Optimization of Decanter Centrifuge Performance for Chemical Sludge Handling in a Chemical Manufacturing Effluent Treatment Plant: Impact of Suspended Solids Concentration

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***Abstract*—This study focuses on optimizing the performance of decanter centrifuges used for chemical sludge handling in chemical manufacturing effluent treatment. By analyzing the impact of suspended solids concentration, the research identifies key operational parameters that enhance separation efficiency and sludge dewatering. Results show that adjusting feed concentration significantly improves cake dryness and reduces energy consumption, making the process more sustainable and cost-effective.**

***Index Terms*—Decanter centrifuge, Chemical sludge, Chemical industry effluent, Suspended solids, Sludge dewatering, Process optimization, Wastewater treatment, Separation efficiency**

I. INTRODUCTION

Effluent treatment plants (ETPs) in the chemical manufacturing sector manage highly complex and variable chemical sludges, often characterized by high suspended solids and emulsified waste. One critical unit operation in such systems is the decanter centrifuge, which plays a vital role in separating solids from wastewater. However, frequent choking in decanter centrifuges is a major operational challenge that can impact system uptime, increase maintenance costs, and deteriorate the quality of Centrate requiring further retreatment. This study investigates the relationship between suspended solids (SS) concentration in decanter feed and operational performance, with the objective of determining the optimal feed concentration range for minimizing choking and achieving high-quality Centrate.

II. LITERATURE REVIEW

Decanter centrifuges have been extensively used for sludge dewatering in various industrial wastewater treatment systems, including chemical, pharmaceutical, and food processing industries. Prior studies (Smith et al., 2014; Singh & Sharma, 2020) have shown that feed solids concentration significantly affects the torque, cake dryness, and Centrate clarity. According to research by Panigrahi et al. (2017), higher solids concentration can cause increased viscosity and reduced flowability, thereby escalating choking incidents. In ETPs treating complex chemical sludges, the variability in physical properties of the sludge further complicates performance. However, studies focusing on decanter centrifuge application in the chemical industry are limited, especially with regard to chemical sludge characteristics such as emulsified chemical particles and residual resins.

III. EXPERIMENTAL PART

This study was conducted in the effluent treatment plant of a chemical manufacturing facility located in Mahad, Raigad, India. The investigation focused on operational data, field trials, and laboratory analysis to evaluate the impact of varying SS concentrations in decanter feed. The following key steps were taken:

3.1 Collection of chemical sludge samples from the Decanter feed tank.

3.2 Preparation of feed sludge with controlled SS concentrations ranging from 90% to 5% through dilution using treated effluent.
3.3 Trial runs in the existing decanter centrifuge unit for each prepared sample.
3.4 Monitoring decanter performance parameters including cake dryness, choking frequency, and Centrate quality.
3.5 Laboratory analysis of Centrate samples for SS content.

IV. RESULT AND DISCUSSION

Table No.1 Feed suspended solid concentration and Centrate suspended concentration and observation

Trial No	SS Concentration in Feed %	Choking Observed	Centrate SS %
1	80	Immediate Choking	20
2	70	Immediate Choking	18
3	65	Choking after 20 min	16
4	60	Choking after 01 hrs. 12 min	15
5	55	Choking after 03 hrs. 05 min	14
6	45	Choking after 03 hrs. 24 min	12
3	40	Choking after 13 hrs. 04 min	11
7	30	Choking after 20 hrs. 19 min	10
8	20	Choking after 24 hrs. 15 min	8
9	10	Choking not Observed	4
10	5	Choking not Observed	2

The decanter centrifuge used in this study was a horizontal, scroll-type, three-phase decanter with a bowl diameter of 450 mm and a maximum capacity of 2 m^3/hr.

Graph No.1 Effect of Suspended Solid % Over Centrate Quality

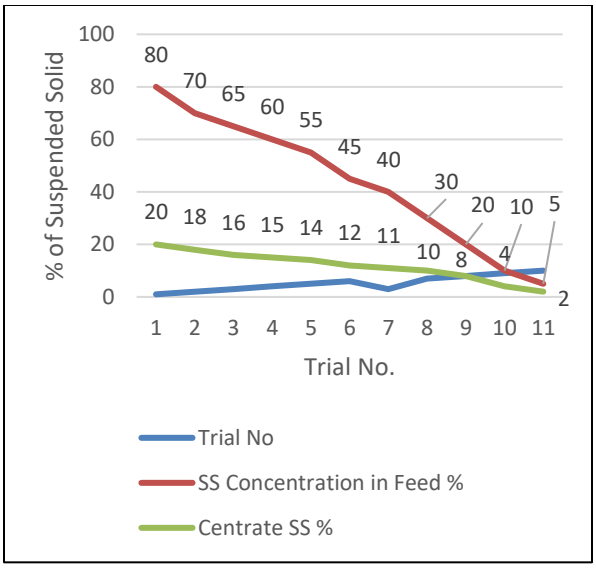

Fig. No.1 Decanter Chocking after High suspended solid in Feed

Fig. No.2 Decanter after Dechocking

Key Observations:

A) Choking tendency increased drastically when SS concentration exceeded 20%.
B) SS concentration of 5–10% yielded the best operational results, including smooth flow, minimal maintenance, and clear Centrate.
C) Centrate clarity below 1% SS ensured reduced load on tertiary treatment units.

V. CONCLUSION

This study clearly demonstrates that the performance of the decanter centrifuge in chemical sludge handling is highly sensitive to the concentration of suspended solids in the feed. Operating the decanter with a feed SS concentration of 5–10% significantly minimizes choking incidents and improves the quality of Centrate. This not only enhances the operational

reliability of the decanter but also reduces the need for retreatment of the Centrate. The findings suggest that pre-dilution or intermediate thickening control may be a practical operational strategy in chemical manufacturing ETPs to achieve optimal decanter performance.

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