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A Case Study on Energy Conservation and Cost Optimization at Amazia Vision Environment Private Limited, Satara

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Abstract
Plastic is a life changing material for mankind, the qualities that make it useful have also created a global waste challenge due to poor waste management. Only 15% of the plastic waste is recycled worldwide and very few companies are contributing to plastic recycle process due to high energy consumption. Amazia Vision Enterprise Private Limited, a Satarabased industry which recycles plastic and produce products such as HDPE, PP granules, LDPE packing bags and PP Twine.
The present work investigates the potential in utilities to save the energy and optimise the cost. The detailed analysis of the process has been carried out to find the scope for conservation of various utilities used at each stage of the operation. Theoretical solutions have been proposed to conservethe energy, reduction in the waste generated and thus minimize the cost of operation. It is also intended to optimise the process for better throughput with minimum waste generation after recycling of the plastic waste.

Keywords: plastic waste, recycling, optimisation, conservation, polyethylene.

Introduction
The aim of the company is to recycle plastic and produce the recycled products such as High Density Polyethylene (HDPE) granules, Polypropylene (PP) granules, Low Density Polyethylene (LDPE) packing bags, PP twine etc. (refer fig 1). The company produces HDPE granules with 600 Mt/month, PP granules with 200 Mt/month, LDPE packing bags with 20 Mt/ month and PP twine with40Mt/ month capacity. The plastic mainly recycled here is the HDPE and PP. The company is spread over 6 acres of land and have available excess additional non-agricultural land of 2 acres. The factory is constructed in an area of 1.5 acre.

Fig 1: Waste Transformation Flow.

The water supplied to the factory is done through a well and they also have a water pipeline directly from the Krishna River. The electricity supplied is 33KV and can take a load of 3025 KVA. The factory has numerous warehouses located in Pune, Kolhapur, Shirwal and Satara. The scrap that has been recycledis mainly collected from all these locations. There are five large scale machineries operating continuously in the whole recycling process. It consists of 2 stage cascade Extrusion line of 180 mm with die face cutter of RR Plastic make having capacity 1 Mt/ hr, 120 mm Vented Extruder, 140 mmMother Baby Extruder, Fully automatic washing line of 1.5 MT capacity of Bhavya Machaniary,Umargaon make and a Colour sorting machine of 1 MT capacity of Venus ColourSorting,Coimbatore. They also have an Effluent water treatment plant (ETP) of capacity 1l00 lit/day. The company holds well experienced staff of 400 workers approximately. The total project cost is 26 Cr of which 8 Cr of authorised capital and 7.5 Cr is paid capital.

Plastic Recycle Process:

Once the plastic regrind material is collected from various warehouses, it is first sorted (2 days) as per the plastic quality and further sent to the size reduction (1 day) process. The materials that are left out after size reduction is the Die waste.Once we have the final plastic selected, it is thoroughly washed, dried and goes through a complete quality check (4 days). The waste water after washing (dirty water) is to be treated in ETP and then it is discharged. Now after washing, the plastic is sent to a compounding and extrusion machine wherein, it is completely crushed, melted and this process takes 4 days to finish. The next process that will take place hereafter the extrusion is the dehumidification and polishing (2 days) wherein, the plastic is granulated into die face cut and is polished to give a final product. The final product then goes through a quality check and later to the bagging (1 day). All the recycled plastic that passes the quality check is bagged and is dispatched (1 day) tothe warehouse for further distribution to various companies. The by-product or the waste (Dubban) that is generated is further used for manufacturing PP twine and for Pyrolysis. This process as a whole takes 15 days to complete (refer fig 2).

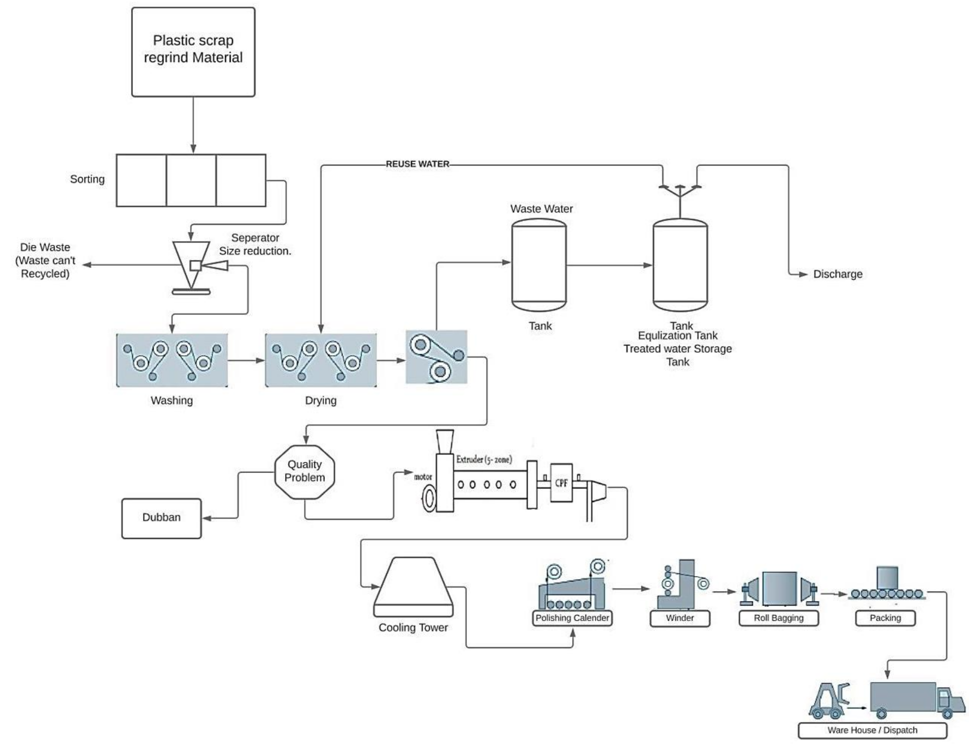

Fig 2: Process Flow Diagram of Plastic Recycle Process

Methodology:

a. Process Tearing and Partitioning

First consideration adopted in the methodology is to tear streams to reduce the complexity of the calculation of the solution. Consider at first sight there appears to be five tear streams in the entire process. The calculation sequence has been partitioned into five sets of blocks. Partitioning identifies the sets of blocks that must be solved together,there is no point solving the second partition until the first partition has been solved. All five blocks have to be solved sequentially to arrive at the solution. The main objective of using this methodology is to understand the working of the individual block along with the streams material and energy balance. Various algorithms are available for the systematic partitioning and tearing of flowsheets. Many computer simulation programs are available commercially to carry out such calculations.

b. Process Economics

Process economics is required to evaluate design options and to make choice of best economical alternatives available.It requires in carrying out process optimization and evaluating overall project profitability.

The operating cost is dominant and usually of raw materials.However, other significant operating costs involve catalysts and chemicals consumed other than raw materials, labour costs, utility costs and maintenance cost. The capital cost can be annualized by considering it as a loan over a fixed period at a fixed rate of interest. As a more complete picture of the project emerges, the cash

flows through the project life can be projected.
Utility operating cost is usually the most significant variable operating cost after the cost of raw materials. This is especially the case for the production of commodity chemicals. Utility operating cost includes:

- Electricity
    - Fuel
- Cooling water
- Steam
- Compressed air
- Refrigeration
- Inert gas.

Utility costs may vary enormously with different processing sites. This is especially true of fuel and power costs. Not only do fuel costs vary considerably between different fuels (coal, oil, natural gas) but costs also tend to be sensitive to market fluctuations. Contractual relationships also have a significant effect on fuel costs.

c. Cost Optimization

Optimization will always be required at some stage in a design of process. Most commonly for the chemical process engineer, an actual plant whose operation one wished to improve is the situation for optimization. Since the goal of optimization is to improve the process, it is necessary to start from a defined process, that is, a base case. Once the base case is chosen, some analysis is necessary todetermine where to begin optimization. At a minimum, the objective function must be calculated. If the objective function includes capital and operating costs, the base case analysis must include equipment sizing and pricing calculations, as well as material and energy balances to determine utility costs. The analysis should clearly show the effect of changes in all important decision variables on the objective function. Virtually every change in process conditions has some downstream effect which must be accounted for.

Discussion and Recommendations:

Process tearing and partitioning has to be implemented at the initial stage of the study. Flowsheet has to be divided in suitable number of blocks. Each blocks thus created need to be treated and solved separately. Material and energy balance and operating conditions of each block is required to find the scope for energy conservation and cost optimization. The operating conditions data as well as mechanical design of the equipments must be analysed properly to make the choice of the design variable used for further study.
All process equipment in each block must be operated under a range of conditions, such as quality of plastic waste feedstocks, varying operating conditions and at different production rates. The utilities used in this industry are mostly electricity and water used for washing purpose. It is recommended to find the rating of all electrical motors connected to various equipments as well as shafts. The revolutions per minute of each and every impeller or shaft have to be measured and thus calculate the power consumed by these equipments. It is also suggested that rpm of shaft or impeller have to be optimized at suitable power requirement.
The optimum conditions selected for the design are most certainly not the optimum and, in fact, might be extremely inefficient. It is our job to understand the process with enough depth to effectively make changes to process conditions to approach an optimum. One must never lose sight of the goal of optimization to maximize the profit of a business. Hopefully, this discussion provided a clear-cut method for selection of process variables, calculation and evaluation of chemical process optimization, although complicated. It is also recommended to carry out the rigorous analysis of all manipulating design variables to arrive at the optimal cost which comprise of capital and running cost.

Conclusion:

The present work is aimed at finding the potential to conserve the energy at the plant Amazia Vision Environment Pvt Limited, Satara. The selected organisation processes plastic waste andproduces recycled plastic granules from plastic waste collected.
The cost of the energy consumed is much higher in various processes and hence our objective is to reduce the energy requirement at these different stages. As a part of our study, the detailed process flow sheet has been partitioned into 5 statges, each stage and its energy consumption needs to be evaluated separately and a target has be chosen to recover the energy in the form of utilities. It is also aimed at optimising the different process parameters at each and every section of the process. The main purpose of the optimisation is to reduce the operating cost of the entire process. Detailed study of economics over the process is required to meet the targets for energy saving and cost optimisation.

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