REVISITNG RENEWABLE ENERGY ECONOMICS (PLASTIC WASTE TO FUEL CONVERSION PROCESSES)

J.K.Chauhan[1], A.R.Patel[2], D.K.Patel[3]

[1,2,3] Assistant Professor, Department of Electrical Engineering, Birla Vishwakarma Mahavidyalaya (Engineering College) Vallabh Vidyanagar, Dist:Anand ,Gujarat 388120 ,INDIA.

jkchauhan1@yahoo.co.in, ashish.patel@bvmengineering.ac.in, dharita@gmail.com

Abstract*—"Necessity is the mother of Invention". This is a universal proverb and fully applies to the energy scenario. With the advances in technology, consistent efforts have been put to harness energy from various renewable sources. A novel and noble approach to do the same is processing the plastic products like plastic goods, has also came into picture because of its availability in abundance and its degradation production across the course of time. In this paper, the authors have attempted to bring in light some issues about the economics of this method.

***Index Terms*—Renewable energy, Plastic waste, Fuel conversion, Cost.**

I. INTRODUCTION

Plastic has now days become one of the most important materials in all the aspects of life on earth. Despite its wonderful advantages like availability in various shapes, colors etc. plastic suffers from the problem of non-degradation in the nature. This has been one of the most critical issues in handling plastic waste. Thus far plastic waste was used for land filling as well as recycling partially. The scope of identifying this waste as useful fuel was alongside thought of by a large learned researchers and scholars. A large number of researchers have opened up directions to produce the useful yields like "Green Diesel", initially on a laboratory scale. This is found functioning smoothly and efficiently on a large scale in various countries of the world. Compare to the other methods of the renewable energy, plastic waste to fuel conversion is much more of an involved process and hence its economics too. [1-20]

II. COST MODEL

On careful study and appraisal of various technical literatures, the throughputs, the catalyst, water, gaseous fuel, electrical energy requirement etc was carefully considered.[1-5] At the same time, the types of the yields, its handling and marketing strategies were also thought of. [4] It was a demand of a problem to fix some of the units as uncommon or non-traditional also. As per the author's opinion and experience the units were either adopted as per the literature or revised also. [1][4]

In this paper the authors have made it much extensive and universal as possible, so that the corresponding calculations can be carried out using simple equations and some latest cost information. A tentative list of various parameters and variables associated with this model are tabulated in Microsoft excel worksheet below:

It is wisdom for any of the researcher to first of all begin with the hypothetical modeling and then revising them to obtain the realistic model. [1][4] In this process also, the authors have made certain assumptions to come to a cost model. This model can be revised or updated by relaxing some of the assumptions or imposing additional constraints. [2]

A.) Assumptions

1. 24 X 365 plant operation
2. Energy requirements of the plants are totally fulfilled from the existing grid
3. Autonomous marketing policy
4. It is assumed that the throughput to the plant is well processed before its input to the first process vessel.

B. Justification of the assumptions

1. The plastic waste will be produced irrespective of holidays, public holidays, etc, so if an outage is taken stocking the feedstock will be a big problem. This will cause a stocking problem at a plant site even if the outage is planned, the waste suppliers will be informed to arrange this stock at their premises.
2. This assumption makes the model much more simplified in order to embed it the cost assessment process and also makes its consideration in terms of the existing figures as it is easily available also.
3. The autonomous marketing policy makes the entrepreneurs to accommodate the sinks of fuel to yield some profit levels and at the same time can also contribute to the national services like providing fuels to the vehicles of educational premises, hospitals and likewise.

4. The preprocessing is necessary to increase the yield amount as well as the yield rates.

A poorly conditioned input is reducing both the above, this assumption can be relaxed later by incorporating the additional machinery and the space issues in the costing process. [1][4]

III. Estimation of Investment and Cost Model

Having an insight into the problem depth, the dependent and independent variables can be found out. There is an exhaustive list of various variables and units associated with that. This list of variables is tabulated as the Microsoft excel sheet attached as Appendix-I.

To address the cost modeling, the following issues are elucidated and suggestions are made which are found worth, rational and substantial in this issue. In any of the production processes, the major costs are classified as:

1. Initial Investment
   - Cost of land
   - Cost of Infrastructure
   - Cost of machinery
   - Cost involved in validation and documentation
2. Running Cost
   - Cost of Raw materials
   - Cost of supporting material
   - Cost of energy
   - Cost of Water
   - Cost of wages and salaries
   - Office expenses

Some other important costs are for the insurance of this plant because their operations are considered as really critical one.

Insurance against the health associated issues of the employees.

Now various issues pertaining to the cost of various segments of the cost model will be elucidated and elaborated. The most important and primary issue in setting up such a plant is procurement of land. The cost of land is one of the most important cost and often depends upon the type of the site, the mentality of local body, the counseling with the local authority and promising them to provide a partial share that the industry earns in a long run. The land can be procured on one of the following basis:

i) Purchasing of land for life time
ii) Purchasing the land on lease basis
iii) Getting the land as donation.

Out of these proposed methods for land procurement, method of purchasing the land on lease basis seems to be more economical as government body may give subsidies rates for the plant installation and operation. This also is going to affect the overall production of the product.

Geographical location of the land should be such that the transportation of the raw material as well as finished goods is easy through appropriate transportation media, but at the same time it has to be substantially far away from the residential premises to avoid hazards of fire and associated problems.

IV. Conclusion

Despite the availability of raw materials the plastic waste is not used for plastic to fuel conversion still in India on a substantial scale. But looking at the process science, its expertise and the yield quality it seems to be the leading one in the coming days, as serves so many other useful purposes. We expect the society to understand the value of wastes. This paper will work as a primary resource in this direction.

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Appendix-I

Variable	Variable Name	Commercial Name	Suggested Unit
x0	Through put	plastic waste	Kg/Day
x1	Plant area required	land	Sq-m
x2	catalyst1		Kg/Day
x3	catalyst2		Kg/Day
x4	catalyst3		Kg/Day
C1	Cost of raw material at site		Rs./kg
C2	Cost of catalyst		Rs./kg
C3	Cost of catalyst		Rs./kg
C4	Cost of catalysts		Rs./kg
X5	Load		kW
X6	Energy		kWh
X7	Process Water		Liters/Day
X8	Service Water		Liters/Day
X9	Waste Water		Liters/Day
X10	Fuel Gas		M^3/Day
X11	Product 1		Liters/Day
X12	Product 2		Liters/Day
X13	Product 3		Liters/Day
X14	Product 4		Liters/Day
X15	Product residue at the end of the process		Kg/Day
X16	Cost of Product 1 at site		Rs/kg
X17	Cost of Product 2 at site		Rs/kg
X18	Cost of Product 3 at site		Rs/kg
X19	Cost of Product 4 at site		Rs/kg
X20	Annual land cost		Rs/Year
X21	Capital cost on plant and auxiliaries		Rs/Year
X22	Annual rate of Depreciation		Percent
X23	Expected life of the plant		Years
X24	Annual salary and wedges		Rs/Year
X25	Energy output index		Kilocalorie/kWh/kg
X26	Dangerous gas liberation in the environment		ppm/M^3
P1	Process type/Type of Plant		