be the circular approach of the completed life cycle. In ancient times we may consider the less sophisticated technologies were available and thus all the natural ingredients were essential to prepare a final product. The general approach of any product formation is shown in *Figure 3.* The desired product is always the combination of two homogeneous or heterogeneous raw materials. The system has to pass through several reformations depending on the interest of the manufacturer. Let us consider the process by which we have to use the raw materials those are originated naturally. In this case, the desired product would be having properties depending on the heating, cooling, or any other processing media used. One important point to be noted here is that there is less chance that undesired products may be observed. Since we are dealing with natural resources it may not be harmful to nature, whereas it can be accommodated by the nature itself in the further step. This is primarily a process of closed loop and we used to refer to it as a circular approach.

The imagination of humankind brought laurels to the era. Industrialization is one of them. It has a key approach in this process and thus we are fortunate to excess the premium grade products in day-to-day life. Though it has many superior applications one has to also consider its inferior side as well. The present article is a getaway to these issues. The author is willing to present the Strength, Weaknesses, Opportunities, and Threats analysis (SWOT) with references to the two case studies i.e. plastic waste as a wealth and zero liquid discharge.

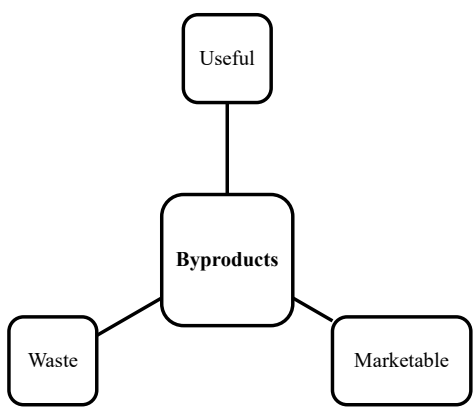
Figure 3. General mechanism of product formation



It is always observed that nature has its limitations and excess burden may force the restart of the respective system. The above-mentioned approach has been observed many times.

There are a few examples like the rejuvenation of the river, any free-flowing river has a capacity for self-cleaning. Undesired changes in the natural properties have altered the scenario and now we can observe the capacity of self-cleaning has reduced to a significant level. Similar situations in the different domains are alarming hazards. The approach needs a closer look and proper understanding will be helpful to cope-up with such situations. The most important aspect now we can emphasize is the economy. The overall idea is to approach a suitable mechanism to mimic environmental hazards. Since the earlier focus was on natural resources and due to the drastic increase in the population, artificial products were necessary to meet the demands. Furthermore, processed or altered products consist of synthetic ingredients that may not have the essence of natural ingredients. One of the basic approaches toward the byproduct is shown in *Figure 4.* In this process, primarily it has been categorized as a useful, waste, and marketable entity. The author would like to emphasize that it may not apply in all the scenarios, it would be selective. Thus, here one has to be very careful while using these three terms. A selective approach will be considered a win-win situation. In this paper, an industrial approach is considered to illustrate the waste-to-wealth approach and the significant measures are also discussed in the detail. The overall study represents the techno-economical approach to tackle the prevailing undesired situations.

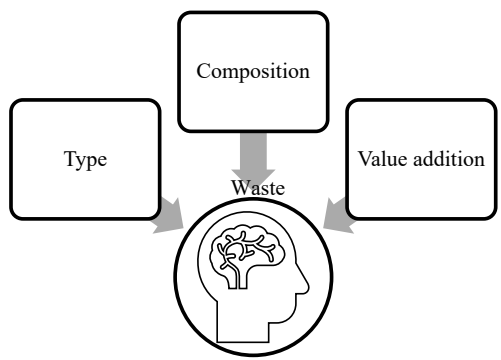
Figure 4. Basic approach toward byproducts



In addition to the objectives mentioned above, the author is highly motivated to contribute towards sustainable development goals (SDGs) designed by the United Nations. The present case will contribute in all possible ways toward sustainability.

The main idea behind the studies presented in this article is shown in *Figure 5*. The byproduct that has been generated from any process may be further analyzed based on the type, composition, value addition, and so on. In this study specifically, these three approaches have been kept for reference. The readers are also suggested to understand the mechanism and apply it to the same application in the different domains of interest.

Figure 5. Schematic representation of the thought process on waste analysis



The unwanted material from any process should not be considered trash but there should be a mechanism where it is to be considered as a reach source of raw material. Furthermore, this mechanism will serve as one of the potential steps toward the circular economy approach. To highlight such approaches, the following case studies are presented.

Case Study – 1. Co-processing

In this first case study, the author would like to present *Figure 6*. In this figure, plastic bags are represented waste collection. The waste in this case is generated from the household or any other area. The waste may be compostable or non-compostable. The major reason for this situation is globalization. The principal

category of waste the author has targeted is municipal solid waste (MSW) since it is an essential part of our daily life. The MSW consists of different waste categories, here we are interested in plastic waste. It may be noted that there are several types of plastics available. Plastic is nothing but polymers and it can be molded in the desired form. Depending on its structure it can be used in different applications. Now, we have to focus on the plastic waste collected from the MSW. The plastic of the desired composition should be collected, segregated, and then shipped to the targeted further processing units.

Figure 6. Waste collection

The idea is to use this segregated plastic as a source of energy. It will help to connect the waste to the best approach. This approach has been used in the cement industry. The cement industry is referred to as one of the Energy Intensified Industries (EII) along with the steel and power generation industries. In most industries coal is the major source of energy. Since we are dealing with a sustainable approach one should emphasize the alternative method of the energy supply. One more approach is to support green energy. In the present case study, the combination of plastic waste along with the appropriate amount of coal is suggested.

The combined approach is referred to as a co-processing of plastic waste. A major discussion will arise about the amount of emission. The plastic used in the co-processing to generate the energy in the clinker section along with the appropriate proportion of the coal needs proper attention.

The following points need to be taken care of in this process

1. Quality of the plastic.
2. Toxic gases emission.
3. Blending proportion.

4. Quality of the cement produced.
5. Any modification required in the existing mechanical design of the clinker.
6. Careful observation of all the parameters.
7. Economical aspects.
8. Environmental hazards, if any.
9. Amendments to the policies.

The details of the co-processing have been drafted and presented by Prakash and Palkar (2021).

The major steps to be taken at this point to come up with such effective sustainable and circular economy approaches are listed below.

1. Awareness in the school, colleges, societies, etc.
2. Special attention to this field with new courses.
3. Audio-visual clips to demonstrate safe practices in sustainability.
4. Monetary appreciation to enhance participation.
5. Active use of social media.
6. Online courses with specialized delivery by the experts.
7. Appropriate MSW collection mechanism.

Case Study – 2. Zero liquid Discharge

One of the major problems is water pollution. The treatment of the water is essential since untreated water is harmful to the ecosystem. There are many such occasions where water is contaminated and needs proper attention and treatment before it is sent to the water bodies. There are several things we can highlight, out of that one is Zero Liquid Discharge (ZLD). As the name suggests that there won't be any discharge of water from the premises of the society or the industry. So, in this case, the proper mechanism should be maintained for the in-house processing. In every city, we have a water treatment facility available that will be a common facility located in the far place. In this approach, a common area should be allocated at the society premises to process wastewater generated. Many societies are using this concept for different purposes. It needs a boost up in all the sectors. This approach will also contribute towards a circular economy and will help to contribute towards a greener and healthier environment. Proper attention should be given to the technology and its maintenance.

Summary

In this present work, the author has highlighted two approaches viz., Co-processing of plastic waste and Zero Liquid Discharge. The present work gives an overall idea about the sustainability approach along with the circular economy. The most popular approach is Reduce, Reuse and Recycle i.e., 3R's. The first case study has come up with 3R+C i.e., co-processing. Proper attention should be given to the major areas such as technology, awareness, and maintenance of the systems. The present case studies are the short pathway to achieve the circular economy, it needs proper refinement as per the need of the domain.

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