10:00 to 10:45 A.M. - PROCESS DIVISION

ACHIEVING OPTIMUM EFFICIENCY IN FILTRATION OPERATION

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ABSTRACT

Filtration is basically the frontline discharge point of impurities and the preliminary source of sucrose loss. Innovations were implemented in the Rotary Vacuum Filter (RVF) station specifically in the Mud Withdrawal System in the Juice Clarifier, Feed Mud System of the RVF, and Filtrate Removal System that created huge impact in the operation achieving optimum efficiency resulting to considerable increase in Sugar Recovery.

INTRODUCTION

In the past several years, Central Azucarera Don Pedro Inc. (CADPI) encountered severe problem in the Filtration Operation resulting to mill stoppage, lower sugar recovery, and water pollution problem. Strategic actions were implemented based on the basic concepts and theories of Filtration Operation to address the perennial problems that adversely affected the Boiling House operation.

FILTRATION

Filtration is the removal of solid particles from a fluid by passing the fluid through a filtering medium on which the solids are deposited. During filtration, the solid in the slurry are retained in the unit and form a bed of particles through which the filtrate flows. In sugar manufacturing, the most commonly used equipment for filtration operation is the continuous Rotary Vacuum Filter (RVF).

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STAGES OF SUGAR FILTRATION

There are three (3) main stages of Filtration Operation such as:

1. Cake Formation
2. Cake Washing
3. Cake Discharge

OBJECTIVES OF SUGAR FILTRATION OPERATION

The main objective of sugar filtration operation is to maximize the removal of suspended matters and impurities from the muddy juice through the filter cake and recycle good quality filtrate. Secondarily, to optimize the sugar recoveries in the muddy juice by producing filter cake with lower sucrose content.

IMPORTANT BASIC CONCEPTS

The innovations implemented were basing on these important basic concepts to ensure the right strategic actions as follows:

1. The floc formation is an irreversible process that once destroyed it can no longer be restored.
2. The filtrate flow rate in the filtration operation varies inversely with square root of the viscosity.
3. The opportunity for microbiological losses in the filter is relatively high if the mud temperature is allowed to fall below 75 degree C.

KEY PERFORMANCE INDICATORS

The performance of filtration operation is mainly indicated and gage in the "Retention", % Pol of Filter Cake and Purity Drop.

1. Retention is the proportion of suspended matter extracted by the Filter which is expressed as percentage of the suspended matter contained in the muddy juice fed in the filter.
2. % Pol of Filter Cake is the percentage of sucrose retained in the Filter Cake.
3. Purity drop is the difference of the purity from Clarified Juice to Filtrate Juice.

OPERATING CONTROL PARAMETERS

To ensure optimum efficiency in the Filtration Operation, there should be operating control parameters as guide and reference as follows:

1. Drum speed	: 10-16 RPH
2. Pick-Up Vacuum	: 8"Hg-12"Hg
3. Clear Vacuum	: 12"Hg-18"Hg
5. Filter Cake Thickness	: 1/4"-3/8"
6. Temperature of feed muddy juice	: at least 80 deg. C
7. % Wash Water	: 100 – 150 on Filter Cake
8. Temperature of wash water	: at least 80 deg. C
9. Mud tray level	: at least 80%

OPERATING TARGETS

Operating targets to monitor and control the results to achieve optimum efficiency as follows:

1. % Pol in Filter Cake : 1.0 – 2.5
2. %Moisture in Filter Cake : 70%-75%
3. Retention : 60% and above
4. Purity Drop : not more than 1.0

GENERALLY ACCEPTED CAPACITY STANDARD OF RVF

The generally accepted standard capacity of Rotary Vacuum Filter ranges from 5.0 – 6.0 sq. ft./ TCH. This technical information is very much useful as guide and reference for determining the number of units to be operated at certain milling rate.

VACUUM PUMP CAPACITY REQUIREMENT

The rule of thumb for estimating the Vacuum Pump requirement is on the range of 1.0 CFM – 2.0 CFM per filtering area. This is based on experience and technical information from vacuum pump catalog. This data is used as guide and reference in the installation and provision of the needed Vacuum Pump to supply vacuum in the Rotary Vacuum Filter.

KEY OPERATING FACTORS TO ACHIEVE OPTIMUM EFFICIENCY

There are key operating factors that should be given utmost consideration to achieve optimum efficiency in the Filtration Operation such as:

1. Stable and sufficient vacuum supply.
2. Proper and right muddy juice withdrawal in the Juice Clarifier.
3. Proper mud handling and feeding in the Rotary Vacuum Filter.
4. Suitable feed muddy juice with optimal density, good porosity and low viscosity.
5. Efficient Filtrate withdrawal system.
6. Efficient wash water system.

THE INNOVATIONS IN THE RVF STATION:

1. GRAVITY MUD WITHDRAWAL IN THE JUICE CLARIFIER

The Gravity Mud Withdrawal system in the Juice Clarifier is a method of withdrawing muddy juice at the bottom mud booth with mud outflow above the level of the desired mud-juice interface in the Juice Clarifier. Please see and refer to figure 1. Subsequently, the muddy juice moves forward to the Mud-Bagacillo Mixer then passes through the Distribution Surge Tank. Then, the muddy juice is fed into the mud tray of the RVF on automatic control mode. The flow of muddy juice from the Juice Clarifier to the Rotary Vacuum Filters is totally on gravity flow on pump-less system preserving the floc formation. Mud pumping destroys the floc formation due to rigorous agitation resulting to the formation of colloids. This is on the concept that the floc formation is an irreversible process that once destroyed it can no longer be restored.

With the innovation, the density and porosity of the muddy juice improve significantly resulting to Filter Cake with normal thickness and can be scraped easily.

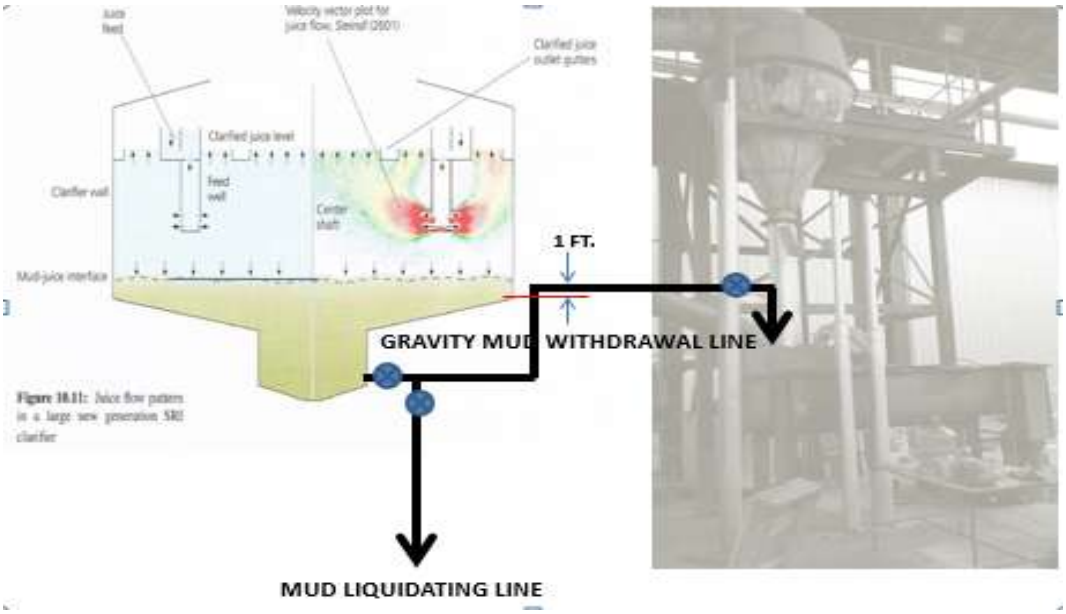

Figure: 1 Gravity Mud Withdrawal System

2. AUTOMATIC FEED CONTROL SYSTEM OF MUDDY JUICE

The Automatic Feed Control system of muddy juice in the Rotary Vacuum Filter is an approach of feeding the muddy juice in the RVF on automatic mode depending on the desired level in the mud tray of RVF minimizing or avoiding overflow. Likewise, the feed entry is top-dual feed for proper mud distribution and short circuiting reduction. Please see and refer to figure 2. The feed system minimizes or eliminates muddy juice recirculation that prevents the lowering of temperature and destruction of flocs. This is on the concept that the opportunity for microbiological losses in the filter is relatively high if the mud temperature is allowed to fall below 75 degree C.

With the revision, the quality of feed muddy juice improves considerably maintaining the desired temperature and porosity of the muddy juice.

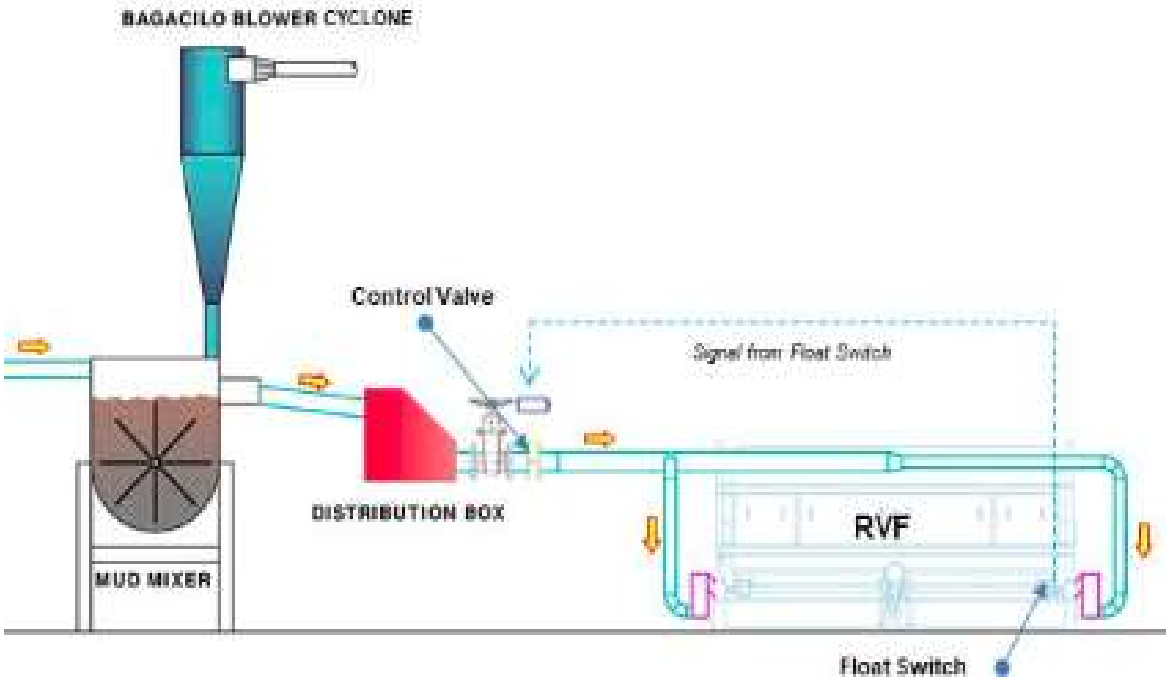

Figure 2: Automatic Feed Control System

3. FILTRATE REMOVAL AT VALVE HEAD LEVEL

The Filtrate Removal at Valve Level system in the RVF is a technique of removing the filtrate at the same level with the Valve Head of the RVF through a nearby Filtrate Tank with barometric leg directed to the Filtrate Seal Tank. Please see and refer to figure 3. Then, the combined filtrate overflows to the filtrate surge tank and pump forward to the MJ Tank.

The innovation significantly improved the RVF performance due stable vacuum in the valve head with no disturbance from flooding of filtrate.

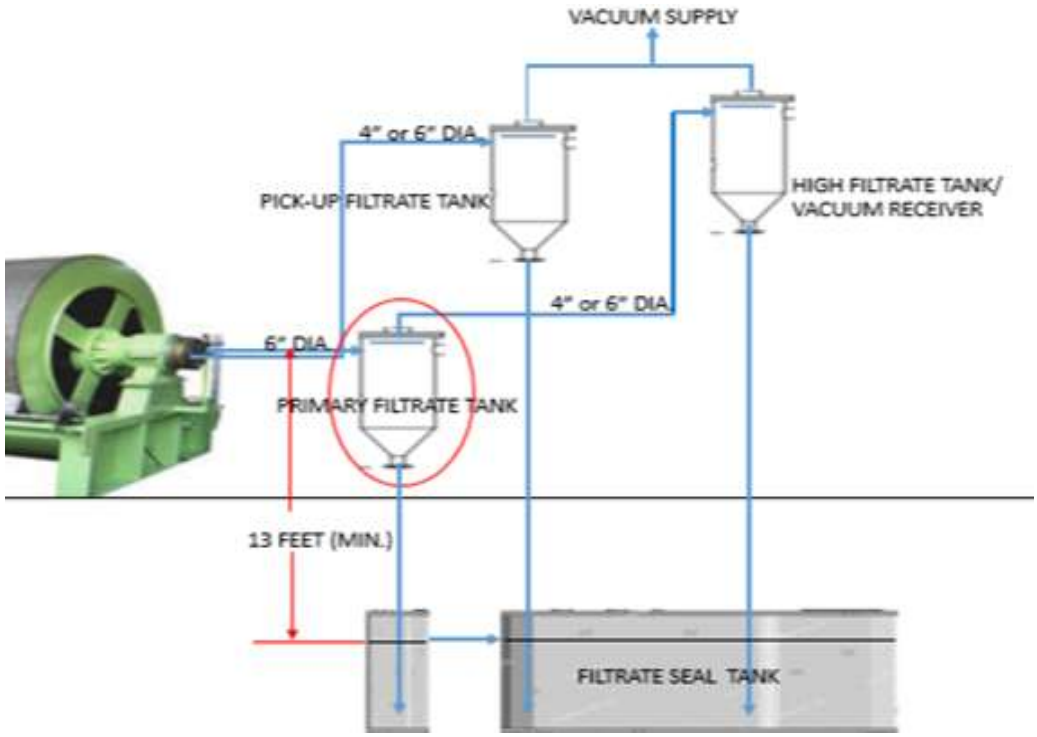

Figure 3: Filtrate Withdrawal at Valve Head Level

MAJOR SIGNIFICANT IMPROVEMENTS

1. Lower Turbidity of Clarified Juice
2. Lower % Pol in Filter Cake
3. Dry Filter Cake

OVERALL IMPACT IN THE FACTORY OPERATION AND PERFORMANCE

1. Higher grinding rate due increase in capacity of juice clarifier and evaporators because of lesser impurities recycled to process
2. Production of good quality sugar attributed to low turbidity of clarified juice
3. Increase in Boiling House Recovery due lower %Pol in filter cake.
4. Reduce water pollution due to minimal mud washing and draining.

TECHNICAL MANIFESTATION

Filtration operation should not be underestimated and taken for granted because the consequences of its poor operation is very detrimental to the clarification process which is the key factor for the production of good quality sugar and efficient boiling house operation. It should be considered as vital and essential operation considering its importance to Clarification Process. No amount of improvement in the boiling house can compensate the failure in the clarification process.

CONCLUSION

The innovations have contributed to the significant improvement in the Rotary Vacuum Filter (RVF) operation subsequently resulting to good Clarification Process. The achievements of optimum efficiency in the RVF operation substantially increase the milling capacity, higher sugar recovery and better sugar quality.

REFERENCES:

Mc Cabe, W. L. and Smith, J. C., Unit Operations of Chemical Engineering, 2nd Edition

Hugot, E., Handbook of Cane Sugar Engineering

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[i] A topic presented to the PHILSUTECH 66th Annual National Convention held at Waterfront Hotel Cebu City, on August 15, 2019