Cane Sugar Industry Potential and Measures To Reduce Sugar Production Cost

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ABSTRACT:-

The objective of the paper is to evaluate the potentials of sugar industry, it is the only industry which is self sufficient regarding in house requirements except raw material. It has rich by product, a sensible use of these by products can easily be converted into remarkable revenue. In these by products bagasse is the back bone of the industry ,Which can be used to make extra electrical power than requirement and by this extra energy lot of things can be done .The main issue is how to save bagasse and make all the dreams come out it. How in house electrical consumption can be reduced? By efficient use of this byproduct sugar manufacturing cost can be reduced. Cane sugar industry in Pakistan is facing challenges to survive; cost of raw material has gone very high . In this paper potentials of sugar industry are discussed by following/ adopting them, sugar production with lower cost can be achieved. This credit goes to Almoiz' industries who introduced 1st time in Pakistan latest technologies which changed the old concept. Main focus remained on development of cane with best recommended quality seeds, increase in operational time of the mills by slicing beet and power export. Modern equipments installed such as falling film evaporators and automation in different areas of plant to reduce steam consumption. Similarly different techniques /machines installed to reduce electrical consumption of plant such as compact gears, variable frequency drives etc. this paper also covers that how high pressure system is better than the low pressure system.

This is difficult to have significant reduction in production cost by choosing one or two factors, it can only be done by improving all areas even on small scale but its overall impact will be much higher

How to reduce cost of production?

Cost of sugar production can be reduce by the following.

- **Cane Quality/Cane yield**
- **Increase in yearly operational time of plant**
- **Less steam %cane and bagasse saving**
- **Energy conservation /power export**

Cane Quality/cane yield per acre.

Cane quality means "the cane which has high sugar /fiber contents". High sugar contents will give better sugar production /ton cane and high fiber will help in more bagasse saving. Following chart will explain that at what sugar recovery % present cane price becomes viable.

- **Cane Price Rs. 180/40 Kg**
- **Sugar Price Rs. 50/kg**

Sr.No	Cane Crushed Kg	Recovery % Cane	Sugar Production Kgs	Cost Of Cane Rs	Cost Of Sugar Rs	Difference B/W Cane cost per Sugar Rs
1	100	8	8	450	400	-50
2	100	8.5	8.5	450	425	-25
3	100	9	9	450	450	0
4	100	9.5	9.5	450	475	25
5	100	10	10	450	500	50

***Other expenses not included in this table.**

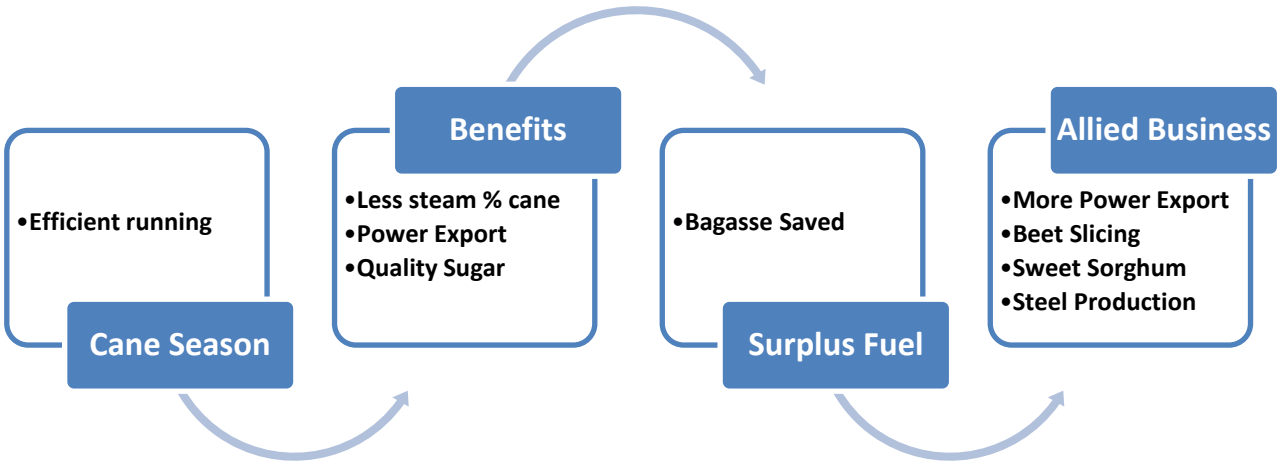
Every 0.5% increase in sugar cane recovery reduces the production cost of sugar by 4-5%.To get best cane special attention is required from sowing to processing ,until every step is not taken care of best results cannot be achieved. To achieve maximum recovery following points to be considered,

1. Cane cultivation at proper time (September sowing gives better results than Feb. sowing)
2. Use of approved /good quality seed for cane cultivation.
3. Training of cane staff and growers to ensure good cultivation practices.
4. Shortest time between cane cut and crush.
5. Clean cane without tops and trashes.
6. Minimum processing losses.

Cane quality and quantity /acre, both are important, with better yield /acre operational time of the plants can be increased resulting in better production and profitability.

How a mill can increase its Operational Time?

Profitability/sugar production cost can be reduced by increasing the total operational time of the plant; it can be explained by the following cycle,



It is clear from above cycle that a sugar mill has lot of potentials to improve its profitability and the

main weapon is bagasse which is the rich source of energy and if a sugar plant mange it well and saves maximum fuel, many things can be done.

1. Efficient running of cane season (full capacity utilization with minimum or no stoppages)
2. Less steam% cane (it will facilitate to save maximum bagasse)
3. Less power consumption of the plant (it will facilitate to export more power during season)

It means that during crushing season at high pressure system ,if steam % cane is even 45% and power consumption of plant is controlled, a sufficient amount of power can be exported during season.

A plant having capacity of about 8000TCD,with 45 steam % cane can export 7-8 MW electricity/hr with 25 tons of bagasse saving/hr(600 tons/day equal to 186MW electricity) in addition.

Every 1% reduction in crushing capacity will increase production cost by 1.4-1.5% in high pressure system at 10% recovery.

For example,

For H.P System

	100 % Capacity	10% reduced capacity
Cane crushed	**= 300 TPH (7200 TPD)**	**270 TPH (6480 TPD)**
Bagasse Produced (30% cane)	**= 90 TPH (2160 TPD)**	**81 TPH (1944 TPD)**
Steam produced (1:2 bagasse to steam)	**= 180 TPH (4320TPD)**	**162 TPH (3888 TPD)**
Power Generated (6.45t/MW)	**= 27.8 MWH (669MWD)**	**25.09MWH (602MWD)**
Cost of power generated	**=Rs.222400/hr (5337600/day)**	**Rs.200720/hr (4817280/day)**

Difference in cost = Rs.21680/hr (520320/day)

* **Cost of power generated (Rs.8.00/KWH)**

For L.P System

Every 1% reduction in crushing capacity will increase production cost by 0.82% in low pressure system at 10% recovery.

	100 % Capacity	10% reduced capacity
Cane crushed	**= 300 TPH (7200 TPD)**	**270 TPH (6480 TPD)**
Bagasse Produced (30% on cane)	**= 90 TPH (2160 TPD)**	**81 TPH (1944 TPD)**
Steam produced (1:1.9 bagasse to steam)	**= 171 TPH (4104TPD)**	**153.9 TPH (3693.6TPD)**
Power Generated (14.8 t/MW)	**= 11.55MWH (277.2MWD)**	**10.39MWH (249.5MWD)**
Cost of power generated	**= Rs.92400/hr (2217600/day)**	**83120/hr (1994880/day)**

Difference in cost = Rs.12400/hr (298480/day)

* **Cost of power generated (Rs.8.00/KWH)**

REQUIREMENTS FOR BAGASSE SAVING.

To save maximum bagasse two areas must be very efficient,
1. Process house, by an efficient and well managed process house steam % cane can be reduced significantly.
2. Boiler efficiency.

Steam% cane.

Every 5% reduction in steam% cane will decrease production cost by 1.2% in high pressure system and 0.72% in low pressure system at 10% recovery.

Cane crushed = 300 TPH (7200 TPD)

Bagasse Produced = 90 TPH (2160 TPD)

Steam % Cane	**45%**	**50%**
Steam required	**= 135 TPH (3240TPD)**	**150 TPH (3600 TPD)**
Bagasse required	**= 67.5TPH (1620TPD)**	**75 TPH (1800 TPD)**
Bagasse saved	**= 22.5TPH (540TPD)**	**15 TPH (360 TPD)**
steam produced by saved bagasse	**= 45 TPH (1080TPD)**	**30 TPH(720 TPD)**
Power generated by saved bagasse	**= 6.92MWH (166.15MWD)**	**4.6MWH (110MWD)**
(By high pressure boiler)		
Difference in MW	**= 2.32MWH (55.68MWD)**	
Cost difference (Rs.)	**= 18560/hr (445440/day)**	

How steam % cane can be reduced.

Steam % cane can be reduced by adopting following:
Use of right size evaporators. In quintuple effect, steam saving is maximum, to achieve minimum Δt .
Latest technology/equipments (FFE) can be used to achieve minimum Δt.
Use of 2^{nd} and 1^{st} vapors for centrifugals and re-melters
Maximum utilization of 3^{rd} vapours for pan boiling.
Usage of 5^{th} , 4^{th} vapours & condensate water to juice heaters.
Minimum usage of raw water at pan section, maintaining the molasses brix.(A.H,B.H,C.L etc.) in the range of 75-82 ^{0} with Molasses Conditioner.
Minimum usage of 4 bar steam in process House.
Use of minimum 70^{o}C imbibitions water for mills.
Minimum make up steam(for exhaust steam) for process house.
Steam leakage is to be avoided and steam drainage should be minimized.
Proper insulation of equipments.

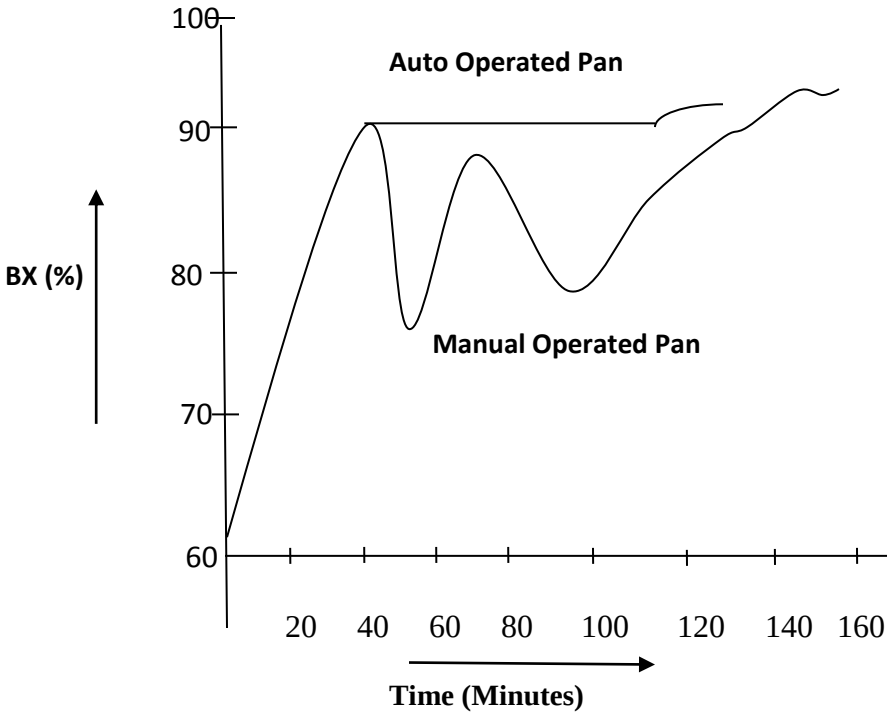
Use of automation.

Automation can change the scenario of plant in different ways. Such as

- **Capacity Enhancement with existing equipment**
- **Quality Improvement**
- **Reduction in steam % cane**
- **Less losses**
- **Automation of pans can easily reduce steam % cane by 1.5-2.0 %.**
- **Automation of juice heaters can also save 0.5 % steam.**

Effect of Automation on Refine Batch Pan

Difference of auto operated & manual operated pans



Efficiency of boiler depends upon.

Every 1% increased efficiency of the boiler will reduce cost by 0.925%.

- **Bagasse moisture**
- **Bagasse Pol.**
- **Flue gas temperature.**
- **Feed water temperature.**

Good cane preparation and milling can reduce the bagasse moisture and pol.

If all other figures are fixed (Bagasse pol, Flue gases temperature, Feed water Temperature) and only bagasse moisture changes by 1%,the efficiency of boiler may increases/decreases by 2.31%.

If all other figures are fixed (bagasse moisture, pol, and feed water temperature) and only flue gases temperature changes by 10˚C. The boiler efficiency increase or decrease by 2.78%.
Optimum capacity/efficiency of economizers can give low flue gas temperature.
Every 10˚C change in feed water temperature will lead to increase or decrease by 1.86% bagasse consumption per unit steam.
Closed circuit condensate system can give feed water temperature up to 115 ˚C without any injection of steam.
In short about 2-2.5% efficiency of boiler can be increased by optimizing above parameters, saving 2-2.5% more bagasse. This saved bagasse can be used as fuel for power generation to run the allied business like Steel production, power export, beet slicing.

cane crushing	**= 300TCH(7200TCD)**
Qty. of bagasse saved by better efficiency of boiler(2.5%)	**= 2.25TPH(54TPD)**
Steam produced	**= 4.612TPH (110.7TPD)**
Power produced	**= 0.71MWH (17MWD)**
Cost saved (Rs.)	**= 5680/hr (136320/day)**

How extra power can be generated.

To go for co-generation two things have considerable importance excluding bagasse saving.

1. use of high pressure boiler and turbines.

2. Reduction in power consumption of plant

Steam Consumption at H.P Turbine

$$\mathbf{Q} = \frac{\mathbf{860}}{(\mathbf{x} - \boldsymbol{\lambda}')\boldsymbol{\eta}(\mathbf{em})(\mathbf{er})(\mathbf{eg})}$$

Q = steam Consumption Kg/KW.h
X = total heat of inlet steam at 480 ^{0}C = 806 kcal/kg
λ = Total heat of exhaust steam at 150 ^{0}c = 655.5 kcal/kg
ṅ = Thermodynamic efficiency of turbine = 0.97%
e_m = Mechanical efficiency of turbine = 0.97%
e_r = Efficiency of reduction gear = 0.97%
e_g = efficiency of Generator = 0.97%

$$Q = 860/(806 - 655.5) \times 0.97 \times 0.97 \times 0.97 \times 0.97$$

$$Q = 6.45\ kg/kwh$$

Steam Consumption at L.P Turbine

$$\mathbf{Q} = \frac{\mathbf{860}}{(\mathbf{x} - \boldsymbol{\lambda}')\boldsymbol{\eta}(\mathbf{em})(\mathbf{er})(\mathbf{eg})}$$

Q = steam Consumption Kg/KW.h
X = total heat of inlet steam at 350 ^{0}C = 746.3 kcal/kg
λ' = Total heat of exhaust steam kcal/kg at 150 ^{0}c = 655.5 kcal/kg
η = Thermodynamic efficiency of turbine = 70%
e_m = Mechanical efficiency of turbine = 97%
e_r = Efficiency of reduction gear = 97%
e_g = efficiency of Generator = 97%

$$Q = 860/(746.3 - 655.5) \times 0.70 \times 0.97 \times 0.97 \times 0.97$$

$Q = 14.8\ kg/kwh$**(varies w.r.t manufacturer betwee11-15kg/kwh)**

High Pressure steam consumption /MW =6.45 T
Low Pressure steam consumption /MW = 14.8 T
Cost of 1kw= Rs.8/-
Cost of 62 MW power is Rs.496000 /day
Cost of 27.02 MW power is Rs.216160/day

Reduction in power consumption of plant:

Selection of efficient /right size equipment(especially gears).
Use of VFDs for different applications.
As much in-house power saved, can be exported and will reduce the production cost. In sugar industry in-efficient gearing systems are in use and their efficiencies are 25-50% less as compared to modern gearing, resultantly 25-50% extra power consumption. Worm and worm wheel are the most in-efficient part of the drives which increase the power consumption and are usually used for crystallizers ,magma minglers, vertical crystallizers, juice clarifiers etc. In mills house low speed gears are most in-efficient part of the system which significantly increases power consumption.
For example.
In mills house three type of drive systems are currently available :
Conventional system.
1. Drive (motor) ----high speed gear-----low Speed gear------tail bar/rope coupling-----pinion-----mill

(1000 KW) 960KW 883.2KW 529.92KW 514KW 472.9KW

(47-48% efficient)

Compact gear system(Proved technology)

2. Drive (motor) ---------compact gear ---------tail bar/rope coupling --------pinion---------mill

(1000 KW) 960KW 883.2KW 856.7KW 788KW

(78-79% efficient)

New /latest technology

3. Drive (motor) -------compact gear direct couple to top roller of mill.

500KW 480KW 456KW

Drive(motor)---------compact gear direct couple to mill (feed/discharge roller)

250KW 240KW 228KW

(91-92 % efficient)

About 30-43% more power can be saved by using efficient /right sized equipments with variable frequency drives throughout the plant.

CONCLUSION.

- **Industry has to take diligent measures in order to enhance the quality cane cultivation.**

- **If sugar price kept at Rs.50/Kg, cane at Rs.180/md. & Rs.5/kg other expenses then break even sugar recovery is 9.9%.**
- **Every 0.5% increase in sugar recovery reduces the sugar production cost by 4-5%.**
- **Overall plant efficiencies need to be improved.**
- **Every 1% reduction in crushing capacity will increase production cost by 1.6% in high pressure system at 10% recovery.**
- **Every 1% reduction in crushing capacity will increase production cost by 0.82% in low pressure system at 10% recovery.**
- **Quality sugar production(25% of total) can reduce cost by 1% / kg sugar.**
- **9-10 %/kg sugar cost can be reduced if all surplus power is exported for high pressure system and 3-4% for low pressure system.**
- **Every 5% reduction in steam% cane can reduce cost by 1.2% / kg sugar in high pressure system and 0.72% in low pressure system at 10% sugar recovery .**
- **Every 1% increased efficiency of the boiler will reduce cost by 0.925%.**

Referances

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