CP Case Study: Cleaner Production in an Agricultural Industry

S. P. Sharma and G. H. Ban

***Abstract*—Agriculture is the backbone of Indian economy. Up to 70% of the population is engaged in farm sector directly or indirectly. Growing Indian population needs sufficient farm product. During the Green Revolution, achieving high crop yields at any cost was the ultimate goal. The emphasis now is on sustainable agriculture-increasing yields without harming the environment at low cost. In the last half of the 20th century, there has been a growing worldwide movement among government and industry to change the way industry interact with the environment. Cleaner production is outcome this progress. Cleaner production is a way of looking at what causes waste and then figuring out the best way to reduce the pollution before it is created. Applying CP tools to the industry is really worth?**

***Index Terms*—Clean production, sustainable agriculture, scrapped equipments**

I. Introduction

THE primary function of the industry is to process input resources in to products. However all the inputs are not transformed in to product, the portion that does not get transformed in to products comes out as waste. This transformation in to waste depends on the technology employed and efficiency of the production process. Identify activities or areas in process where wastes don't need to be created, such as where efficiency can be improved; where less-toxic substances can be substituted for more-toxic ones, and where, water or other raw materials can be saved.

Cleaner Production aims to prevent pollution, reduce the use of energy, water and material resources and minimize waste, profitably and without reducing production capacity. It involves rethinking conventional methods to achieve 'Smarter' products, product components, and production processes. The United Nations Environment Program (UNEP) defines Cleaner Production as 'The continuous application of an integrated preventive environmental strategy applied to processes, products, and services to increase efficiency and reduce risks to Humans and the environment'[1][2].

II. Cleaner Production Techniques

Cleaner production techniques are methods, which are employed to find the way out for prevention of pollution. Generally the applicable methods for cleaner production in the Indian context can be classified in the following categories:

- Waste reduction at source
  - Good housekeeping
  - Process Changes
- On-site Recycling
- Product Modification
- Energy Conservation[1][6]

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III. Benefits of the Cleaner Production

Apart from reducing the manufacturing costs and thus, improving the profitability, cleaner production offers several other benefits as follow.

- Conservation of raw materials & energy
- Lower costs
- Improved environment
- Quality improvement & market requirement
- Improved efficiency & better access to fionance [1][6]

IV. Barriers to Cleaner Production

Barriers are positive, proactive steps that cleaner production advocates can take to overcome the resistance to new ideas and practices that often blocks cleaner production programme.

The major barriers are as follows:

- Attitudinal barriers
- Systematic barriers
- Organizational barriers
- Technical barriers
- Economic barriers
- Government barriers [1][7]

V. Cleaner Production Methodology

The approach to be adopted for the exploitation of the maximum CP potential should be a systematic, step-by-step approach. The approach must be flexible enough to adapt to unexpected circumstances. One of the most successful approaches developed by NPC and which has been used with considerable success in various industrial sectors.

The approach consists of six steps or stages:

- Getting Started
- Analyzing Process Steps
- Generating Cleaner Production Opportunities
- Selecting Cleaner Production Solutions
- Implementing Cleaner Production solutions
- Sustaining Cleaner Production [1]

VI. About Thiophanate Methyl

Thiophanate-methyl is a systemic fungicide used to control various diseases caused by fungal pathogens. TPM was first registered as a pesticide in the U.S. in 1973 for use as a fungicide. EPA issued a Registration Standard for TM in March 1996. Thiophanate-methyl inhibits fungi growth by

interfering in the biosynthesis of DNA in the fungal cell division process.

TPM formulations include dust, granular, wettable powder, water-dispersible granular, and flowable concentrate. TPM may be applied with aerial, chemigation or ground equipment (broadcast, band, or soil drench); as a dip treatment for cut flowers, rose budwood, or nursery stock; and as a seed treatment for peanuts and potato pieces. Handheld equipment may be used on turf and ornamentals. The majority of the crops are treated with post emergent broadcast applications.[8]

VII. Use of Thiophanate Methyl

It is a fungicide, effective against a wide range of fungal pathogens. Also used on almonds, pecans, tea, coffee, peanuts, Soya beans, tobacco, chestnuts, sugar cane, citrus fruit, figs, hops, mulberries, and many other crops. Used additionally as a wound protectant for pruning cuts on trees. [8]

VIII. TPM Production

Capacity of plant: 610 - 615 Kg TPM Per batch

IX. Raw materials

TABLE I
Raw materials

Raw Material	Quantity, Kg
STC	350
MCF	400
OPDA	108
DMA	7
EDC	1400

X. Reactions

Step 1

$$NaSCN + C_2H_3ClO_2 \Longrightarrow C_3O_2H_3SCN + NaCl$$

Step 2

$$2[C_3O_2H_3SCN] + C_6N_2H_8 \Longrightarrow C_{12}H_{14}N_4O_4S_2$$

XI. Process Description

- First EDC is charged in the reactor. EDC act as a medium for carry out the reaction. Maintain the temperature around 15^0 C by chill water supply. After that charge STC and stir for 60 min.
- Then start addition of 1st drum of MCF in 2-3 Hrs. during addition maintain temp. below 15^0C
- Then start addition of 2^{nd} drum of MCF in 2-3 Hrs. during addition maintain temp. below 20^0C Stir for 1 hour at 20^0C
- Add DMA in EDC [DMA 7 Kg + EDC 50 Kg] in 2 hrs below 35^0C Stir the mass for 3 hrs at 30 - 35^0C
- Check the sample. If MCF is higher then 2 % send sample every two hours. Temp to be maintained is 32 - 35^0C
- Cool the mass below 15^0C
- Start addition of OPDA powdered below 18^0C.First 90 % in 7-8 hours maintain 20^0C for 1 hour and remaining OPDA & EDC added in the 1 hour
- Maintain the condition at 30^0C
- Filter batch in ANF. Distill out EDC from the cake in ANF or dump the cake to distill EDC
- Dump the wet cake in 1000 Lit. water and filter the batch in SNF. The liquid waste is sent to the incinerator and cake is taken in to centrifuge
- In centrifuge another wash of hot water (60-65^0C) is given to the cake. After centrifuge cake is send to Tray Dryer
- From tray dryer the product containing around 0.6% moisture is taken to the pulverizer, where product is in the fine powder that can be packed as a finished product

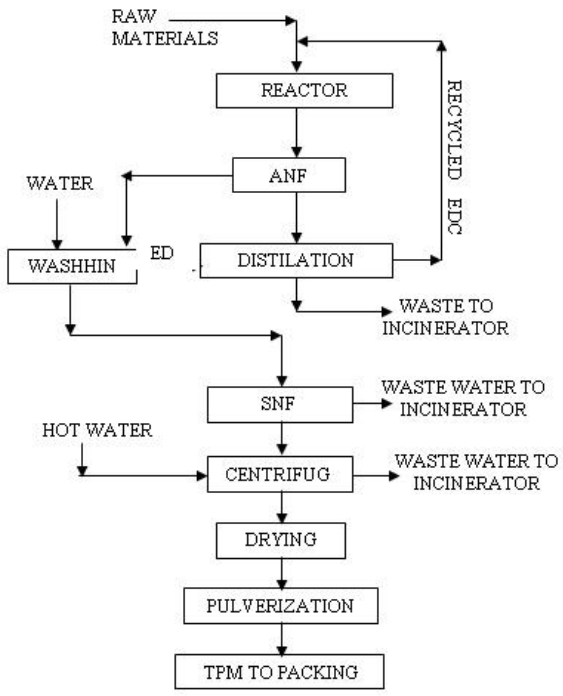

Fig. 1. Flow diagram of TPM Production

XII. Identification of Problem

After studying the process, and by adopting CP methodology identified following problem with existing production of TPM

- EDC losses from the existing operating method
- Steam consumption in tray dryer and time for drying
- Total time taken for one batch production

XIII. Solution to the problem

By installing the Agitate Filter Dryer in place of the ANF, the problems can be solved. AFD will give better performance by improving recoverability of EDC, time of operation and Steam consumption

XIV. Agitated Filter Dryer

Agitated Filter Dryer is a closed vessel designed to separate solid and liquid by filtration under pressure or vacuum. The closed operation ensures odorless, contamination-free and non-polluting working conditions maintaining product purity and hygiene. The advanced technology of agitation and hydraulics used in the equipment makes it versatile and user friendly. The resulting wet cake can be reslurried and washed thoroughly with water or solvents unlike in "Nutsche" type filters or centrifuges. Wash liquid quantity can be controlled and recycled, reducing effluent load. The discharge of wet cake is automatic. If the process demands, filtration in chilled or hot condition can be done. Drying of wet cake is also possible when drying features are incorporated

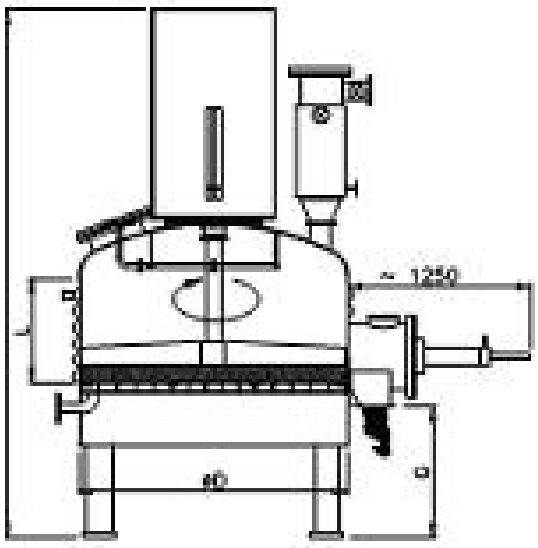

Fig. 2. Agitated Filter Dryer

Agitated Filter Dryer filters and dries the product in a single charge without vessel transfer. After filtration the product is heated under agitation from shell, bottom and agitator. The vapors are carried to the condenser through product filter. Often a lump breaking system is introduced from top to break lumps during drying. The drying time is appreciably reduced and solvents recovered

Agitated Filter is a cylindrical, vertical closed vessel made as per pressure vessel code. The vessel is fitted with plane filter media, either metallic or synthetic at the lower end of the vessel. Specially designed, slow speed, robust Agitator assembly is mounted on vessel. The agitator design adopted is advanced and unique to this system. The "S" type self-centering blades are made from heavy sections to handle liquid as well as solids. It has four movements; each movement, either single or in combination is designed to carry out specific operations.

XV. Advantages of the Agitated filter dryer

- Toxic and hazardous material can be processed
- Product purity maintained
- Sterilizable unit available
- Product can be washed thoroughly and economically with solvents
- Blending of product possible before discharging
- Almost complete discharge possible.
- Avoids cumbersome and repeated handling of process materials. Saves on number of equipment used in filtration process viz. crystallizing vessel, intermediate hold vessel, reslurry vessel, etc. Streamlining process, thereby saving on power, labour, floorspace, spillage and time
- Large quantities can be processed faster than the conventional systems
- Complete automation with PLC is available
- Higher cake thickness possible in the equipment for crystalline products
- The equipment is functionally safe and easy to operate
- It can carry out various phases of process operations, viz: Crystallization, Filtration, Extraction, Discoloration, Washing and Drying
- The numbers of conventional machines employed for filtration process are also reduced
- It has multi-functional utility, saves on power, labor, floor space, material wastage and time
- The Agitated filter dryer has wide field of application in Chemical, Pharmaceutical, Agro Chemicals, Fine Chemicals and Food Industries. Sterilizable pharma versions are available for aseptic requirements
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XVI. The implementation of this option has yielded following benefits

- EDC recovery can be increased. EDC recovery = 50 kg / batch
- The total production time cycle of the TPM manufacturing can be reduced. Saving in production time = 21 Hrs
- The steam consumption in the production is reduced. Reduction in Steam Consumption = 140 kg / batch.
- The no. of equipment can be reduced and by that reduce in requirement of men power and maintenance cost of the equipment.
- Total Investment = 35, 00,000 Rs
- Net Savings = 2754966.48 Rs.
- Payback Period = 1.27 yrs

XVII. Application of the Scraped Equipments

The scraped equipment after the installation of the AFD, the equipments will be set up for another manufacturing unit for the use of the equipment. Therefore, there is no issue of the selling or the replacement of the equipment

XVIII. Overall Results achieved

XIX. Conclusion

In the last half of the 20th century there has been a growing worldwide movement among government and industry to change the way industry interact with the environment. Cleaner production is outcome this progress. Cleaner production is a way of looking at what causes waste and then

TABLE II
RESULTS ACHIEVED

Sr.No	Parameter	Before CP	After CP	% Saving
1	EDC Recovery Recovery	200 lit	250 lit	25
2	Steam consumption	893.025 Kg /batch	753.2 kg /batch	16

figuring out the best way to reduce the pollution before it is created. Historically, people looked for ways to control pollution after it was created while here emphasis on ”source reduction”. Try to reduce the waste first and then recycle. This approach can benefit the environment and save money. This is what industries are looking for profit. Cleaner production is best technique for environmental protection with economical benefit.

At Agricultural Industry, three problems were identified, for overcome these problems Agitated Filter Dryer (technology up gradation) option implemented and due that recovery of EDC from operation, saving of the steam consumption and total production time is reduced. With removal of EDC from the wastewater, treatment cost associated with waste will be reduced and recovery of EDC as valuable product will be recycled, gain environment as well as economical benefit to the company.

REFERENCES

[1] Training Manual, ”National Productivity Council”
[2] Bhatt B. I. & Vora S. M. ”Stoichiometry” second edition, Tata Mc Graw Hill Publishing Company Ltd., New Delhi, pp 60-87 & pp 67-291, 1990.
[3] Perry R. H., Green D. W. & Malony J. A. ”Perry’s chemical engineers handbook”, 6th edition, Mc Graw Hill Book Co., Singapore - pp 1025-1110,1984.
[4] Shreve R. N. & Brink J. A. ”Chemical Process Ind.” 4th edition, Mc Graw Hill Kogakusha Ltd, Tokyo, pp 641-643, 1977.
[5] Dryden C. E. ”Outlines of chemical technology” 2nd edition, Effiliated East West Press Pvt. Ltd., New Delhi,pp 619-647
[6] www.cleanerproduction.com
[7] www.epa.sa.gov.au/pdfs/cpsmiths.pdf
[8] www.chinesepesticide.com/fungicide.htm
[9] www.hlengineers.com/construction.html

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