Spray Dryer for Evaporation of Effluent of Acid Black 194

Irfan Kagzi[1] Shaikh Mohammed Usman[2]
[1]Student [2]Assitant Professor
[1,2]Department of Environmental Engineering
[1,2]Swarnim Startup & Innovation University, Gandhinagar, India

Abstract— Looking to the present status for compliance of Common Effluent Treatment Plans (CETPs), no new permissions for accepting effluent to CETP are permitted as Central Pollution Control Board, a statutory Body has imposed direction under section 18(1) B of the Water Act 1974.This retards the growth of industries which have potential to expand. Keeping this restriction in view, If alternative of CETP is explored, a situation may come up in favor to the industry which will not only comply the prevailing imposition of restriction under 18(1) b of the Water Act 1974 but also will allow industrial unit to grow. Alternative is not to discharge waste water to the CETP, instead it is to be evaporated keeping the air emission within National Ambient Air Quality Standards. As discussed in this paper, cost of evaporation of waste water bears higher cost than conventional treatment, products having good profit margin can go for pursuing alternative of spray drying of effluent. A case study of spray drying of treated waste water of Acid Black 194 is considered where the spray dryer is already existing for drying the products.

Keywords: Common Effluent Treatment Plant, Central Pollution Control Board, Reactive Dyes, Azo Dyes

I. INTRODUCTION

Honorable High Court of Gujarat in the year 1995, (in the case of Pravinbhai C Patel v/s Government of Gujarat and Others) issued closure to the industrial units causing pollution in Ahmedabad. In the order, it was directed to develop environmental infrastructure facilities namely Treatment, Storage, Disposal Facilities for solid waste (TSDF), and Common Effluent Treatment Plants (CETPs) for safe disposal of industrial effluent. As a result CETPs and TSDF at GIDC were come up. Due to change in market scenario over two decades, industrial units felt expansion with making of different range of products to meet international demand and at the same time performance of the CETP was also required to be improved. Keeping noncompliance of CETPs for discharge of waste water, Central Pollution Control Board (CPCB) issued direction under 18(1) b of The Water Act 1974 restricting them to accept additional hydraulic as well as organic load of effluent. This situation has compelled all the concerned to think of alternative of a CETP with making no additional discharge of waste water to CETP and pursue zero liquid discharge. Further, the industrial units started optimum use of water with reduction in volume of waste water. Following the zero liquid discharge scenario, Industrial units have started use of multiple effect evaporators (MEE), Agitated thin film dryers (ATFD) and spray dryers.

II. STUDY AREA

A study for evaporation of wastewater originated from manufacturing of Acid Black 194 to assess the adequacy of evaporation as well as economy of evaporation is performed at the industrial unit having facility of spray dryer for the product at the industrial unit located in Gujarat Industrial Development Corporation, Vatwa. GIDC, Vatwa is an industrial cluster located in the eastern side of the Ahmedabad City, Gujarat, India established in the year 1968. It has total area of 527 hectare and houses about 2500 industries most of them are Dyes and Dye Intermediates. It has common infrastructures like Common Effluent Treatment Plant and Treatment, Storage and Disposal facilities (TSDF) for hazardous waste.

III. METHODOLOGY OF THE STUDY

- Identification of manufacturing process of Acid Black 194.
- Collection of samples of waste water from manufacturing process of Acid Black 194 and after its primary treatment.
- Conduct of trial evaporation run in spray dryer for evaporation of waste water of Acid Black 194 which is already existing for spray drying of Acid Black 194.
- Collection of air emission sample during trial run from the stack attached to the Spray dryer followed by Air Pollution Control Devices.
- Comparing techno-economic feasibility between conventional treatments versus spray drying of waste water of Acid Black 194.

A detailed study of manufacturing process of Acid Black 194 revealed there is generation of 3500 kg of Acid Black 194 along with generation of waste water of 5884 Litre. A material balance is given in Table 1.

Sr. No	Input Quantity in kg		Sr. No	Output Quantity in kg	
1	Beta Napthol	300	1	Effluent to ETP	5884
2	Caustic	285	2	Acid Black 194	3500
3	Sodium Nitrate	154			
4	Water	1000			
5	ICE	2955			
6	6 Nitro 1-Diazo 2 Napthol 4 Sulphonic Acid	600			
7	Steam	2540			
8	Salicylic Acid	50			
9	Basic Chromium Sulphate	300			
10	Salt	1200			
	Total	9384	Total		9384

Table 1: Material Balance for Acid Black 194

Waste water generated after manufacturing of the intended product is collected for analysis from the collection

tank of primary ETP and a sample is also collected from the treated waste water tank after primary treatment and results are given in Table 2.

Sr No.	Parameters	Unit	Untreated waste water of Acid Black 194	After Primary Treatment of waste water of Acid Black 194
1.	pH	pH Scale	7.0-8.0	7.5-8.5
2.	T.S.S	mg/l	150	80-90
3.	C.O.D	mg/l	6500-7500	5000-6500
4.	TDS	mg/l	120000-125000*	130000-45000

Table 2: Effluent Characteristics of Acid Black 194 before & After Primary Treatment

*Out of 1200 Kg Salt for isolation, around 80-85% salt goes with effluent

After primary treatment of effluent, possibility of the evaporation is explored in spray drier maintaining flow of 900 litre per hour with temperature profile 150 Deg C-250 Deg C which caused complete evaporation of the high TDS waste water. The evaporation occurs in spray dryer as effluent is allowed to pass through main chamber of spray dryer followed by cyclone separator, bag filters and water scrubber wherein majority of suspended particulates are settled and scrubbed with water. The scrubbed water is further recycled to spray dryer. Final emission complying prescribed norms is allowed through stack. As explained above, economy of the spray drying of waste water comes to be Rs 2.10 per litre if imported coal is used in hot air generator and it comes to 3.30 if natural as is used in hot air generator. A trial run is conducted for evaporation of waste water bearing characteristics mentioned in Table 1 in spray drier which is existing for spray drying of Acid Black 194 itself to evaluate feasibility. A sample of air emission through stack of spray dryer is collected during trial run for emission of Particulate Matter under iso-kinetic condition and emission results analyzed as 66.24 mg/NM3 which is well within National ambient air quality standard prescribed as 150 mg/NM3. Cyclone separator, bag filter followed by water scrubber are provided with spray dryers to control emission of particulate within norms.

- A=Solution or suspension to be dried in,
- B=Atomization gas in,
- 1= Drying gas in,
- 2=Heating of drying gas,
- 3=Spraying of solution or suspension,
- 4=Drying chamber,
- 5=Part between drying chamber and cyclone,
- 6=Cyclone followed by Water Scrubber,
- 7=Drying gas is taken away,
- 8=Collection vessel of Evaporation Salt

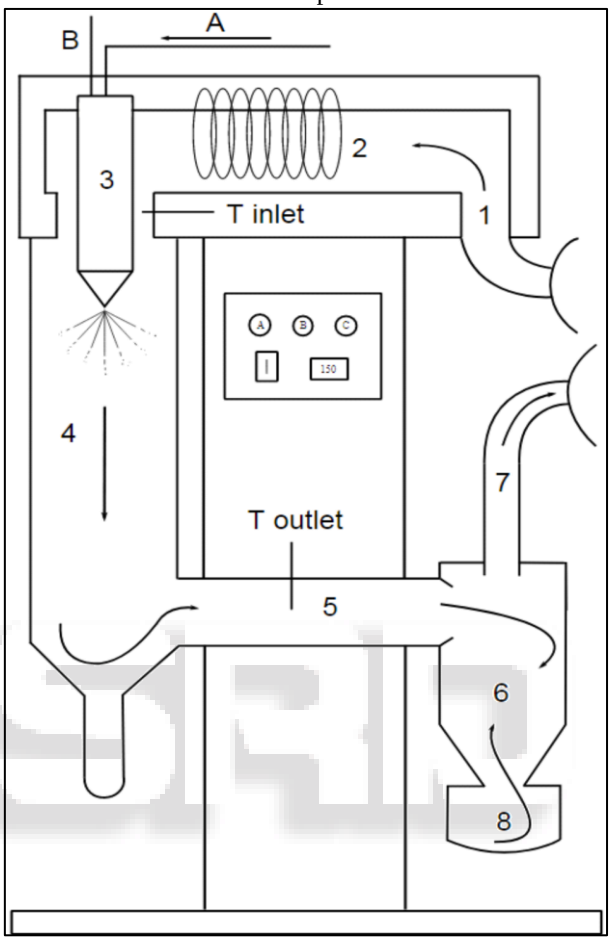

Fig. 1: Schematic Diagram of Spray Dryer

A Comparing scenario for the merits and demerits among conventional effluent treatment versus spray drying of waste water of Acid Black 194 is discussed in Table 3 given below.

Sr. No.	Particular	Disposal Through CETP	Disposal Through Spray Drier
1.	Area	Space restriction in small plant to installation and modification	Collection Tank is required for neutral wastewater
2.	Capital Cost	Capital Cost for primary treatment	Higher Capital Cost for installation of spray drier and its APCM
3.	Dosing Chemical	Area required to store chemical dosing and manpower is also required	No chemical dosing required for neutral wastewater
4.	Sludge	Separate Sludge storage area is required	No sludge storage area is required as direct drying occurs
5.	Norms	Inlet norms to CETP are to be maintained	No norms to be monitored as wastewater is without any VOC and spray drying emission falls within norms passing through Air Pollution Control Devices.
6.	Operation	0.50 INR per Liter of effluent	3.30 INR per litre of effluent in Natural Gas

	Costing		2.10 INR per litre of effluent in Imported Coal
7	Manpower	Manpower required for ETP Operation	No manpower required as Operation is auto controlled by computer.
8	Operation and Maintenance	Easy to maintain and operate	For only wastewater disposal, it's difficult to operate but for dual purpose of spray drying of product as well as effluent, it is feasible based on product profit margin
9	Efficiency	Affected by manual error and dosing chemical properties	Time duration depend on TDS in wastewater. Higher TDS gets good result in evaporation.

Table 3: Comparison of Disposal Method of Waste Water of Acid Black 194

IV. Results & Discussion

The waste water generation from manufacturing of Acid Black 194 is explored to be evaporated in spray drying instead of its discharge to CETP. The discharge of treated waste water to CETP is restricted as per the inlet norms of CETP failing to which additional penalty is levied by CETP authority. In addition to this, due to nonperformance of CETP, expansion of the industrial unit is not permitted. Pursuing evaporation of waste water in spray drying with relatively higher cost than the conventional treatment, opens up scope of industrial unit to grow by obtaining statutory permissions from the concerned authorities.

The following facts come up after going through an experimental study of evaporation of waste water of Acid Black 194.

1) Net Profit to manufacture one kg of Acid Black 194: 12 INR/kg
2) Profit of 3500 Kg Acid Black 194 (One Batch) : INR 42000/-
3) Effluent quantity is 5884 litre for 3500 Kg of product and hence economy for conventional treatment of effluent in ETP considering 0.50 INR per litre= INR 2942/-
4) Spray drying based on natural gas for evaporation of 5884 litre of Acid Black 194 effluent considering Unit cost of evaporation as INR 3.3 per litre=INR 19,417/-.
5) Spray drying based on imported coal for evaporation of 5884 litre of Acid Black 194 effluent considering Unit cost of evaporation as INR 2.10 per litre=INR 12,356/- .

Considering above, it reveals that even after spray drying of effluent of Acid Black 194 with natural gas as fuel, it is acceptable to manufacture Acid Black 194 with selection of alternative to conventional ETP followed by its discharge to CETP. This can allow industrial unit to grow amidst prevailing strictures of CPCB under section 18-1-b of the Water Act 1974.

V. Conclusion

Waste water of Acid Black 194 can be evaporated in spray dryer complying prevailing norms which is certainly a costlier affair (cost of evaporation is 6.5 times higher than conventional treatment), however can be implementable to all dye making units for sustainable existence. In addition to above , tangible benefits for spray drying of effluent are (1) Energy conservation by switching over run of product to run of waste water for similar product (2) Ease of getting Statutory permission considering Zero Liquid Discharge units(3)Product loss if any can be recovered as bleed of scrubber thereby maintaining minimum loss.

VI. Declaration

A. Authors Contribution

All the authors make a substantial contribution to this manuscript. DT, and DS participated in drafting the manuscript. DT wrote the main manuscript; all the authors discussed the results and implication on the manuscript at all stages.

B. Acknowledgements

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C. Availability of Data & Material

All relevant data and material are presented in the main paper.

D. Competing Interests

The authors declare that they have no competing interests.

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G. Ethics approval and consent to participate

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