Journal of Engineering, Management and Information Technology

ASPUR PUBLISHING

Vol. 03, No. 01 (2025) 45-52, doi: doi:10.61552/JEMIT.2025.01.006 - http://jemit.aspur.rs

ENHANCING SUGAR PRODUCTIVITY BY USING CANE DIFFUSER WITH DEWATERING MILL IN JUICE EXTRACTION PROCESS

Moti Melkamu [1]
Birhane Desta Atsegeba

Received 08.01.2024.
Revised 18.03.2024.
Accepted 01.04.2024.

Keywords:

Sugar productivity, Diffuser with dewatering mill, Milling tandem, juice extraction.

Original research

A B S T R A C T

Ethiopia becoming one of the fastest economically growing countries in the world and expanding different manufacturing sectors. Sugar manufacturing is also one sector that produces sugar and sugar is an essential commodity and sugar industries play a great role in the economic development of the country. Sugar manufacturing needs to produce a product that satisfies customers according to its requirements and increases the competitiveness of companies by reducing the supply-demand gap that exists. But exist sugar productivity is very low and the sugar production process is unsatisfactory for the country's competitive advantage. Sugar product has a high value in the country and there is a gap between locally produced supply and demand, also the amount of produced sugar is much bellow of the manufacturing management expectation. The system of the juice extraction process in the sugar manufacturing shows loss of sugar because it uses a sugar mill which is an old and traditional system in juice extraction process with less efficiency of juice extraction, high microbial growth, high maintenance, operational, and capital cost, high power consumption and supervise manpower requirement. Due to these reasons, the productivity of sugar is very low when compared with existing demand. To enhance sugar productivity, it needs to improve and update the ways of producing their extraction of juice in the sugar manufacturing process. To enhance the productivity of sugar manufacturing, it uses a diffuser with a dewatering mill in juice extraction, because it has less power consumption, high efficiency of juice extraction, high-quality sugar and less manpower, microbial growth, maintenance, capital, operational, foundation and construction cost. This paper, depending on the different gaps existing on juice extraction it takes a single sugar manufacturing among existing because all are it uses sugar mill in juice extraction and it focused on the diffuser with dewatering mill is essential in enhancement of sugar productivity. The result of the study is to reduce the existing: manpower to 21, microbial growth with a temperature of 80 oc. to 85 oc., maintenance and operational by $71500, capital by $1957500, foundation and construction by $442580 cost and increasing of juice extraction efficiency to 98.4% per day extraction, quality of sugar and end product yield by 29.33 tons per day.

[1] Corresponding author: Moti Melkamu
Email: motimelka.auit@gmail.com

1. INTRODUCTION

Ethiopia becoming one of the fastest economically growing countries in the world and Sugar cane is an important crop widely used in the sugar production process in Ethiopia (Ekubaygebregeorgis, 2015; Tena et al, 2016). Sugar is an essential commodity and sugar industries play a great role in economic development in Ethiopia (Bayrau et al., 2014; Sulaiman et al. 2019) also manufacturing organizations must increase their competitiveness to compete with the national and international market through updating their process with technology (Dadi & Azene, 2017). Then to more developing the economy it expanded sugar factories and due to shortage of sugar imported more than 20% of sugar requirement to meet the local demand (Ekubaygebregeorgis, 2015). Currently, the demand for sugar outstrips its production in Ethiopia and it needs to improve the sugar production process to meet local demand for export (Tena, et al., 2016). Because of population growth, increasing income, consumption habit and growth of industrial and service sectors, mainly hotels and restaurants it increases consumption of sugar in the countries (Ekubaygebregeorgis, 2015) and also rapidly increasing of the population it needs to enhance the sugar productivity, economic and population growth to continuous increases sugar consumption and demand (Sulaiman et al., 2019). Ethiopian sugar productivity is very low and the sugar production process is unsatisfactory for the country's competitive advantage (Ekubaygebregeorgis, 2015). In Ethiopia, there is no technical information and improvement in the juice extraction process (Esayas, 2016), because Juice extraction is one major stage in the sugar production process (Gunawan et al., 2018) and also it uses a sugar mill for juice extraction process in sugar manufacturing system (Tena, et al., 2016), but Sugar mill is an old and traditional system uses in sugar production factories (Birru et al., 2016). Using of sugar mill in juice extraction has the problem: less juice extraction efficiency (less yield), high consumption of power, high manpower requirement, high capital, foundation, construction, and maintenance cost, and increasing growth of microbial activity(less quality) (Mullapudi Narendranath, 2010, Gunawan et al., 2018). In case of insufficient working of sugar mill for extraction juice in a sugar production factory, the produced amount of sugar is not match with the existing population and demand and also it affects the qualities of the sugar and then to enhance the sugar productivity in Ethiopia it needs to improve the existing method of juice extraction in sugar manufacturing process (Tena et al. 2016), For increasing sugar productivity it uses scientific and modern way process is essential for both customers and organization (Singh et al. ,2019).

2. LITERATURE REVIEW

2.1 ways juice extraction in sugar production

The extraction of juice is one of the first and main stages of sugarcane processing, and obtaining high sucrose extraction efficiencies is essential for the productivity of sugar industries (Noel Simas Barbosa et al., 2017). In sugar manufacturing systems there are two methods for juice extraction: milling tandem and diffuser.

Enhancing their productivity is essential programs and it used their profitability and international competitiveness in sugar manufacturing company and Sugar industries it uses traditional conduct systems like milling tandem in the juice extraction process, however, the systems face some problems and complex issues, which difficult to solve in the past experiences and it needs improvement (Mullapudi Narendranath, 2010; Wood, 2003). The production of sugar industries quantity and quality is affected during the juice extraction process because different fungal, bacteria, and virus disease are there in sugar cane which needs high temperature to kill otherwise it affects the quality and production yield of the sugar during juice extraction (Singh et al., 2019).

Juice extraction from sugar cane is the preliminary operation for the manufacturing of sugar (Gunawan et al., 2018). Mill is an old and traditional used method and Insufficient sugar mill its effect on sugar productivity and also it's difficult to meet customers need and demand when a population growth increase, because, the consumption of sugar also increases through the year (Birru et al., 2016). Sugar mill in juice extraction has the problem: less juice extraction efficiency (less yield), high consumption of power, high manpower requirement, high capital, foundation, construction, and maintenance cost, and increasing growth of microbial activity(less quality) because of mills has low temperature investigated microbial activity in milling is very high (Mullapudi Narendranath, 2010; Gunawan et al., 2018).

During the 1960s, experiments German get a new concept of the diffuser with more economical, efficient and easy to operate at 80ºc to 85ºc which is adopted to the sugar manufacturing and it became increasingly used over the years by sugar production for juice extraction (Mullapudi Narendranath, 2010).

Using the diffuser with dewatering mill in the sugar production process is cost-effective, easy operation and control, microbiological loss, high raw juice quality with overall sugar quality than milling tandem. In milling tandem it requires more supervisor in case of operation and also juice quality of the cane diffuser is 25% higher than the milling tandem. Because of the existence of the high-temperature diffuser, it is used to kill microbiological and also the losses of milling is about 16 times that in a diffuser. The extraction plant is generally expensive, however, the milling is much higher than that of the diffuser, and the ability of extraction of the diffuser is high around 98.4%. Also, the maintenance cost of milling tandem is 70% to 80% highest than an equivalent diffusion extraction system and the diffuser can run with less supervision and fewer operators than milling tandem (Rein 1995, Mullapudi Narendranath 2010).

2.2 Generalize the advantages of diffuser over milling tandem for juice extraction

Specify the advantages of the diffuser over milling tandem for juice extraction in sugar manufacturing process and also Foundation and construction costs for a diffuser much lower than that of milling tandem (Kent & Lewinski, 2007; Mullapudi Narendranath, 2010).

Cane diffuser is more popular in South Africa in the 1960s and 1970s, using European technology and used to achieve the highest extraction 98.4% rates in the world, to meet the industries requirements with high capacity, low capital, and

[1] Corresponding author: Moti Melkamu
Email: motimelka.auit@gmail.com

maintenance cost and lower power consumption using a diffuser are more advantages in sugar production industries (Voigt, 2009; Mullapudi Narendranath, 2010).

Table 1. Advantages of diffuser over milling tandem for juice extraction

Activity	**Diffuser with dewatering mill**	**Milling tandem**
Juice extraction efficiency	98,4%	95%
Man power requirement	21	43
Power consumption for juice extraction	2237.5kw	3217.5 kw
Once overall maintenance and operation cost	$47500	$119000
Capital cost	$2990000	$3958000
Foundation and construction cost	$222720	$665300
Operation temperature	80^{o}c to 85^{o}c	60^{o}c

Advantages of diffuser over milling tandem for juice extraction is presented in Table 1.

The diffuser is to extract a maximum amount of juice in sugar manufacturing and also it kills bacteria in a juice because of high temperature (Merino et al., 2017). The diffuser is replaced place of the mill for juice extraction due to their lower manpower needs, lower power consumption, low operating and maintenance cost, increase exportable electricity, and better operation flexibility, and also better for reducing microbial activity (Mullapudi Narendranath, 2010).

2.3 Role of juice extraction efficiency on sugar productivity

The extraction of juice is one of the first and main stages of sugarcane processing, and obtaining high sucrose extraction efficiencies is essential for the productivity of the sugar industry (Noel Simas Barbosa et al., 2017) and play a great role in the productivity of sugar in the sugar manufacturing process and also play a great role on economic development of the country (Bayrau et al., 2014). The extraction process is related to the output/yield of sugar, overall quality, power consumption, manpower, cost, and maintenance of the overall equipment's uses in extraction in sugar manufacturing.

3. METHODOLOGY

In the study it used comparison and evaluation methodology on juice extraction for sugar production process. Also it focused on the system which enhance sugar productivity in juice extraction method.

3.1 Gaps existing on sugar productivity-related with juice extraction

Ethiopia is a developing country in sub-Saharan Africa, with a population of 94 million people in 2012 and also it has rapid population growth through the year and The main target of the Ethiopia government on first growth and transformation program (GTP) it expands the sugar sector for Ethiopia to become one of the top ten sugar exporter in the world (Ad Shiferaw 2017)., Sugar is an essential commodity and sugar industries play a great role on economic development in Ethiopia (Bayrau et al., 2014; Sulaiman et al., 2019). Sugar manufacturing industries beginning in 1954 in Ethiopia, but until to know the number of sugar manufacturing industries is very few because they exist sugar manufacturing productivity is very low and it requires high capital (Sushil, 2015; Gunawan et al., 2018). Sugar product has a high value in Ethiopia and there is a gap between locally produced supply and demand, also the amount of produced sugar is much bellow of the manufacturing management expectation. The overall annual production of sugar 275943 tons per annum is small when compared with the demand society and it needs improvement on the manufacturing process (Dagne, 2018). In Ethiopia sugar serve for householding consumption, restaurant and hotels and also an intermediate input for other industries like bottling companies and breweries and the population is rapidly growing and also sugar consumption/demand also increase through the year, because of Sugar industries require a huge capital investment and the payback period is longer around 12 year, so it is difficult to expend a new for a short time (Bayrau et al., 2014; Sushil, 2015). There is less capacity to meet domestic demand for sugar (Ad Shiferaw, 2017), the existing sugar manufacturing in Ethiopia producing sugar for the local market, and the rest import from another country (Bayrau et al., 2014).

According to a report in 2017, the total amount of produced sugar is decreased, but the demand for sugar is much high. Ethiopia has a growth transformation program and the sugar manufacturing project is the main program, so to compete with another world it must modernize the process of sugar production because of the shortage of sugar becoming the main problem of the economic, business, and individuals (Dagne, 2018).

In Ethiopia exist system juice extraction process in the factory shows loss of sugar and the end yield of sugar is below the expectation of manufacturing management and manufacture of sugar from sugar cane is a distinctive industrial process and using of sugar mill in juice extraction for the production of sugar and there is a shortage of sugar (Sushil, 2015; Dagne, 2018; Gunawan et al., 2018). It needs improvement to exist in the sugar production manufacturing process because cane milling is major factors that affect sugar productivity with low extraction efficiency, reduce quality, growth of microbial activity, high power consumption, high maintenance and operating cost, high supervision manpower, and expensive materials (Clarke, 1999; Mullapudi Narendranath, 2010; Sushil, 2015; Gunawan et al., 2018) and Juice extraction process is one of the major areas which needs consideration in sugar manufacturing and it requires high power, expensive equipment in milling tandem (Mitullah et al., 2017).

3.2. Milling tandem Sample from a single sugar manufacturing among exists.

All exist sugar manufacturing uses milling tandem in the juice extraction process (Dagne, 2018; Gunawan et al., 2018).

Milling juice extraction efficiency is 92% per day production

- ✓ Annual sugar yield 458.33 tons per day
- ✓ Once overall Milling tandem maintenance and operating cost = $178500
- ✓ power consumption milling tandem(4 mill + dewatering mill) = 3217.5 kw
- ✓ man power uses = 43
- ✓ operation temperature = 60^{o}c
- ✓ Capital cost = $5937000
- ✓ Foundation and construction cost = $665300

3.3 Diffuser with dewatering mill sample for a single sugar manufacturing

- ✓ juice extraction efficiency is 98.4% per day production
- ✓ Annual sugar yield 487.66 tons per day
- ✓ Once overall Diffuser with dewatering mill maintenance and operating cost = $107000
- ✓ power consumption of diffuser with dewater mill(diffuser + dewatering mill) = 2237.5 kw
- ✓ man power = 21
- ✓ Operation temperature = 80^{o}c to 85 ^{o}c.
- ✓ Capital cost = $3979500
- ✓ Foundation and construction cost = $222720

3.4 Overall gap identification for both

Existing gaps between milling tandem and diffuser with dewatering mill is presented in Table 2.

Deference efficiency of juices extraction is:

(Diffuser with dewatering juice extraction efficiency % per day extraction) - (Mill tandem juice extraction efficiency % per day extraction).

98.4% per day extraction - 92% per day extraction = **6.4%** per day extraction

The deference of sugar yield per day is:

(Diffuser with dewatering sugar yield per day) – (Mill tandem sugar yield per day)

487.66 tons per day – 458.33 tons per day = **29.33 tons per day**

Deference of maintenance and operating cost is:

(Once overall milling tandem maintenance and operating cost) – (Once overall Diffuser with dewatering mill maintenance and operating cost)

$178500 - $107000 = **$71500**

The difference in power consumption is:

(Power consumption milling tandem) - (power consumption of diffuser with dewater mill)

3217.5 kW - 2237.5 kW = **980kW**

Deference of manpower is:

(Manpower required for milling tandem) – (Manpower required for a diffuser with dewatering mill).

43 – 21 = **22 manpower**

Deference of Operation temperature is:

The operation temperature of milling tandem is 60^{o}c at this temperature the microbial activity is not stopped or does not kill the microbial in the juice and also the microbial activity grows up and affect the quality of the juice with sugar, but the Operation temperature of the diffuser is between 80^{o}c to 85 ^{o}c. this temperature kills the microbial activity in juice and keeps the quality of the juice and sugar.

The deference of Capital cost is:

(Capital cost of milling tandem) – (Capital cost of diffuser with dewatering mill) $5937000 - $3979500 = **$1957500**

This indicates a much high difference capital cost between diffuser with dewatering mill and milling tandem, so it is essential for sugar manufacturing uses of the diffuser with dewatering mill in the place milling tandem because it requires less capital cost than milling tandem.

The difference between foundation and construction cost is:

(Foundation and construction cost of milling tandem) – (Foundation and construction cost of the diffuser with dewatering mill)

$665300 - $222720 = **$442580**

In this case to construct and establish the milling tandem is very difficult, because the requirement cost is very much, but construction and foundation of the diffuser with dewatering mill is very easy for sugar manufacturing with less cost.

Table 2. Existing gaps between milling tandem and diffuser with dewatering mill.

Activity	Milling tandem	Diffuser with dewatering mill	Exist deference's
Efficiency of juices extraction per day	92%	98.4%	6.4%
Sugar yield per day	458.33 tons	487.66 tons	29.33 tons
Maintenance and operating cost	$178500	$107000	$71500
Power consumption per extraction	3217.5 kW	2237.5 kW	980kW
Man power	43	21	22
Operation temperature	60^{o}c.	80^{o}c. to 85^{o}c.	20 ^{o}c. to 25 ^{o}c.
Capital cost	$5937000	$3979500	$1957500
Foundation and construction cost	$665300	$222720	$442580

To enhance the productivity of the sugar is a key goal related to energy uses, efficient process, quality product, and production cost and also to improve the sugar productivity it needs to optimize the manufacturing process/ system with Enhancement of the sugar productivity gained through (Stephen, 1999):

- High sugar yield
- High efficiency of juice extract.
- Updating the process and information's with technology
- Low maintenance and repair cost
- Low operating cost
- Using less expensive and available equipment.
- Low energy consumption
- Operability or suitability
- Low capital utilization
- Supervise with less manpower

From the above gaps, the advantages of the diffuser with dewatering mill are very high to enhance sugar productivity, because the amount of sugar yield and quality it increases and

maintenance, operation and capital costs, manpower also decrease. Then, the manufacturing systems easy to expand the sugar manufacturing through the country to reduce the gap between supply and demand by fulfilling the local demand according to its requirements. So the existing sugar manufacturing needs to use a diffuser with a dewatering mill, to enhance the sugar productivity in Ethiopia it needs to improve the existing method of juice extraction in the sugar manufacturing process (Tena et al., 2016) for increasing sugar productivity it uses scientific and modern way process is essential for both customers and organization (Singh et al., 2019).

4. IMPLEMENTATION OF THE DIFFUSER WITH DEWATERING MILL FOR JUICE EXTRACTION

Diffuser**:** the diffuser is more popular in South Africa in the 1960s and 1970s, using European technology and used to achieve the highest extraction 98.4% rates in the world, to meet the industries requirements with high capacity, low capital and maintenance cost and lower power consumption using a diffuser are more advantages in sugar production industries (Voigt, 2009; Mullapudi Narendranath, 2010).

Dewatering mill: - it's a pair of mills which used to extract a juice which left in the bagasse in the form of press water and also remove moisture of bagasse.

The Schematic diagram of a cane diffuser with a dewatering mill (Rein, 1995).

Cane feed to diffuser**:** The right-angled feed slat conveyor, with adjustable deck cut-outs, arrows the distribution of cane across the width of the diffuser to be adjusted to achieve an even bed of cane in the diffuser. An even bed of cane is vital for uniform percolation of juice throughout the bed for optimized extraction.

Scalding juice heaters: Juice is extracted from the first and second trays and pumped through the scalding juice heaters to be returned to the feed end of the cane bed.

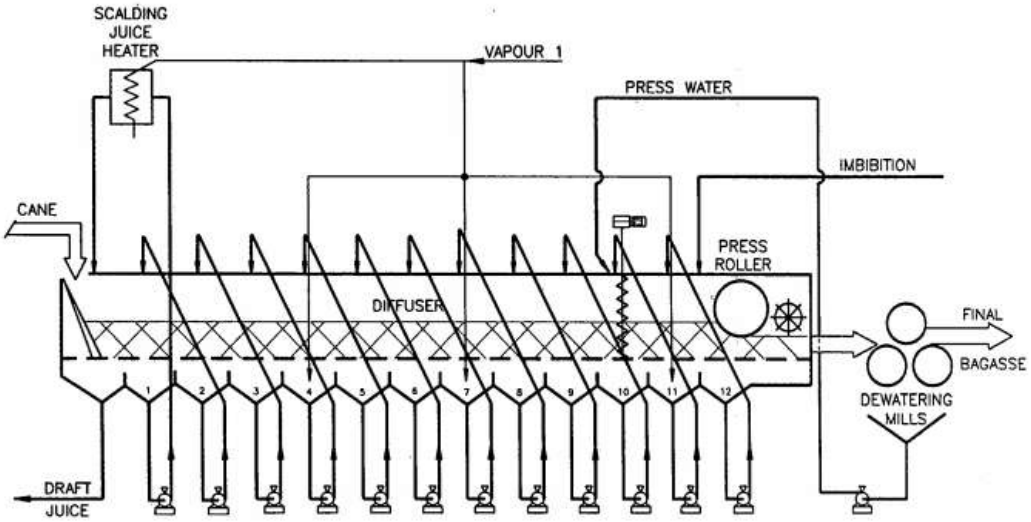

Figure 1. Schematic diagram of a cane diffuser with dewatering mill

This scalding juice heater is sized for vapor as the heating medium. Scalding juice is applied to the first stage at 85℃ and most of the heating is provided by indirect heating in the scalding juice heaters and the temperature in the diffuser is maintained by direct injection of vapor.

Press roller: Diffusers generally have a large press roller located before the discharge of the diffuse, riding on the cane bed. Its purpose is to prevent flooding of juice and cane out of the diffuser and to reduce the moisture content of the bagasse leaving the diffuser by the weight of the roller squeezing the bed.

Lifting screw: Designed to improve juice percolation, and low-pressure pre-dewatering unit arranged in the dewatering zone. To prevent the bagasse bed from becoming compacted and lose its permeability through rotation of the screws to agitate the bagasse.

Vapour (exhaust steam**)**: used to heat the prepared cane enters to the diffuser which is at ambient temperature to an extraction temperature of 80℃ and used to heat juice to a temperature of 80℃- 85℃.

Draft juice**:** is a juice extracted in the diffuser from the cane and used to produce sugar after passing in a different process.

Press water**:** which has a small amount of juice and a high amount of water and also used in the form of imbibition in the extraction of juice.

Imbibition**:** is the method of using water or press water to extract juice from a cane.

Schematic diagram of a cane diffuser with dewatering mill is presented on Figure 1.

4.1 Operation process of diffuser

The operation process of diffuser it contain some terms and process to extract a juice from sugar cane in the sugar manufacturing process (Smet., 2018).

A) Temperature in Diffuser

The optimum temperature in the diffusion process is 80℃ to 85 ℃ this temperature is important to kill the non-opened cells to permit diffusion through the wall of the cell, to suppress bacterial action, and to prevent sucrose losses resulting from the presence of enzymes.

B) Disintegration of Bagasse

It is not necessary to disintegrate bagasse into very fine particles. If the particles are very small the percolation of juice through the layer of bagasse will be very much reduced, thus decreasing the capacity of the continuous diffuser. The polarization of exhausted bagasse is practically the same whether the particle size is 4in (100mm) or 0.4in (10mm). The bagasse must suitable for diffusion is flattened pieces of a homogeneous size, with the maximum length of particles 4in (100mm), free from non- crushed cane and with a maximum of 10% fines.

C) Rate of percolation

The rate of juice percolation through the layer of bagasse is 85mm/s (3.35 in/s) being slower when bagasse is finer. The minimum retention time in the diffuser is 20 min. Excessive retention time and higher temperature may increase undesirable extraction of no sugars.

D) PH in the Diffusion process

Diffusion can occur at neutral on low PH. However, if diffusion is conducted at low PH, the diffuser must be made of stainless steel where it comes in contact with acid juice, to avoid corrosion.

4.2 Control process of the diffuser.

In the process of juice extraction by using a diffuser with a dewatering mill control each process during operation to extract juice properly (Rein, 1995).

Cane bed depth

Prepared cane is admitted at the diffuser feed end and distributed evenly to obtain a level bed. The design bed height is 1.7m and the height of the bed is measured by 3 level sensors in the diffuser and it is varied by adjusting the diffuser bed speed at a particular cane throughput.

Imbibition water

The following of imbibition water is controlled by a flow control loop and control valve. Imbibition water temperature and flow are monitored in the control panel.

Scaling heating

Temperature transmitters in the outlet juice pipes from each of the two juice heaters are used to control outlet temperature through control valves on the vapor supply to each heater.

Bed liquid control

The level of liquid in the bed must be adjusted from time to time to obtain optimum performance. The operator views the state of the juice in the diffuser on the surface of the cane bed and he can also see the level of juice as the cane/bagasse is drawn past the windows. By adjusting the throw of the sprays, he can influence these factors, and thus optimize extraction

Temperature control

Two sets of three direct-injection vapor heating pipe are provided to control the internal temperature of the diffuser to about 85℃

Monitoring at the diffuser

The following facilities have been supplied for the monitoring of conditions at the various points in the diffuser plant.

- Temperature indication in each juice tray.
- Level transmitter on each tray with a high-level alarm.
- Pressure indicators on juice heater steam chest and vapor supply.
- Bed speed indication.
- Scalding juice temperature in and out .
- Bed level.
- Pump monitor running indication in all pumps.
- Load in main drive monitor and kicker motor.
- Lifting screw motor running indicator high ON/OFF.

4.3 Safety procedure for a diffuser with dewatering mill

In diffuser plant, some safety rule is there:-

A) Personal protection: the body of the diffuser is hot when operating. The non-insulated outer metal surface temperature can be expected to be about 80℃. this is sufficient to cause a burn if bare skin is allowed to contact the surface. Adequate protective clothing includes overalls and gloves should be worn by all persons at or near the diffuser body.

B) Diffuser chains: the chains under the diffuser are not individually guarded, this area should be barricaded OFF to prevent unauthorized access to personal. During operation, hands or other objects should not be inserted in the chains and return, because around this chain there is a serious injury or damage to equipment.

C) Entry into the diffuser: During operation, entry into the diffuser must be prohibited to all persons. The steam valves must be closed and locked out before persons entered the diffuser. The diffuser must be allowed to cool down before any person enters.

D) Diffuser in feed carrier and discharge conveyor: The in-feed carrier and discharge conveyor are both items of moving machinery that carries and moves the cane or bagasse. Persons around this area should not wear loose clothing or this could be caught up in moving parts, leading to possible serious injury to the person. So do not place hands or other objects near any part of the moving machinery.

E) Pipework and scalding juice heaters: both are extremely hot because hot steam and juice flow in the pipework and also a high amount of temperature is there around scalding juice heaters. Persons working in this area should wear the appropriate safety equipment, especially gloves.

5. CONCLUSIONS

Ethiopia becoming one of the fastest economically growing countries in the world and expanding different

manufacturing sectors. Sugar manufacturing is also one sector that produces sugar and sugar is an essential commodity and plays a great role in the economic development of the country. The productivity of the existing sugar manufacturing is very low due to using of sugar mill tandem with the factors of less efficiency of juice extraction, high microbial growth, high maintenance, operational, and capital cost, high power consumption and supervise manpower requirement of milling tandem in juice extraction, in case of this reason there is a supply-demand gap with a shortage of sugar through the country. Sugar manufacturing produces a product that satisfies customers according to its requirements and increases the competitiveness of companies by reducing the supply-demand gap that exists. To enhance the productivity of sugar manufacturing, it uses a diffuser with a dewatering mill in juice extraction, because it has less power consumption, high efficiency of juice extraction, high-quality sugar and less manpower, microbial growth, maintenance, capital, operational, foundation and construction cost. In this study, it takes a single sugar manufacturing among existing, because all are it uses sugar mill tandem in juice extraction and it focused on the diffuser with dewatering mill is essential in enhancement of sugar productivity. The result of the study is to reduce the existing: manpower to 21, microbial growth with 80^{o}c to 85 ^{o}c., maintenance and operational by $71500, capital by $1957500, foundation and construction by $442580 cost and increasing of juice extraction efficiency to 98.4% per day extraction, quality of sugar and end product yield by 29.33 tons per day

References:

Ad Shiferaw, A. (2017). Productive capacity and economic growth in Ethiopia. United Nations, Department of Economics and Social Affairs.

Bayrau, A., Bekele, F., Assefa, B., & Mihiretu, M. (2014). An institutional assessment of the cotton and sugarcane commodities in Ethiopia: the climate change perspective. Addis Ababa, Ethiopia.

Birru, E., Erlich, C., Herrera, I., Martin, A., Feychting, S., Vitez, M., ... & Puskoriute, L. (2016). A comparison of various technological options for improving energy and water use efficiency in a traditional sugar mill. *Sustainability*, 8(12), 1227.

Clarke, S. J. (1999). Outlook for emerging technologies in sugar processing. In Proceedings (Vol. 75, p. 411). US Department of Agriculture, World Agricultural Outlook Board.

Dadi, G., & Azene, D. (2017). A TQM and JIT integrated continuous improvement model for organizational success: An innovative framework. *Journal of Optimization in Industrial Engineering*, 10(22), 15-23.

Dagne, S. (2018). Assessment of Project Identification and Selection Practice of Ethiopian Sugar Corporation. University of Addis Ababa.

Ekubaygebregeorgis, B. (2015). Analysis Of Technical Efficiency Of Sugarcane Production In Ethiopia: The Case Of Wonji/Shoa Sugar Cane Estate Farm (Doctoral Dissertation, St. Mary's University).

Gunawan, A., Bantacut, T., Romli, M., & Noor, E. (2018). Production and productivity improvement through efficiency sugar mill. *International Journal of Advanced Research*, 6, 1931-1941.

Kent, G., & Lewinski, J. (2007). Milling and diffusion extraction: theory and practice. In Proceedings of the 26th International Society of Sugar Cane Technologists (ISSCT) Congress (pp. 1404-1411). South African Sugar Technologists' Association (SASTA).

Merino, A., Alves, R., Acebes, L. F., & Prada, C. (2017). Modeling and simulation of a beet pulp dryer for a training simulator. Drying technology, 35(14), 1765-1780.

Mitullah, W., Kamau, P., & Kivuva, J. M. (2017). Employment Creation in Agriculture & Agro-Processing Sector in Kenya in the Context of Inclusive Growth: Political Economy & Settlement Analysis. Partnership for African Social and Governance Research Working Paper, 20.

Mullapudi Narendranath, M. N. (2010). Comparison of diffusion and milling at a cane sugar plant. Proc. Int. Soc. Sugar Cane Technol., 27, 1-12

Noel Simas Barbosa, L. D. S., Santiago, P. A., & Seleghim Jr, P. (2017, December). Modelling a multi-stage diffuser for sucrose extraction in sugarcane biorefineries. In Defect and Diffusion Forum (Vol. 379, pp. 149-156). Trans Tech Publications Ltd.

Rein, P. W. (1995, June). A comparison of cane diffusion and milling. In *Proceedings of the South African Sugar Technology Association* (Vol. 69, pp. 196-200).

Singh, P., Singh, S. N., Tiwari, A. K., Pathak, S. K., Singh, A. K., Srivastava, S., & Mohan, N. (2019). Integration of sugarcane production technologies for enhanced cane and sugar productivity targeting to increase farmers' income: strategies and prospects. 3 *Biotech*, 9(2), 48.

Sulaiman, A. A., Sulaeman, Y., Mustikasari, N., Nursyamsi, D., & Syakir, A. M. (2019). Increasing sugar production in Indonesia through land suitability analysis and sugar mill restructuring. *Land*, 8(4), 61.

Sushil, K. (2015). India's development cooperation with Ethiopia in sugar production: an assessment. RIS Discussion Papers, (198).

Tena, E., Mekbib, F., Shimelis, H., & Mwadzingeni, L. (2016). Sugarcane production under smallholder farming systems: Farmers preferred traits, constraints and genetic resources. *Cogent Food & Agriculture*, 2(1), 1191323.

Voigt, I. (2009). The implementation of South African sugar technology: the world's largest sugarcane diffusers.*Proc. Int. Soc. Sugar Cane Technol*., 27, 1-10.

Wood, R. (2003). Innovative approaches to enhancing sugar industry productivity and profitability: the contribution from crc sugar. *Proc. Aust. Soc. Sugar Cane Technol., 25*, 1 - 4.

Moti Melkamu
Department of Industrial Engineering, Institute of Technology,
Ambo University, Ambo, Ethiopia
Email: motimelka.auit@gmail.com
ORCID: 0000-0002-9968-1293

Birhane Desta Atsegeba
Department of Industrial Engineering, Institute of Technology,
Ambo University, Ambo, Ethiopia
Email: birhane1112@gmail.com
ORCID: 0000-0003-0663-455X