

Influence of High Mud Volume On Vacuum Filter Performance A case Study- Elguneid Sugar Factory, Sudan

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ABSTRACT

Elguneid Sugar Factory is designed for manual harvesting cane but the field labor has become scarce and wages for field work is very high. For this reason, Elguneid Sugar Factory has introduced mechanical harvesting; therefore there was an increase in the ratio of mud which enters to Elguneid Sugar Factory. This study aimed to know the influence of high mud level which resulted from mechanical harvesting on the efficiency of Rotary Vacuum Filters. The experimental tests were carried out on the Rotary Vacuum Filters of Elguneid Sugar Factory. The filter dimensions were calculated and found to be 6096 mm length, 3658mm Radius and 174m² total filtering surface areas. The Rotary Vacuum Filters were tested under different speeds varied from 7.5-12cycle/hr. The low vacuum was 361.2mm Hg, and 412.8mm Hg for high vacuum. Washing water temperature was found to be 81oC and quantity of bagacillo for each crushed tone of cane was found 13Kg/hr. The thickness of filter cake ranged between 3.5-5.2mm which decreased with the Rotary Vacuum Filter Speed (RVFS). In this research work it was found that sucrose in filter cake ranged between 1.39-2.21%, which increased with RVFS. Also it was found, that moisture content of filter cake ranged between 60.8-62%. The increase in moisture was dependent on RVFS increase. The mud quantity was calculated and found to be 133.63-147.87Kg/hr. The filter retention was calculated and found to be 7.2% and this considered very low when compared to the international standard which was 70% as average. All these results showed that the rotary vacuum filters in Elguneid Sugar Factory has a bad performance for removal of the increasing mud level.

INTRODUCTION

Sugar is generally referred to be sucrose which is found in appreciable quantities in many plants. As it is well known, the two important plants for sugar extraction are the sugar beet and sugar cane (Alexander, 1977).

Sucrose is the technical name for sugar, however, sugar cane and sugar beet are the only plants that make enough sucrose for commercial production, whether produced from cane or beet, the result is the same-pure sugar (Galloway, 1989). The sugar establishments deal with all the problems that are related to the industry, some of these problems are concerned with marketing, some are factory related and others are agricultural.

One of the major factory related problems is the presence of mud in juice of the sugar cane. The presence of mud in the sugar juice is due to the problems related to the harvesting and loading of

sugar cane. In several countries cutting and loading of cane has been completely mechanized and other regions are still cutting by hand with a cane knife then loaded mechanically for transportation to the sugar factory. (Baikow, 1982). The mud or impurities are separated from the juice by sedimentation and the use of vacuum filters (Harry, 1980). The Rotary vacuum filter have been widely used in sugar. And many other chemical process industries for many years because they are particularly suited to application where both. Washing and drying and required.(Internet,1997). mud contains: a part from dirt, suspended matter, gums, waxes and bagacillo whereas sugar in solution is found in the liquid portion.(Assalaya sugar factory ,2002)

Amount of Mud:

The amount of mud can vary from < 2% of the weight of cane for clean sugar cane to > 5% for mechanically harvested and loaded sugar cane. With increased use of mechanical loaders, the mud cake contains more sand, clay, muck and other insoluble ingredients of soil brought with sugar cane from the fields.

The proportion of mud which is separated in the clarifier amounts to between 3 to 10% of the volume of juice. The muds as discharged from the clarifier contain (6-10) % solids of which up to 30% are bagacillo particles which are carried over in clarification.

To obtain high-quality refined sugar, it is important to remove all suspended matter from the sugar liquor which are filtered at three stages of filtration when a screen is dipped into a mud trough and to the back side of the screen,when suction is applied then juice is sucked in and a cake of solids is formed on the surface of the screen. As more suction, after removing the screen from the trough is applied, the cake became firmer and after a time flow ceases. If to this cake water is applied, fluid flow to the suction increases. The suction will help drive out moisture to some extent. After some time suction is removed and cake can be scraped easily (Training Team, 1998).

The objective of this research was to measure the filter cake parameters such as, moisture %, pol%, thickness and filter retention, evaluate the filter performance according to high mud level. Also to study the influence of filter speed on mud characteristics.

MATERIALS AND METHODS

Materials

All samples were collected from Elguneid sugar factory during the crop season 2009-2010 and transferred to laboratories of chemical analysis of Elguneid sugar factory.

Methodology

Determination of Pol % Filter Cake:

According to (SAAST, 1991)) 25.5 g of the sample were weighed and put in a sugar scoop , and mixed with 25 ml of distilled water by using a glass rod until smooth paste formation . The sample mixture was completed to 200 ml Kohrauch flask with distilled water. Two grams of lead sub –acetate were added to the mixture.

The mixture was filtered and first filtrate was discarded, and it was transferred into saccharimeter tube and the polarization was recorded.

Then the reading was multiplied by 2 to give Pol % filter cake.

Determination of Moisture in Filter Cake:

Moisture contents of the various samples investigated in the present work were determined according to Whalley method (1964). Moisture content = loss in weight / weight of sample x 100.

Determination of Mud Solid% Filtrate and Filter Feed:

The mud solid % filtrate and filter feed was determined according to (SAAST, 1991).

Determination of Bagacillo% Filter Feed:

The Bagacillo % Filter Feed was determined according to (SAAST, 1991).

$$\text{Bagacillo \% filter feed} = \frac{\text{Mass of bagacillo} \times 100}{\text{Mass of feed}}$$

Determination of Brix % Filter Cake and Filter Feed:

One gramm Kieselguhr was added to 100 ml of filtrate and was shaken to disperse the Kieselguhr. Filter was a trough fluted filter paper supported in a funnel which was rested directly in the mouth of a squat beaker and the funnel was covered with a watch glass to minimize evaporation.

First milliter of filtrate was discarded, and then sufficient filtrate was collected to measure its refractometric brix and a result was noted.

The instrument reading was converted to brix reading by using the table supplied with the instrument.

Determination of Quantity of Filter Cake:

Filter cake was discharged on to a belt or drag conveyor and then into the mud cake bin, from which was weighed before leaving the factory then the bin and filter cake were weighed together. From this weight the filter cake was calculated (Hugot, 1972).

Determination of Filter Retention:

According to SAAST (1991) retention were determined according to the following formula :

$$\text{Retention\%} = \frac{(\text{mud solid\% filtrate}) \times (\text{brix\% filter feed})}{(\text{mud solid\% filter feed}) (\text{brix\% filtrate})}$$

RESULTS AND DISCUSSION

Physical Measurements of Filter Cake:

The texture of the filter cake was found to be a paste-like. It had a dark brown color.

Thickness of Filter Cake:

The thickness of the filter cake was variable according to filter speed. (Table 1).

It was found in Elguneid factory that very weak cake was obtained with thickness of (3.5 -5.2) mm as average which is lower than (6.35 -12.7) mm which was reported by (Deogan, 1983).

Fig. 1 shows that speed of vacuum filter was in reverse relationship with the thickness of cake or mud.

Table 1: Relationship between Thickness of Cake and Speed of Rotary Vacuum Filter.

Speed of rotary vacuum filter (cycle \hr)	Thickness of cake (mm)
7.5	5.2
10	4.2
12	3.5

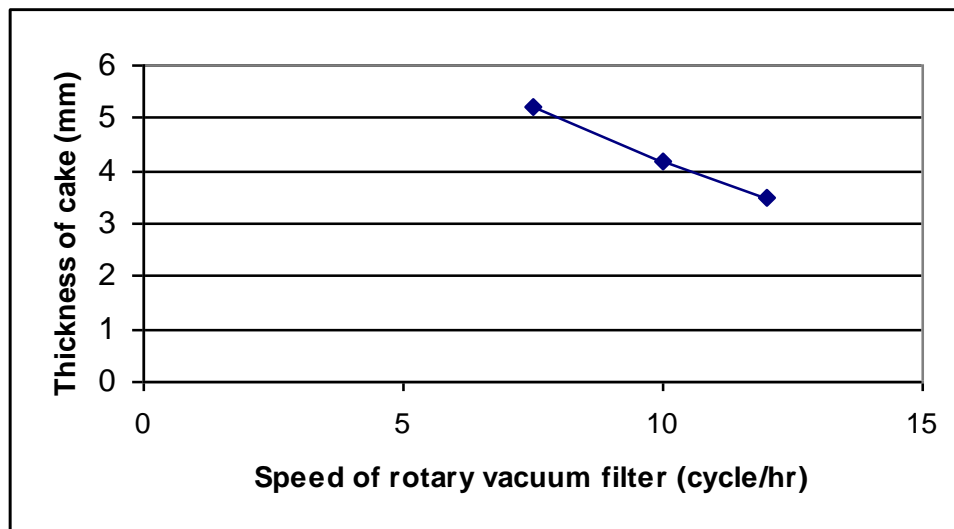


Fig (1): Relationship between Thickness of Cake and Speed of Rotary Vacuum Filter

Texture of Mud:

The texture of mud was found heavy, soft and sandy.

Control parameters:

Some conditions like washing water, temperature and amount of the washing water have been taken as a fixed condition.

Washing water temperature was found to be (81) °C as an average which is higher than (75-80) °C which was reported by (Hugot, 1972).

Elguneid Sugar Factory there was no device to measure the quantity of washing water.

Perforated Screens:

The screens of the rotary vacuum filters in Elguneid factory has some damages which lead to increase in losses of sugar.

High and Low Vacuum:

The high and low vacuum was found between (14-16) In Hg or (361.2- 412.8) mm Hg. This vacuum that is applied in Elguneid factory was lower than the standard for operation. This standard vacuum ranged between (15- 20) In Hg or (380-530) mm Hg as reported by (Baikow, 1982). Therefore the vacuum is not sufficient to suck all muddy juice into the filter.

Pol% in Filter Cake:

From Table (2) and Figure (2), it is shown that the higher the drum speed the more sugar losses were found in filter cake. The pol% in filter cake was found (1.3 -2.01). For good filter efficiency it is very important to maintain the thickness of the filter cake within ¼ - ½ inch or depending on the volume of mud. When the correct thickness is maintained and the vacuum and washing are adequate the pol% of the filter cake can be as low as 0.5 to 1.5, higher filter cake thickness causes low pol% (Deogan,1983).

Table (2) Relationship between Pol % in Filter Cake and Speed of Rotary Vacuum Filter:-

Speed of rotary vacuum filter (cycle \hr)	Pol in filter cake (%)
7.5	1.39
10	1.97
12	2.21

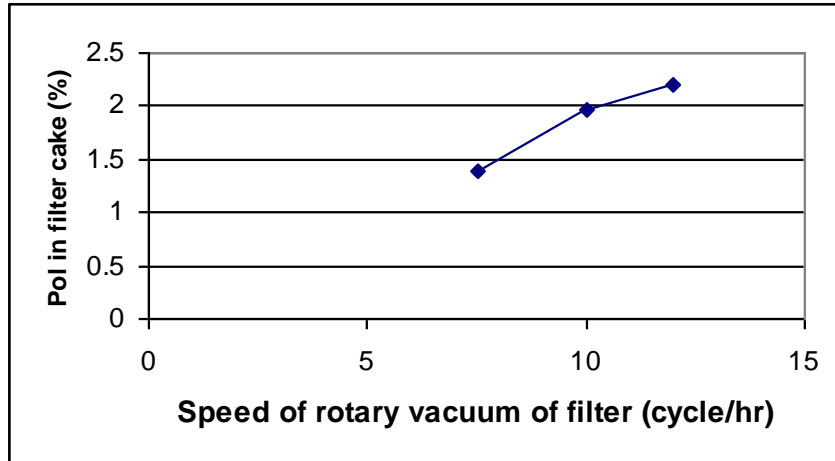


Fig (2): Relationship between Pol % in Filter Cake and Speed of Rotary Vacuum Filter.

Moisture of Filter Cake:

From Table (3), the moisture in filter cake was found between (60.8-62%). This value considered very low in comparison with (75-80) °C which was reported by (Baikow, 1982) and (Hugot, 1972) Also it was noticed that the filter low speed resulted in low moisture content in filter cake.

Table (3): Relationship Between Moisture in Filter Cake and Speed of Rotary Vacuum Filter:

Speed of rotary vacuum filter (cycle \hr)	Moisture in filter cake (%)
7.5	60.8
10	61
12	62

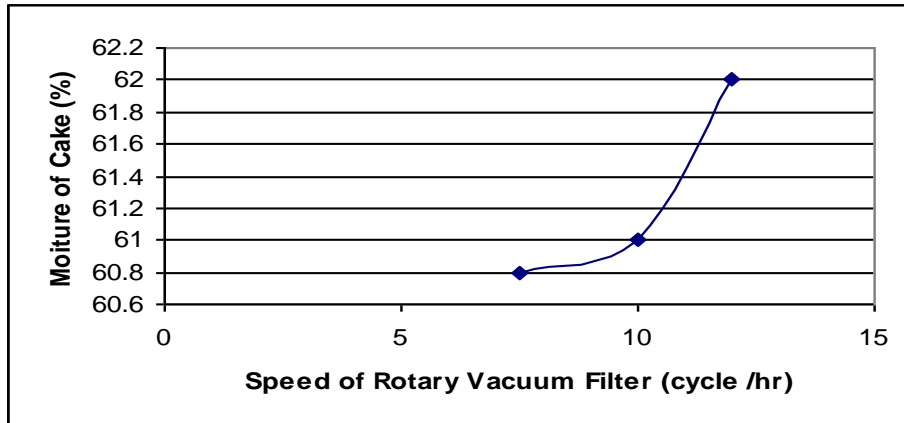


Fig (3): Relationship between Moisture in Filter Cake and Speed of Rotary Vacuum Filter.

Amount of Bagasse in the Mud:

It was found that 13kg /ton of bagasse of cane/hr is low in comparison with 15kg/hour which was reported by (Hugot, 1972).

The amount of bagacillo was lower than that required for operation of the rotary vacuum filter.

Filter Retention:

As a result of the experimental analysis it has been found that the filter retention was 7.2% which is very low in comparison with tests conducted by Jenkins in Queens land where the retention was 70% as an average (Hugot -1972).

Quantity of Filter Cake:

From Table 4 and figure 4 it was found that the filter drum speed and mud quantity are directly proportional.

The quantity of filter cake was found to be (3207.12-3548.89kg/ day) or (70780kg/day) or 2949.16kg/hr. This quantity is very low in comparison with muddy juice which enters to rotary vacuum filters.

Table (4): Relationship between Quantity of Filter Cake and Speed of Rotary Vacuum Filter:

Speed of rotary vacuum filter(cycle/hr)	Quantity of filter cake(kg)
7.5	133.63
10	143.88
12	147.87

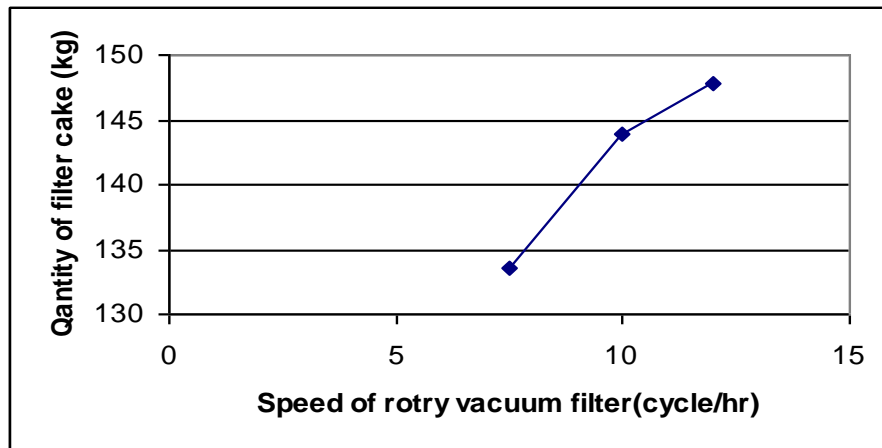


Fig (4): Relationship between Quantity of Cake and Speed of Rotary Vacuum Filter

Surface Area of Filtration:

As a result of the experimental data, it has been found that the whole filtration area of Rotary Vacuum Filters in Elguneid factory is 148m^2 which means that each filter has space of 74m^2 . The filtration area considered necessary to determine the capacity of cane crushing.

The Dorr-Oliver estimates that $0.35\text{m}^2/\text{ton}$ crushing i.e. Area of Oliver vacuum filter 74m^2 sufficient to crush 211.4 ton/hr, but the crushing rate in Elguneid Factory was found 250 ton/hr that means an increase load on Rotary Vacuum Filter station . This increase was found to be 24% which is due to the introduction of mechanical harvesting.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions:

- The muddy juice was increased with increased use of mechanical harvesting.
- The retention of filter was found very low in comparison with standard value.
- The rotary vacuum filter speed was found to be in reverse relation with the thickness of filter cake.
- The increase in the speed of rotary vacuum filter has lead to increase in pol%, moisture % and quantity of filter cake.
- The bagacillo was lower than the required quantity this lead to reduction of the thickness of filter cake, and to increase of sucrose losses .

Recommendations:

- The bagacillo ratio should be increased.
- The low and high vacuum should be raised.
- The optimum number of drum revolutions of the vacuum filter should be (7.5 -10) cycle/hr.
- In order to reduce the load on rotary vacuum filters and chemical consumption, it is recommended to do the following:
 - Divide the receiving tank filtrate into two tanks. One tank can receive the heavy filtrate and the second tank can receive the light filtrate.

- Futuer research should be conducted to optimize the speed of the rotary vacuum filter to be suitable for both the level of sucrose in filter cake and the production of the cake output.
- Increase of whole surface area of filtration by adding a new filter.
- Increase of washing water in the preparation of cane to obtain a less quantity of mud.

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اثر زيادة الطين علي كفاءة المرشحات الفراغية الدوارة- مصنع سكر الجنييد ، السودان

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الملخص

صمم مصنع الجنييد على أساس الحصاد اليدوي ولكن مع ارتفاع زيادة الأجور تم إدخال الحصاد الآلي وبالتالي زادت نسبة الطين الداخلة إلى المصنع. هدفت هذه الدراسة لمعرفة تأثير زيادة الطين الناتجة عن زيادة نسبة الحصاد الآلي على كفاءة المرشحات الفراغية الدوارة. تم إجراء الاختبارات على مرشحات مصنع سكر الجنييد حيث أوضحت القياسات بأن المرشحات بطول 6096 ملليمتر وقطر 3658 ملليمتر وبمساحة سطح ترشيح كلية تساوي 174 متر مربع تم تشغيل المرشحات بسرعات دوران مختلفة تتراوح من (5,7 - 12) لفة/الساعة وتفريغ منخفض 361.2 ملليمتر زئبقي في المتوسط ، وتفريغ عالي 8,412 ملليمتر زئبقي في المتوسط وكانت درجة الحرارة للماء المضاف للمرشح تساوي 81 درجة مئوية. وكانت كمية البقاس المضاف لكل طن قصب تساوي 13 كيلوجرام/الساعة. وجد أن سمك طين المرشح يتراوح من (3,3 - 2,5) ملليمتر حيث يتناسب عكسياً مع السرعة فكلما زادت السرعة قل السمك وكذلك وجد أن نسبة السكر في طين المرشح تتراوح من 1.39% إلى 2.21% حيث ترتفع النسبة كلما زادت السرعة. وكذلك وجد أن نسبة الرطوبة filter cake تتراوح من 8,60% إلى 62% حيث تزداد هذه النسبة كلما زادت السرعة كما أوضحت النتائج أن كمية الطين filter cake الناتج تتراوح من 133.36 - 147.87 كيلوجرام/الساعة حيث تقل كمية الطين كلما قلت السرعة كذلك وجد أن نسبة الطين المزاح Retention تساوي 7,2%. وهي نسبة قليلة عند مقارنتها مع النسبة العالمية التي تبلغ 70% في المتوسط. أوضحت النتائج أعلاه أن المرشحات الدوارة في مصنع سكر الجنييد غير جيدة الأداء في إزالة الطين الزائد.