# BEST PRACTICES IN SUGAR TECHNOLOGIES AND ETHANOL PRODUCTION

Presented at

9th CII Green Sugar Summit 2024

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Council Member – STAI
Counsellor from India - ISSCT

# PREAMBLE

- 25 years ago when margins were good and sugar business was profitable so other revenue streams of by products were neglected.
- Sugarcane is a political crop rising it's prices by every crushing season which reversed the profit scenario of sugar business.
- Profits can only gained and sustained by in-house savings and diversification of sugar business.
- Savings triggered the thoughts for various efficiencies e.g. RME, PI, RBHR, energy saving ,reducing waste, and utilizing resources effectively to maximize yield and profitability
- Sugarcane has been projected as the crop for the future contributing to the production of not only sugar but also as a renewable source of green energy in the form of bio-fuels, bio-electricity and many bio-based products.
- A sustainable modern sugar complex integrates innovative technologies and practices to optimize energy consumption while expanding the product portfolio.
- **Isgec is continuously dedicated to develop new Innovative & advance technologies to make sugar industry sustainable.**

# PROCESS AND TECHNOLOGICAL IMPROVEMENT TILL NOW…

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- From non gravity plants to gravity plant
- From steam engines to steam turbine to DC motors to AC motors,
- From open to closed gear boxes , hydraulic drives to dyno drive, and finally settled down to AC variable frequency drives (VFD) with planetary gear box.
- From conventional tail bar coupling to Rope coupling
- From Manually operated to automated machinery
- From double carbonation to double sulphitation to sulphur-free sugar /refined sugar to liquid sugar/pharmaceutical sugar
- From open batch pan boiling to horizontal continuous vacuum pan boiling to vertical continuous pan boiling
- From huge ground water consumption to zero ground water consumption.

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# SUGAR PLANT

# PINIONLESS MILLS - ADVANTAGES

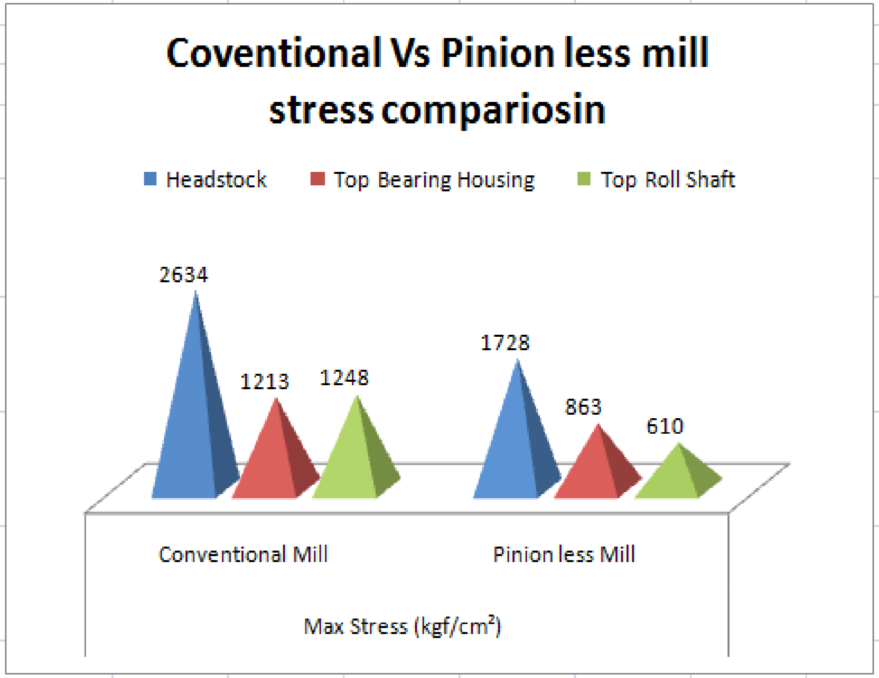
- Elimination of tail bar/rope coupling & crown pinions from a system results in reduced the wear & tear, reduced power consumption up to 15%.

- The tandem with lesser wear tear consumes lesser lubricants & ensures higher service life of equipments.

- Pinion free mill top roller floats easily and reduces mill choking, also it facilitates running of top & bottom rollers at a different speed, a feature which increases mill extraction efficiency.

- Reduced stress level in the mill headstock increases the mill reliability even at high crushing rate.

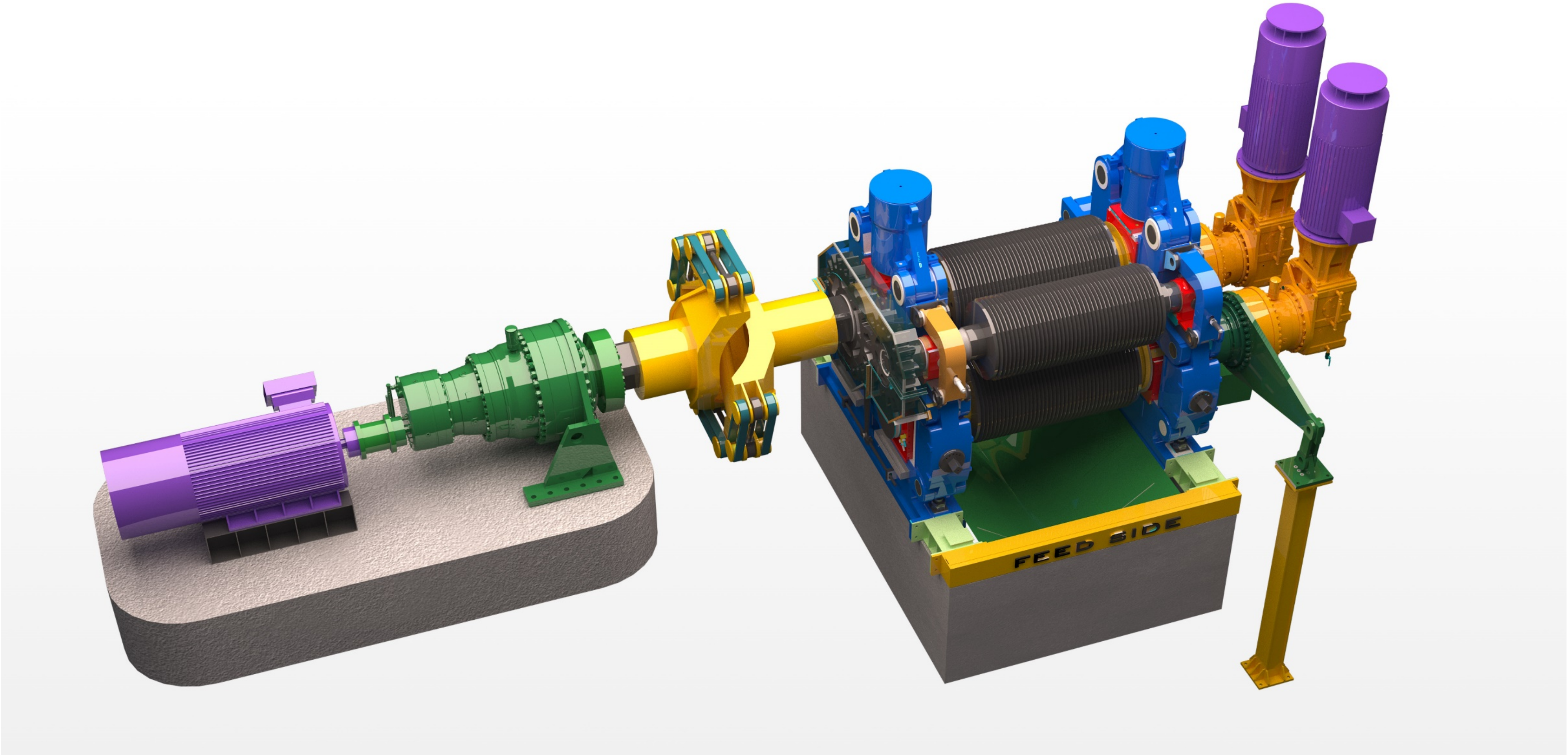
- Pinion less mill saves 50 % of the foot space, this reduces huge civil cost & misalignment between drive & mill.



# COMPARISON BETWEEN CONVENTION & PINION LESS MILLS

| S. No. | Particulars | Conventional Mills | Pinion Less Mills |
|---|---|---|---|
| 1. | **Power Consumption** | 1.7 – 1.8 kW/TCH | 1.3 – 1.4 kW/TCH |
| 2. | **Wear & Tear** | Higher | Lower than conventional mills |
| 3. | **Footsteps** | Higher space required | Approx. 30 % Lesser space required than conventional mills |
| 4. | **Civil Cost** | Higher | Lower |
| 5. | **Overall Drive Efficiency** | 76 % | 88 % |

# PINIONLESS MILLS WITH ASSIST DRIVES




3d Model of Typical pinion less Mill with assist drive

# PINIONLESS MILLS WITH ASSIST DRIVES

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Fig: Actual installation at San Diego, Gautemala Site having Top Roller with Foot mounted drive and Bottom Rollers with Shaft mounted drive

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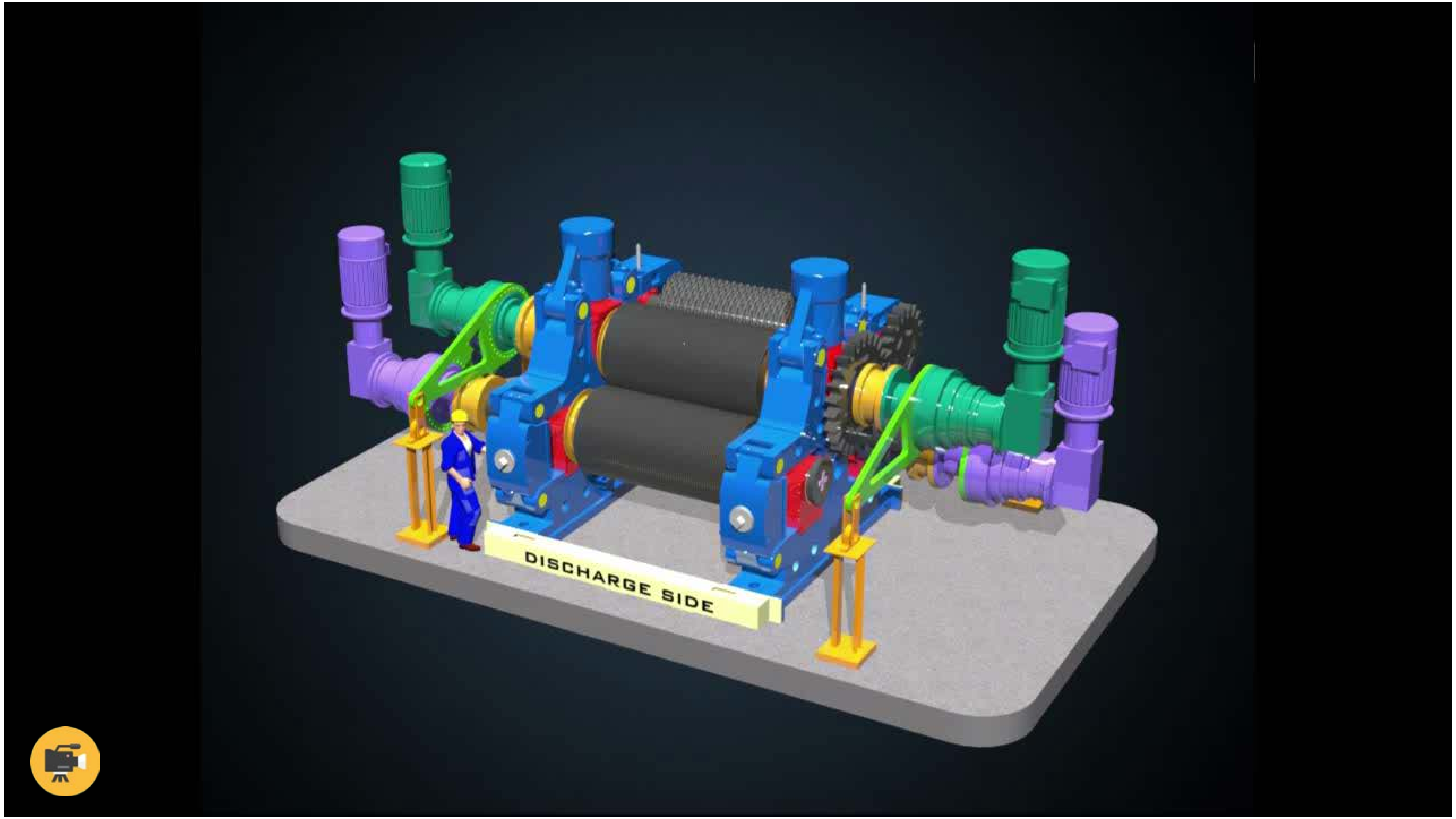
# PINIONLESS MILLS WITH SHAFT MOUNTED DRIVES



# PINIONLESS MILLS WITH SHAFT MOUNTED DRIVES

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Fig: Actual installation at Jay Mahesh Site, India

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# PINIONLESS MILLS WITH SHAFT MOUNTED DRIVES

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Fig : In Line Shaft mounted drive on Top, feed & discharge roller – ISL, Mukerian, Punjab

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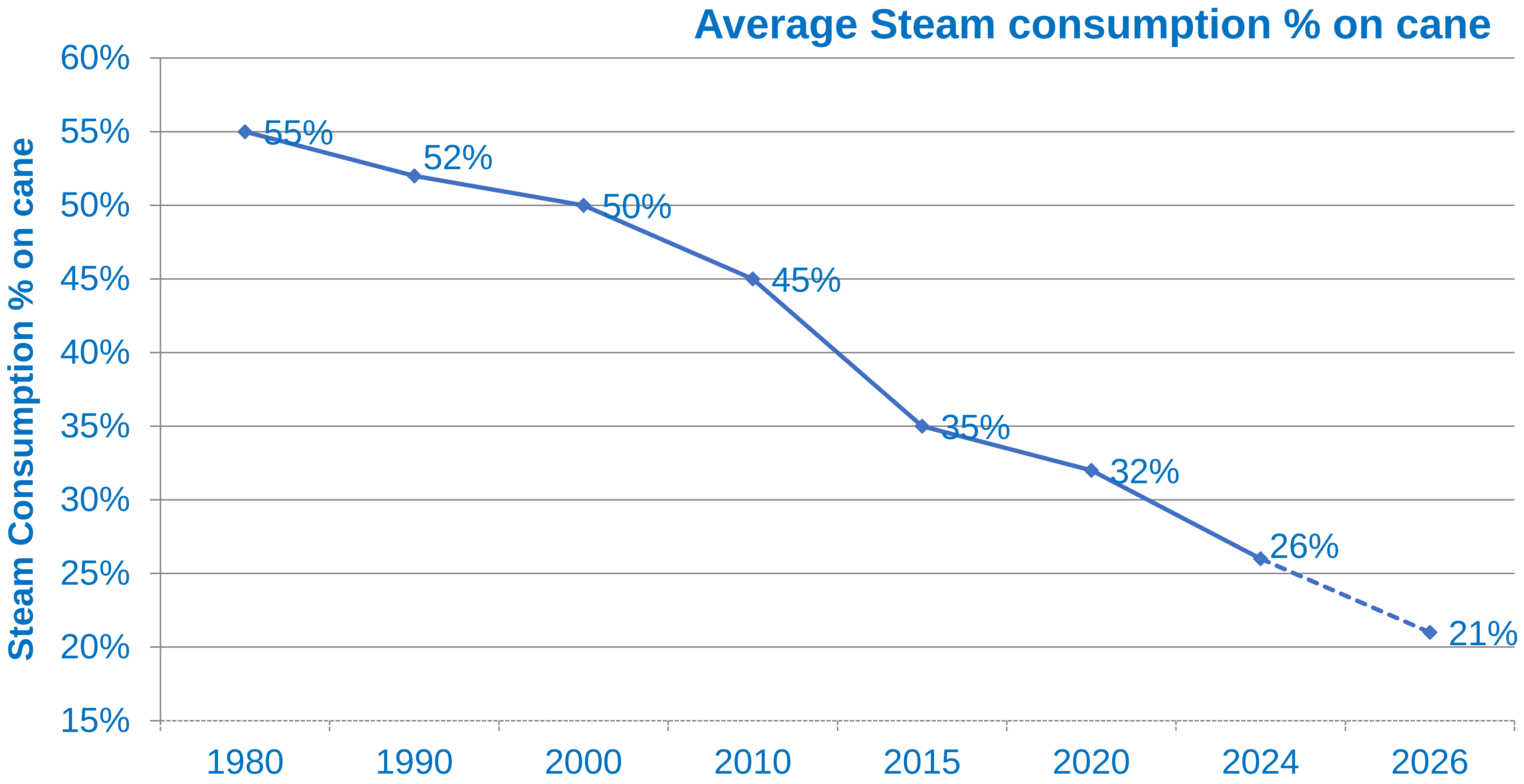
# STEAM CONSUMPTION-GRAPH
## PLANTATION WHITE SUGAR PLANT



# STRATEGIES THAT MADE POSSIBLE….
# TO REDUCE STEAM CONSUMPTION

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## Stepping towards better steam economy

40% → Condensate heat recovery → Plate type & Direct contact juice heaters → Falling film evaporators → Advanced vapour bleeding scheme → Vertical continuous pan → MVR → 21%

- Plate type & Direct contact juice heaters → ✗ Tubular juice heaters → High approach temperature required for operation
- Falling film evaporators → ✗ Robert type evaporators → Operate at high pressure & temperature difference
- Advanced vapour bleeding scheme → ✗ Obsolete vapour bleeding scheme → Use of 2nd & 3rd vapour for pan and juice heating
- Vertical continuous pan → ✗ Batch and Horizontal continuous vacuum pans → Higher vapour temperatures required for massecuite boiling

- **Bindal Paper Mills Limited** has a diversified Business Portfolio in paper industry. Their vision is to save ecosystem and conserving trees for future generation by adopting latest technologies.
- **To fulfil the demand of fibre to their paper plants, company has awarded ISGEC to setup a modern new sugar & Ethanol plant having minimum steam consumption to save maximum bagasse for their paper plants by adopting the following steam saving practices and technologies**

| Crushing capacity | 7,500 t cane/day expandable to 10,000 t cane/day |
|---|---|
| Sugar production | Double sulphitation white sugar |
| Process highlights for steam saving up to 26% on cane | Septuple-effect evaporator (all falling film evaporators) set with condensate flash recovery system<br>Three & Half massecuite boiling: complete C heavy diversion to distillery, vertical continuous pan for B & C massecuite |
| Steam generation plant | 100 t/h at 68 ata, 485±5°C, travelling grate boiler |
| Boiler fuel | 100% bagasse<br>- 40% bagasse + 60% bagasse pith (weight basis)<br>- 30% rice husk +70% bagasse pith (weight basis)<br>- 25% woodchips+75% bagasse pith (weight basis) |
| Power plant | 15 MW captive Power Plant with Backpressure turbine |
| Distillery capacity | 120,000 L/day ethanol on Syrup & B heavy feedstock, 85KLPD on C heavy |
| Incineration for vinasse | 25 t/h , 45 ata vinasse fired incineration boiler with 2.5 MW power generation |

# KEY HIGHLIGHTS OF PROCESS PLANT FOR STEAM SAVING

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1.
- Seven Effect Evaporator Configuration with all Falling Film Evaporator

2.
- Extensive vapor bleeding scheme

3.
- All Batch Pans with Mechanical Circulators design on 5th Vapor

4.
- Vertical Continuous Pan for B massecuite boiling design on 6th Vapor
- Vertical Continuous Pan for C massecuite boiling design on 5th Vapor

5.
- LT-HT condensate use for juice heating

6.
- Use of DCH for juice heating and molasses conditioning

7.
- Condensate flash recovery vessel

8.
- Vapor line juice heater in VCP vapor line

# PLANT OVER VIEW

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# GLIMPSE OF BINDAL SUGAR PLANT

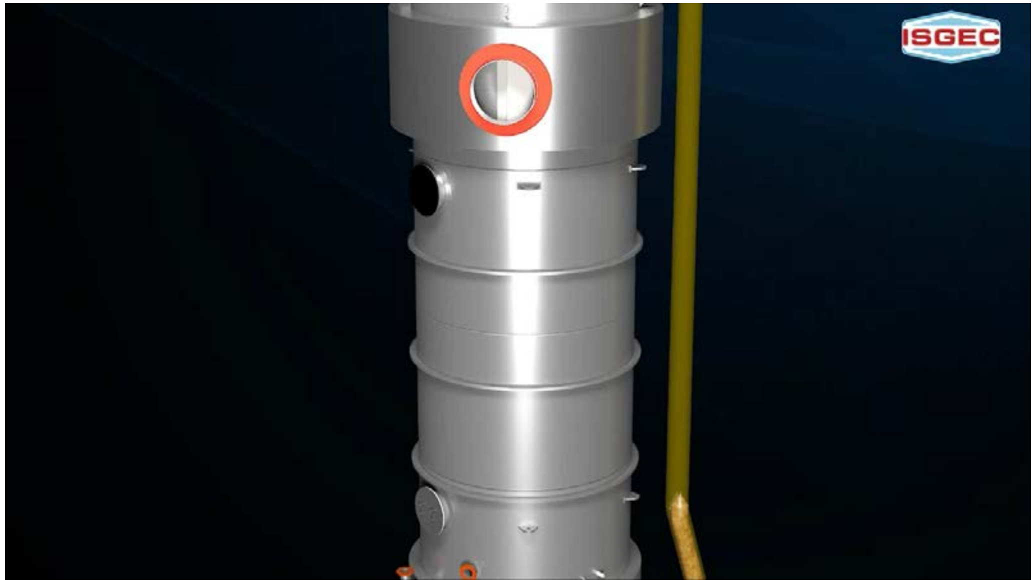

# FEATURES OF ISGEC FFE

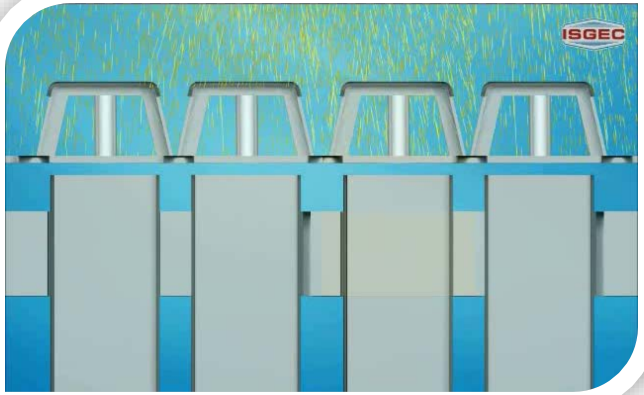
Inbuilt 5-stage cascade type, Maintenance friendly juice distributor that forms a uniform shower of juice across the entire cross section.

Segmented tray plate with individual tripod umbrellas located over each tube. These prevent short circuiting and also ensure equal and uniform wetting of each and every tube.

Height between distributor & top tube sheet is 1.8 m above to facilitate easy access for cleaning and maintenance during season (No need to open cover in season). Tripod system for 100 % wetting of tubes.

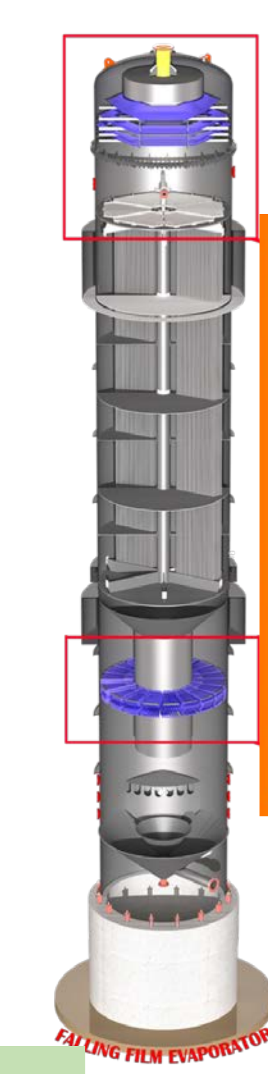
## Juice distribution in FFE




# ISGEC DESIGN MODERN POLY BAFFLE ENTRAINMENT SEPARATOR FOR STRAIGHT DESIGN FFE






ORIGINAL

No. 107509

भारत सरकार
GOVERNMENT OF INDIA
पेटेंट कार्यालय
THE PATENT OFFICE

CERTIFICATE OF REGISTRATION OF DESIGN

| | |
|---|---|
| Design No. | 342289-001 |
| Date | 13/04/2021 12:15:54 |
| Reciprocity Date* | |
| Country | |

Certified that the design of which a copy is annexed hereto has been registered as of the number and date given above in class 15-09 in respect of the application of such design to ANNULAR POLY BAFFLE in the name of ISGEC HEAVY ENGINEERING LTD., A4, SECTOR 24, NOIDA, INDIA

in pursuance of and subject to the provisions of the Designs Act, 2000 and the Designs Rules, 2001.

Controller General of Patents, Designs and Trade Marks

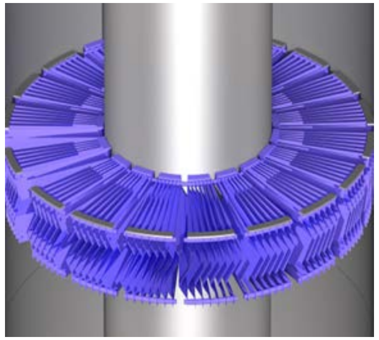
*The reciprocity date (if any) which has been allowed and the name of the country.
Copyright in the design will subsist for ten years from the date of Registration, and may under the terms of the Act and Rules, be extended for a further period of five years.
This Certificate is not for use in legal proceedings or for obtaining registration abroad

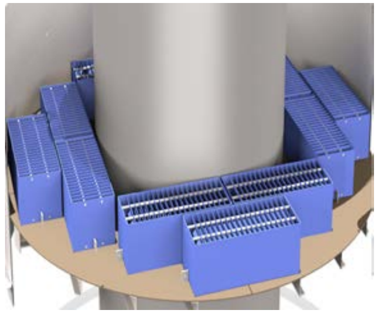
TARUN KHURANA,
KHURANA & KHURANA, ADVOCATES AND IP ATTORNEYS E-13, UPSIDC, SITE-IV (BEHIND GRAND VENICE) KASNA ROAD, GREATER NOIDA 201310, NATIONAL CAPITAL REGION, INDIA.

Date of Issue 19/01/2022 14:11:09

Isgec has made improvements & developed straight design FFE body so that poly baffle area can be high and entrainment chances can be negligible.

## Old vs new Design polybaffles





## New Design polybaffles





**Design of Poly Baffle is registered by Indian Patent Office Government of India**

# ADVANTAGES OF ISGEC VERTICAL CONTINUOUS PAN

Excellent crystal quality in terms of **C.V.** (28%) and **Color** due to better crystal growth and reduction in final molasses purity.

Good centrifuging ability of VCP product.

Reduced vapor requirement – 28-30 % on massecuite.

Flexibility in operation.

No need of Separate grain pan.

No manpower required, complete automation.

# DESIGN FEATURES OF i-VCP

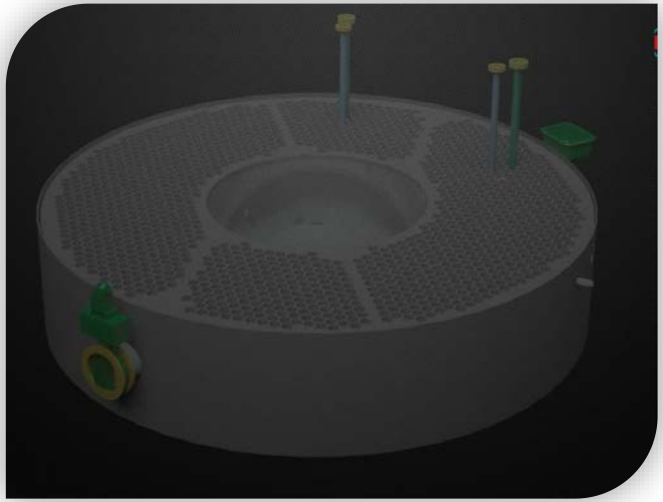
## Partitioned module

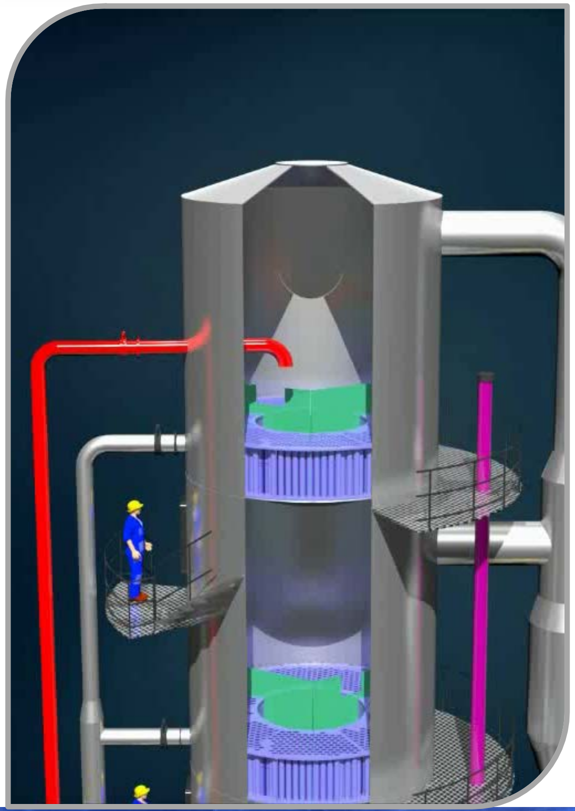
The top two modules for B and C have two and three partitions; respectively, whereas for A and refined massecuite there is no partitioned  module.

**Partition of calandria restricts installation of mechanical circulator like un-partitioned module.**

### The reason of partition is:

- To provide partial plug flow to massecuite to avoid any dead zone formation
- To avoid short circuiting of massecuite so that exhaustion through initial boiling can be improved





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# DESIGN FEATURES OF i-VCP

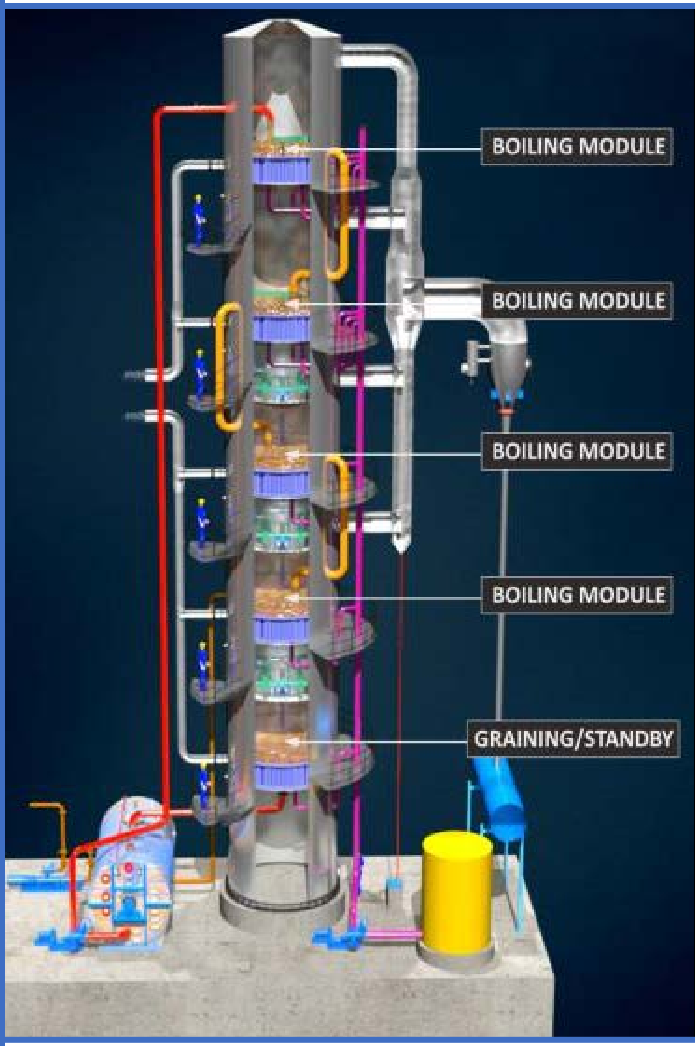
**INBUILT GRAINING/STANDBY module:** i-VCP is designed with bottom most module for graining and standby.

**Benefits of this additional module is:**

- One complete batch type pan for grain preparation is removed.
- Structure requirement of graining pan, grain storage vessel is removed.
- Whenever any of the upper modules are being cleaned, the pan maintains 100% capacity utilization.

**Vapor utilization:**

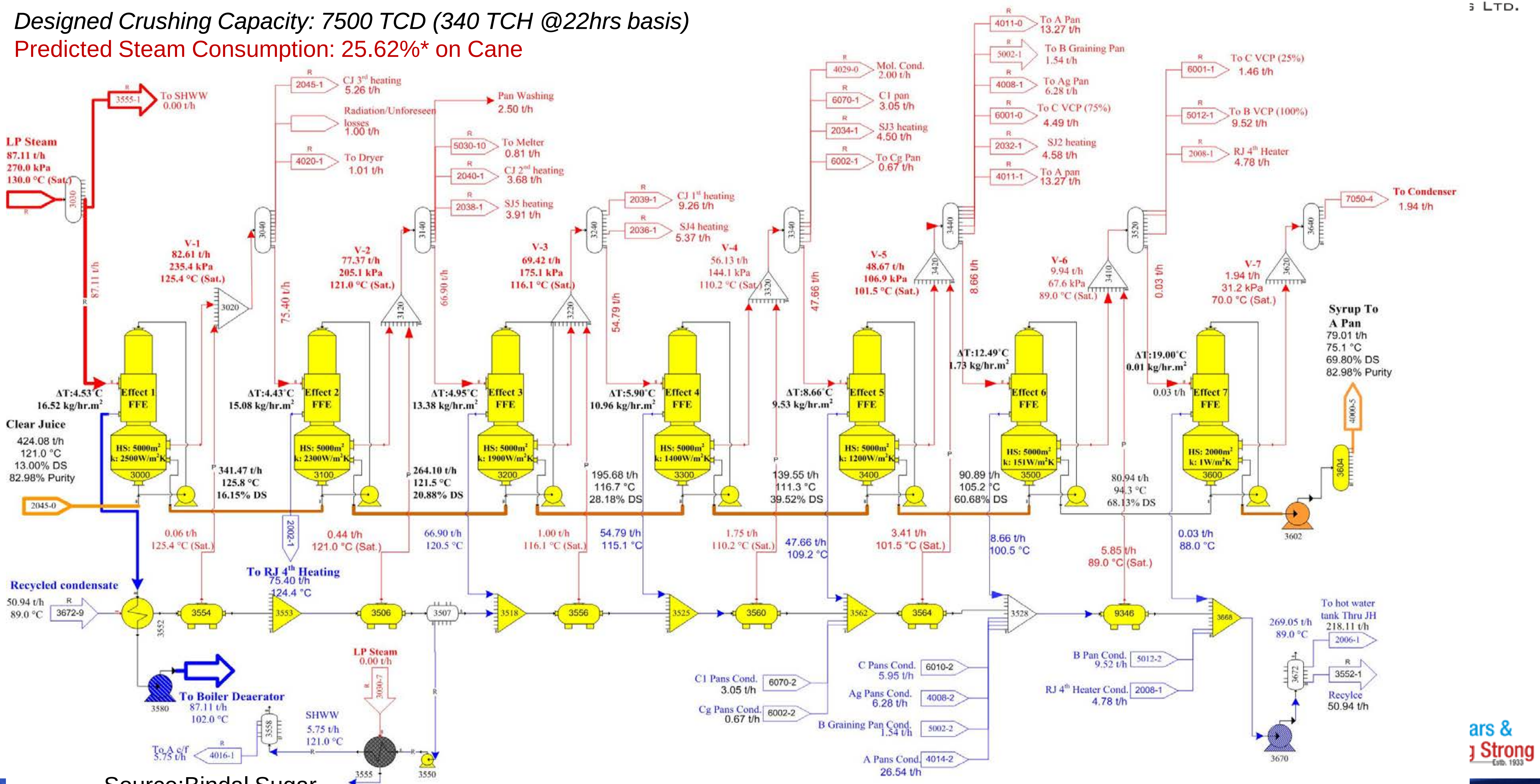
- Since all module calandria are not interconnected so different type vapors can be used individually.
- So low pressure vapors can be used for boiling and higher pressure vapors for tightening module.
- Due to this flexibility of vapor utilization, overall steam consumption is reduced.



# EVAPORATION HMBD WITH 26% STEAM CONSUMPTION

*Designed Crushing Capacity: 7500 TCD (340 TCH @22hrs basis)*

Predicted Steam Consumption: 25.62%* on Cane




Source:Bindal Sugar

# EXTENSIVE VAPOR BLEEDING SCHEME

| 1st effect | 2nd effect | 3rd effect | 4th effect | 5th effect | 6th effect | 7th effect |
|---|---|---|---|---|---|---|
| CJ3 heating (DCH) | SJ5 heating (DCH) | SJ4 heating (DCH) | SJ3 heating (DCH) | SJ2 heating (DCH) | B massecuite boiling (VCP) | Condenser |
| Sugar dryer air heater | CJ2 heating (DCH) | CJ1 heating (DCH) | C1 massecuite boiling (VCP) | B graining (Batch) | C massecuite boiling (VCP) | |
| | B sugar Melting | | Cg graining | A massecuite boiling (Batch) | RJ 4th heating (Tub) | |
| | Pan washing | | Molasses conditioning (DCH) | C massecuite boiling (VCP) | | |

| Heating | Vapour used | Type of heat exchanger |
|---|---|---|
| Raw juice 1st heating | Excess condensate | Liquid to liquid plate type heater |
| Raw juice 2nd heating | VCP vapours (waste vapours) | Vapour line type vertical tubular heater |
| Raw juice 3rd heating | Low temp condensate (waste heat) | Liquid to liquid plate type heater |
| SJ 1st heating | High temp condensate (waste heat) | Liquid to liquid tubular type heater |

Source:Bindal Sugar

# BAGASSE SAVING

| Sl. No. | Date | Cane crushed (in Qtls) | Sugar recovery* (%) | Steam consumption (% cane) | Bagasse saving % on cane | Profit from bagasse saving @ 3000 INR/T (in Lakhs per day ) |
|---|---|---|---|---|---|---|
| **1** | 6.12.2023 | 71000 | 9.15 | 26.58 | 13.15 | 28.0 |
| **2** | 7.12.2023 | 62000 | 9.20 | 30.13 | 12.21 | 22.7 |
| **3** | 8.12.2023 | 42000 | 9.24 | 25.67 | 13.23 | 16.7 |
| **4** | 9.12.2023 | 75000 | 9.28 | 25.60 | 13.6 | 30.6 |
| **5** | 10.12.2023 | 76100 | 9.31 | 26.9 | 13.7 | 31.3 |
| **6** | 11.12.2023 | 67700 | 9.35 | 27.50 | 13.34 | 27.1 |
| **7** | 12.12.2023 | 66600 | 9.46 | 26.21 | 13.18 | 26.3 |
| **8** | 13.12.2023 | 74300 | 9.56 | 25.39 | 13.72 | 30.6 |
| **9** | 14.12.2023 | 67000 | 9.67 | 27.14 | 13.84 | 27.8 |

Courtesy : Bindal paper

**We reached from 8-10% to 13-14% bagasse saving by achieving 26% steam consumption.**

# EMERGING TECHNOLOGY - MECHANICAL VAPOR RECOMPRESSION (MVR)

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- In MVR, the electrical energy used in compression is converted into increased enthalpy of vapors.
- This vapors can be re-used in heating/boiling in spite of going as waste steam in condensers.
- Small quantity of make-up is also used along with to maintain desired temperature and to compensate condensation loss if any.
- Since this compression is done by a mechanical compressor, the process is called Mechanical Vapor Re-Compression

- **Principle :To** use a compressor machine to compress secondary steam (evaporated vapor), to improve it's enthalpy.
- Based on **Boyle's law** for an ideal gas i.e.

$$PV/T = K$$

(Pressure x Volume / Temperature) = Constant

- This shows that during compression as the volume of gas decreases, the pressure and temperature increases resulting increased enthalpy.

- **Single stage MVR increases the vapor temperature ~ 10degC**
- **Average Power consumption 2.35-2.4 kWh/ton of vapor /$^0$C**



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# MVR USE AT SUGAR PLANT

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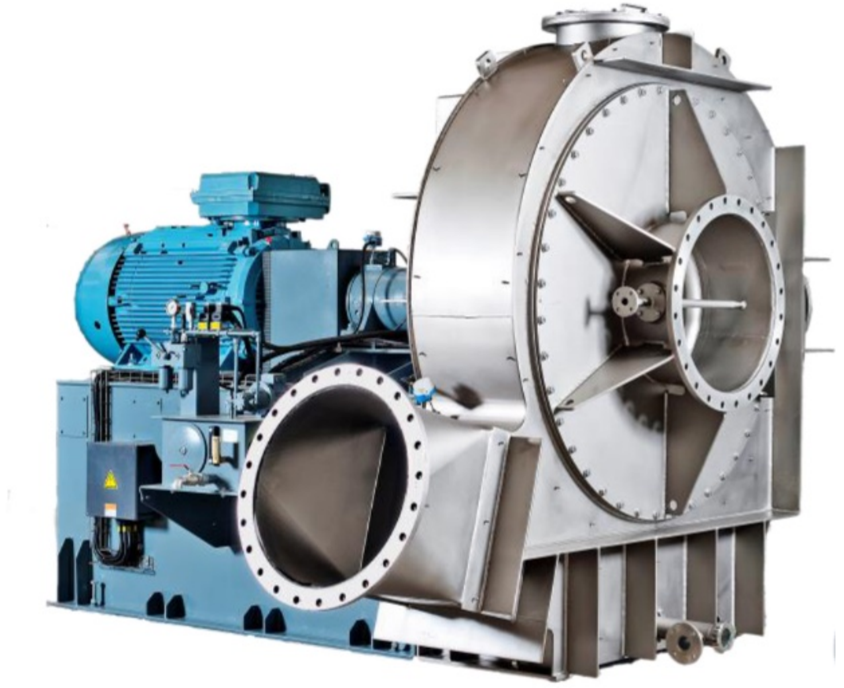
To increase the temperature of evaporator' later effect vapors , So that low pressure vapors can be used for pan boiling and high temp. juice heating.

*Applicable only :*

- *If vapors are in adequate amount at later effect to utilize*
- *Heating surface area at bleeding stage should be sufficient*
- *Single stage MVR is sufficient to raise the temperature*



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# MVR USE AT SUGAR PLANT

To reuse/recycle the outlet vapor of pan, melt concentrator, syrup concentrator in its' own calandria as heating media.

- *Recycling needs minor makeup steam*
- *3-4 stage MVR required for pan boiling (Depending upon the designed temperature in calandria)*
- *Multiple batch pans and horizontal continuous pan can be connected to single MVR system through a common header*
- *Saving on heating surface area of evaporator bodies*
- *For pre-vacuum, small condenser required.*
- *Vapor control to condenser, for vacuum is required.*
- ***Very useful during plant expansion, No need to add boiler for increased vapor demand**.*
- ***Most suitable for standalone refineries where fuel and water is costly, power is subsidized.***

# MVR USE AT SUGAR PLANT

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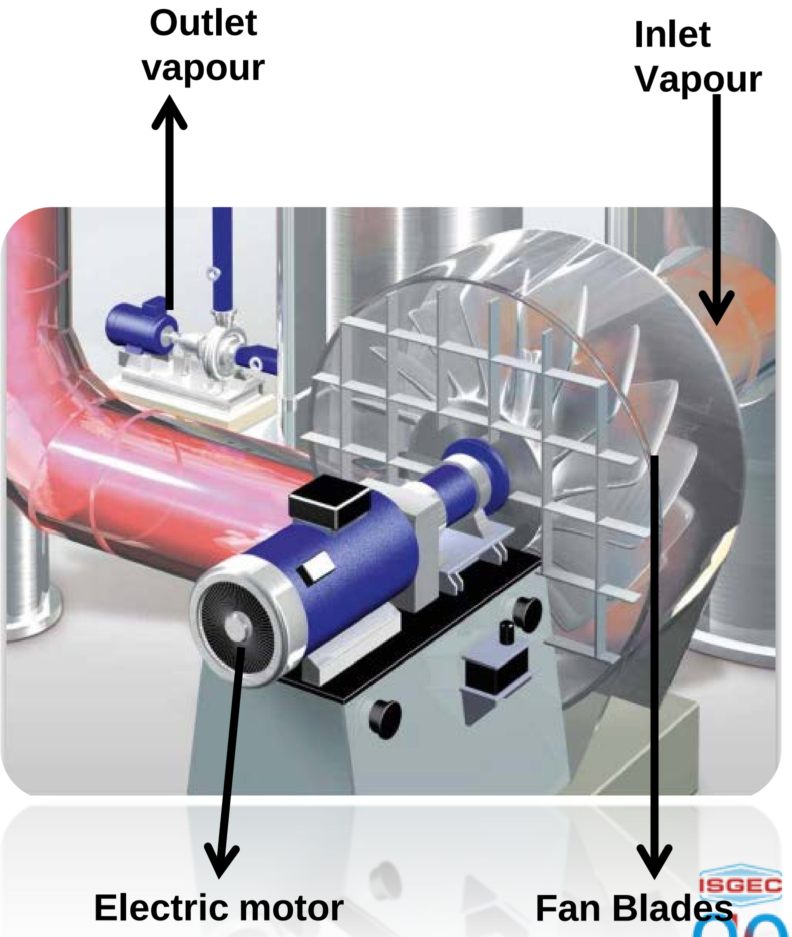
## Water Saving

- *Use of MVR also reduces load on condenser which ultimately reduces load on injection water cooling system and therefore reduces evaporation losses, blowdown losses & drift losses , saves power.*
- ***Since vapor is being recycled so pure condensate obtained which can be utilized for distillery and other utilities.***



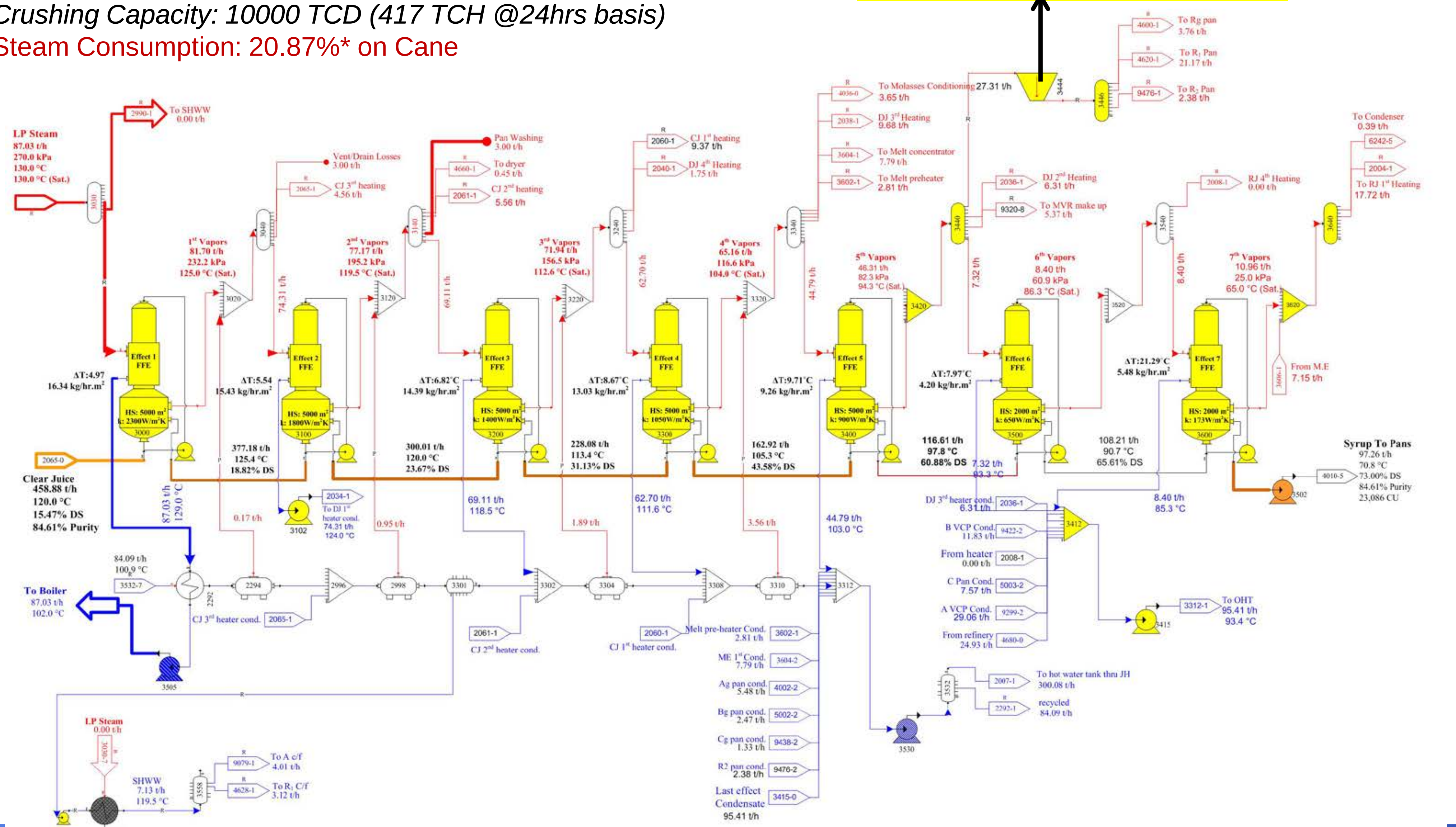
# FUTURISTIC SCHEME FOR EXPANSION OF EXISTING BOILING HOUSE WITH ADDITION OF REFINERY @ 10000 TCD USING MVR

## HMBD WITH 21% STEAM CONSUMPTION

*Designed Crushing Capacity: 10000 TCD (417 TCH @24hrs basis)*

Predicted Steam Consumption: 20.87%* on Cane

**Using MVR to use LP vapors for pan boiling**



# MVR USE AT SUGAR PLANT

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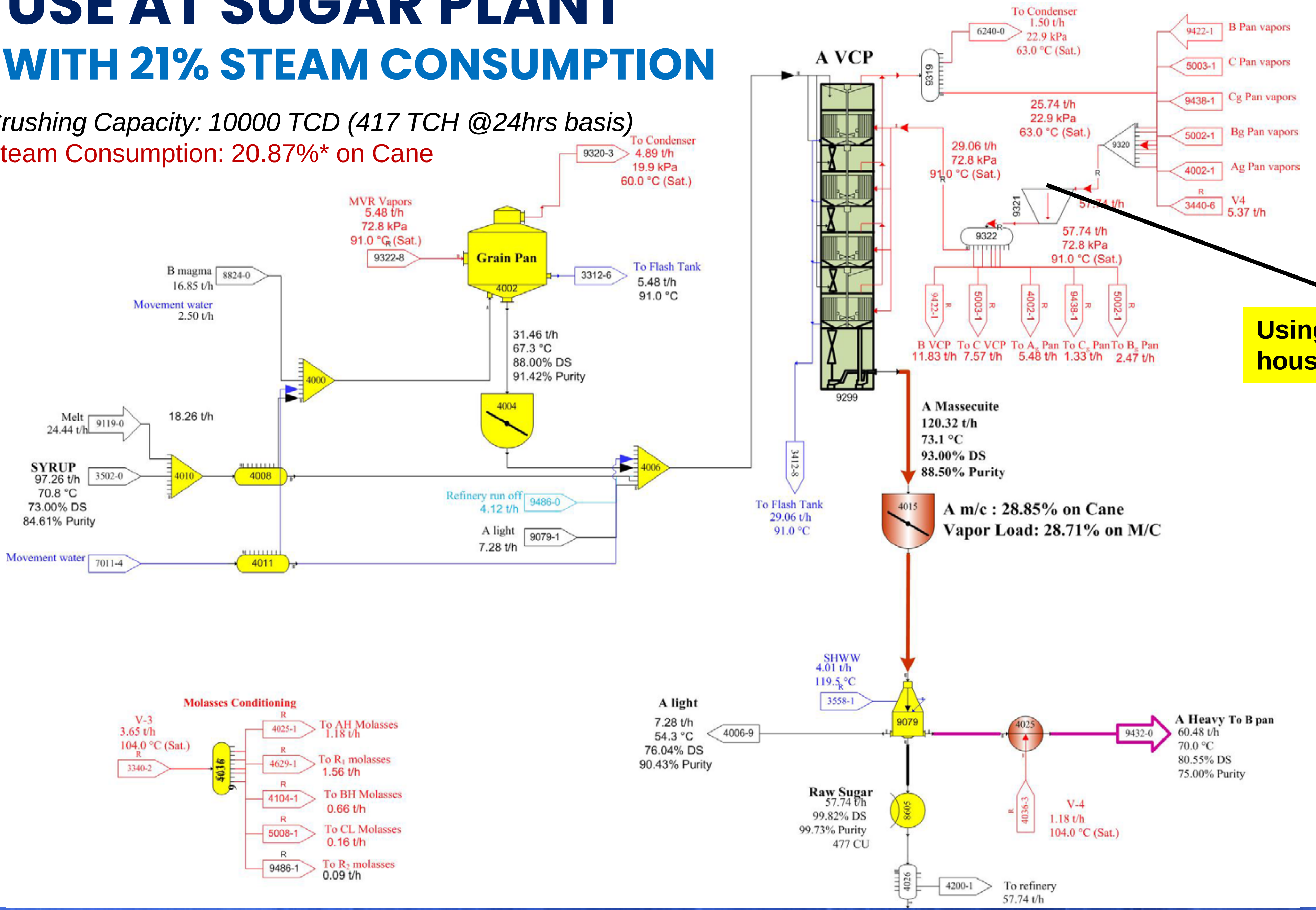


**Using MVR as Raw house VCPs**

# EVAPORTOR VAPOR BLEEDING SCHEME WITH MVR

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| 1st effect | 2nd effect | 3rd effect | 4th effect | 5th effect | 6th effect | 7th effect |
|---|---|---|---|---|---|---|
| CJ3 heating (DCH) | CJ2 heating (DCH)<br>Pan washing<br>Sugar dryer air heater | DJ4 heating (DCH)<br>CJ1 heating (DCH)<br>B sugar Melting | DJ3 heating (DCH)<br>Melt evaporator & preheating<br>Molasses conditioning (DCH) | DJ2 heating (DCH)<br>MVR makeup<br>Refinery pan boiling (through booster MVR) | RJ 4th heating (Tub) | Condenser<br>RJ heating |

***Note: No Vapor is used for Raw house m/c boiling i.e. Raw m/c, B m/c & C m/c boiling. These boiling takes place through MVR vapors**

| Heating | Vapour used | Type of heat exchanger |
|---|---|---|
| Raw juice 1st heating | Excess condensate | Liquid to liquid plate type heater |
| Raw juice 2nd heating | waste vapours | Vapour line type vertical tubular heater |
| Raw juice 3rd heating | Low temp condensate (waste heat) | Liquid to liquid plate type heater |
| SJ 1st heating | High temp condensate (waste heat) | Liquid to liquid tubular type heater |

Source:Bindal Sugar

# MVR USE AT SUGAR PLANT: SAVINGS

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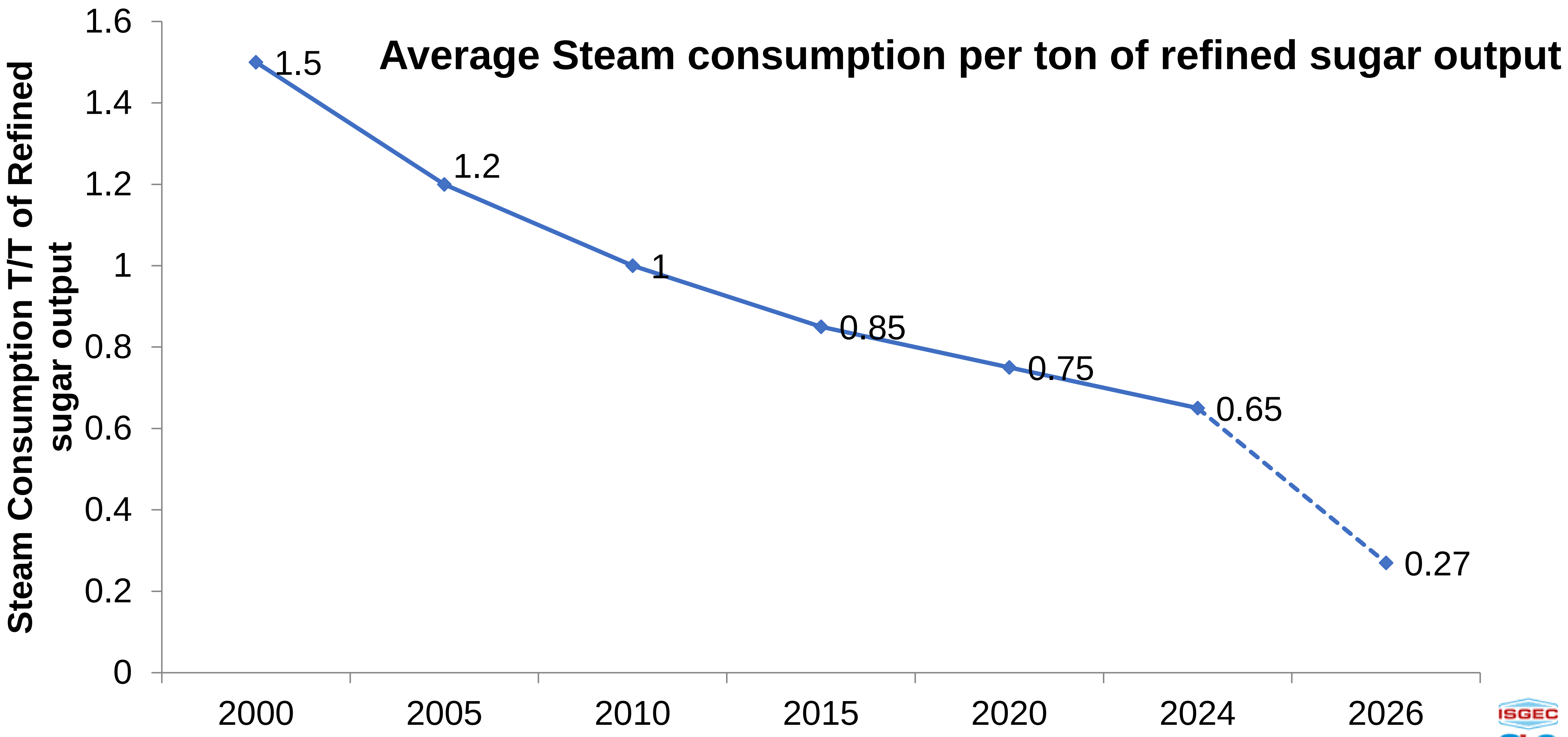
| DESCRIPTION | VALUE | UNIT |
|---|---|---|
| Plant capacity | 10000 | TCD |
| Evaporator configuration | 7 effect | |
| Season days | 150 | |
| Plant Type | Backend Refinery | |
| Steam consumption without MVR ( 4% increase due to addition of refinery) | 30.0% | On cane |
| Steam consumption with MVR | 21.0% | On cane |
| Steam saving | 9.0% | On cane |
| Bagasse saving @ 2.4 steam fuel ratio | 3.75% | % on cane |
| Bagasse saving in season | 56,250 | Tons |
| Profit from bagasse @ 3000Rs./T rate | 16.875 | Crore |
| | | |
| Power consumption of plant @ 30kW/T of cane | 12.5 | MWh |
| MVR Power consumption | 4.6 | mWh |
| Total Power consumption | 17.1 | MWh |
| | | |
| Sugar Plant Steam consumption with MVR | 88 | TPH |
| Steam to HP heater & deaerator | 11 | TPH |
| Total steam generation from boiler | 98 | TPH |
| Power generation | 17.8 | mwh |
| Deficit power | 0.7 | mwh |
| Cost of power @ 3.5Rs./Unit | 0.93 | Crore |
| | | |
| **Net profit** | **15.95** | **Crore** |
| **Capex of MVR** | **24** | **Crore** |
| **Pay back period** | **1.5** | **year** |

# STANDALONE REFINERY

# STEAM CONSUMPTION–GRAPH

## STANDALONE REFINERY



# Features of ISGEC installed 2500TPD standalone refinery

- Port based Standalone Sugar Refinery.
- Refined Sugar output: 2500 TPD of EEC2 grade sugar (<45 IU)
- Yield : > 97.5 % from VHP grade Raw Sugar.
- Clarification Process Adopted : Carbonatation + IER + BRS.
- Colour reduction : > 55% in Carbonatation & > 75% in IER
- Brine recovery : >98 % through NF, RO & Electro Dialysis
- Automated vacuum pan boiling with pan microscope.
- Online Sugar crystal colour & moisture monitoring
- **<65% RSO steam consumption**

# STATE OF ART ATTRIBUTES OF PLANT

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Fully automated sugar refinery.

Automatic bagging of sugar.

Minimal effluent disposal.

Minimal chemical consumption

Energy efficient plant.

Reduced solid waste disposal.

Optimum sea water requirement.

Optimum process water requirement.

# VAPOUR BLEEDING SCHEME

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| Vapor | Pressure in Kpa/Temp. in ⁰C | Vapor |
|---|---|---|
| ST vapor | 219.9 kPa<br>123.2 oC | • RO recovered water heater<br>• Sweet water heater<br>• R1, R2, R3 & C pans<br>• Melt evaporator-FFE<br>• SHWW heater<br>• Dryer air heater<br>• Melt preheater-2<br>• Pan washing |
| V1 | 161.2 kPa<br>113.5 ⁰C | B Pan<br>Retentate evaporators<br>Melt Pre heater-1 |
| V2 | 114.5 kPa<br>103.4 ⁰C | A Pan<br>Screened Raw melt heater<br>Before and After Carbonated melt heaters<br>IER Pre heater |
| V3 | 70.2 kPa<br>90.0 ⁰C | • IER water heater<br>• Process water heater<br>• Fine liquor heater (FFE)<br>• Raw Liquor heater<br>• A melt recirculation heater<br>• R1,R2,R3, A and B molasses conditioners<br>• Melting water heater |

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# STEAM AND POWER CONSUMPTION DURING OPERATION



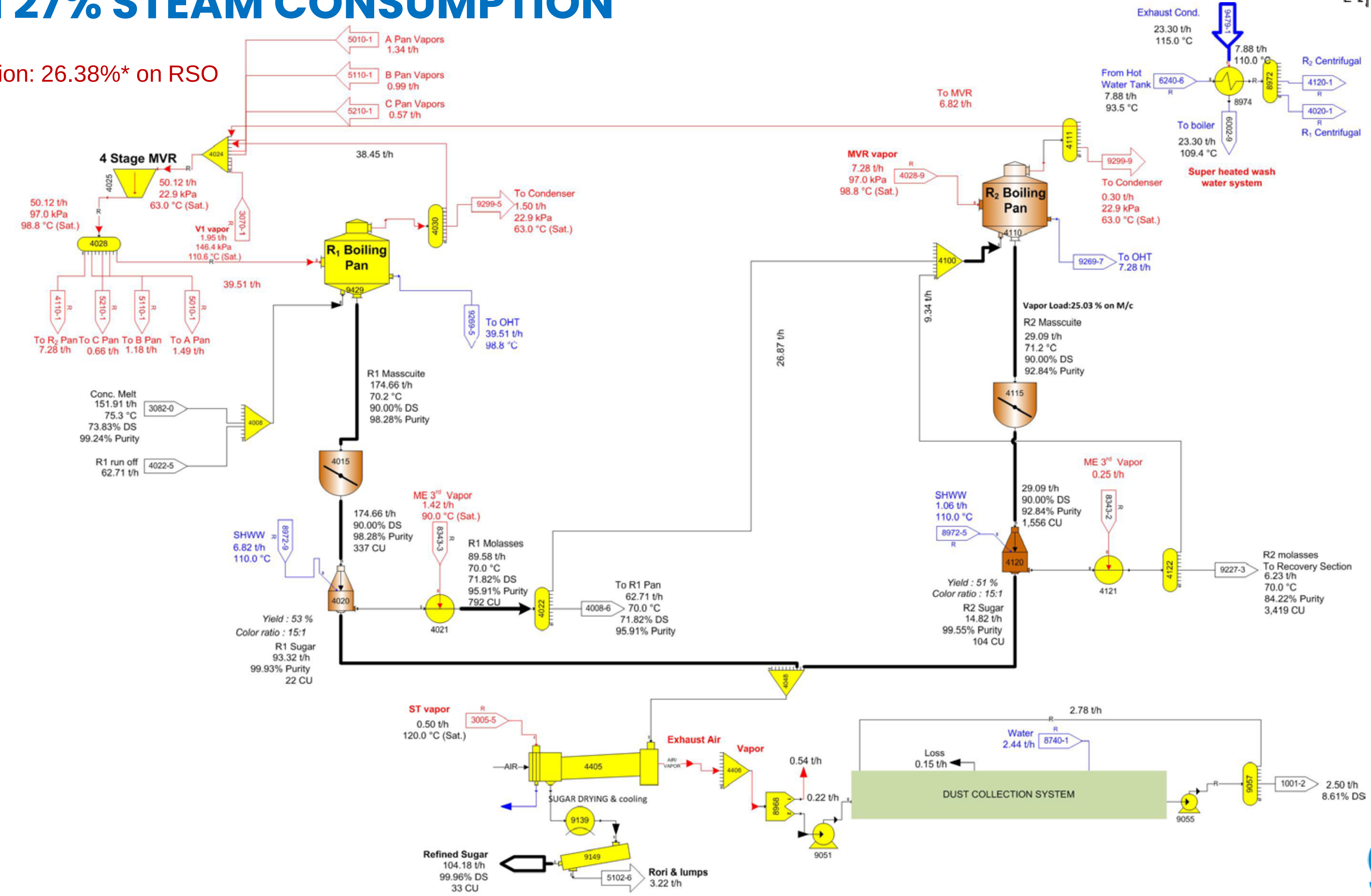
| Date | Raw sugar t/d | Refined sugar t/d | Steam t/d | Power kW/t RSO | Steam kg/kg RSO |
|---|---|---|---|---|---|
| 01-11-2021 | 2478 | 2357 | 1551 | 68 | 0.658 |
| 02-11-2021 | 2232 | 2186 | 1576 | 73 | 0.721 |
| 03-11-2021 | 2616 | 2514 | 1595 | 68 | 0.634 |
| 04-11-2021 | 2361 | 2293 | 1435 | 73 | 0.626 |
| 05-11-2021 | 2408 | 2372 | 1471 | 67 | 0.620 |
| 06-11-2021 | 2681 | 2626 | 1567 | 68 | 0.597 |
| 07-11-2021 | 2480 | 2298 | 1515 | 73 | 0.659 |
| 08-11-2021 | 2326 | 2193 | 1504 | 74 | 0.686 |
| 09-11-2021 | 2161 | 2419 | 1490 | 67 | 0.616 |
| 10-11-2021 | 2299 | 2189 | 1576 | 73 | 0.720 |
| Average | 2404 | 2345 | 1528 | 70 | 0.654 |

# FUTURISTIC APPROACH OF MVR APPLICATION IN STANDALONE REFINERY

## HMBD WITH 27% STEAM CONSUMPTION

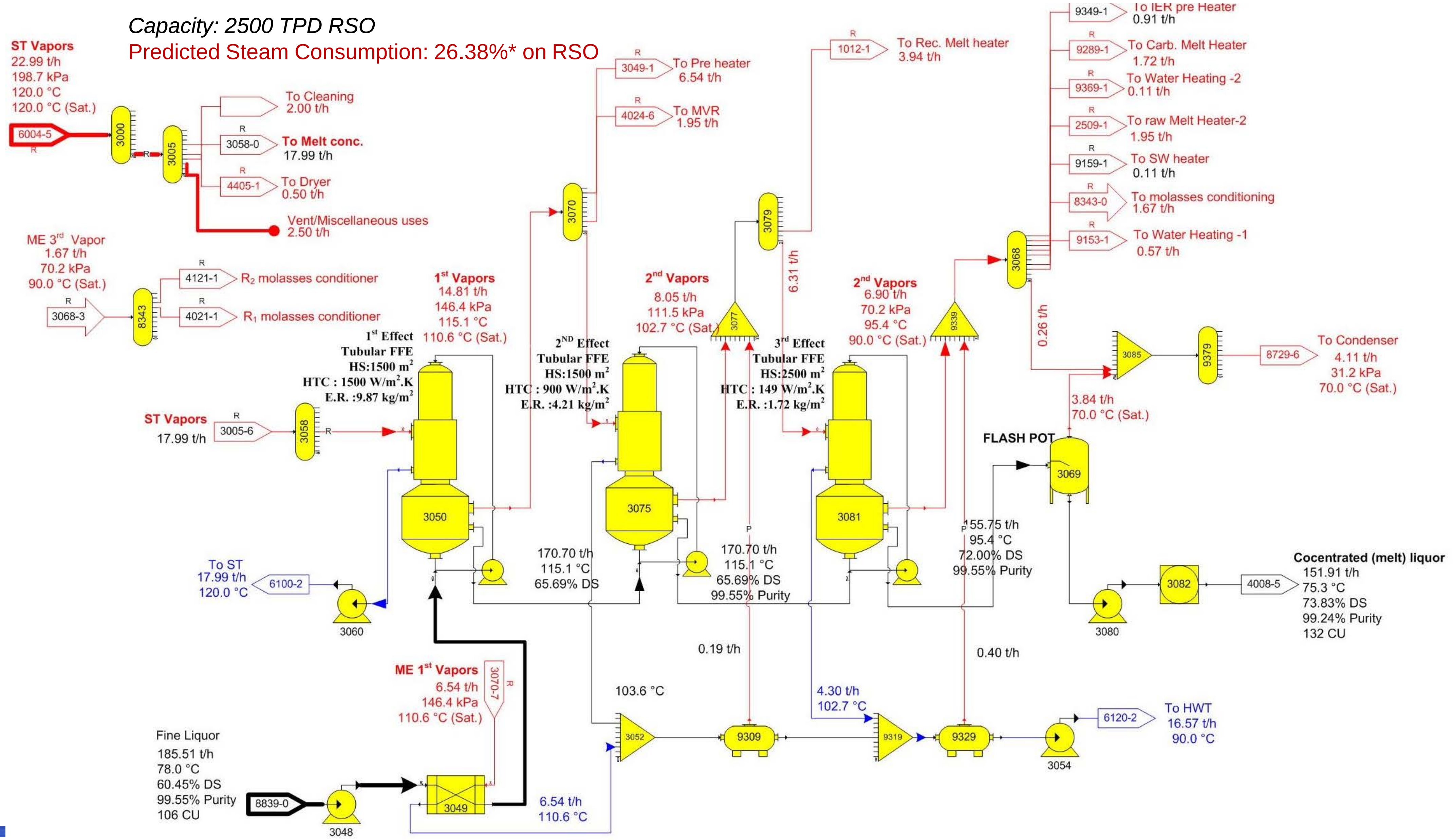
*Capacity: 2500 TPD RSO*

Predicted Steam Consumption: 26.38%* on RSO



# FUTURISTIC APPROACH OF MVR APPLICATION IN STANDALONE REFINERY

## HMBD WITH 27% STEAM CONSUMPTION



# VAPOUR BLEEDING SCHEME WITH MVR ON PANS

ISGEC
ISGEC HEAVY ENGINEERING LTD.

| Vapor | Pressure in Kpa/Temp. in ºC | Vapor |
|---|---|---|
| ST vapor | 198.7 kPa<br>120 ºC | • Melt evaporator-FFE<br>• Dryer air heater<br>• Pan washing |
| V1 | 146 kPa<br>110.6 ºC | MVR makeup<br>Melt Pre heater-1 |
| V2 | 111.5 kPa<br>102.7 ºC | Recirculation melt heater |
| V3 | 70.2 kPa<br>90.0 ºC | • IER pre heater<br>• Carbonated lqiuor heater<br>• Process water heater<br>• Sweet water heater<br>• Raw Liquor heater<br>• R1,R2,R3, A and B molasses conditioners<br>• Melting water heater |

90 years & ing Strong
Estb. 1933

# STANDALONE REFINERY WITH MVR ON PANS: SAVINGS

ISGEC
Isgec Heavy Engineering Ltd.

- *In standalone refineries where fuel is costly, power is subsidized ; MVR is a good option to adopt to bring down steam consumption from 0.65 to 0.27 Tons per ton of RSO.*

**Savings with MVR in standalone Refinery**

| Particulars | Unit | MVR on Refinery and recovery batch pans | No MVR |
|---|---|---|---|
| Total Plant Capacity | TPD | 2500 | 2500 |
| Total Plant Capacity | TPH | 104.17 | 104.17 |
| Steam Consumption (on boiler generation) | % on RSO | 27 | 65 |
| Steam Consumption | TPH | 28.13 | 67.71 |
| Power generation | MWH | 5.11 | 12.31 |
| Boiler Power consumption | Mwh | 0.7 | 1.1 |
| New refinery Process house consumption@40kW/T of RSO | MWH | 4.2 | 4.2 |
| MVR consumption | MWH | 4.5 | 0 |
| Total consumption | MWH | 9.4 | 5.3 |
| Coal consumption@4.5 S/F ratio | TPH | 6.3 | 15.0 |
| Coal cost per year @ 7000Rs./ton of coal | Lakhs | 3465 | 8341.7 |
| Power generation | MWH | 5.1 | 5.3 |
| Deficit power to be purchased | MWH | 4.3 | - |
| Power rate | INR/unit | 3.0 | - |
| Power cost per hour | Lakhs | 0.1 | - |
| Per year Power cost | Lakhs | 1010.5 | - |
| **Total cost (Power +Coal)** | **Lakhs** | **4475.5** | **8341.7** |
| **Difference/Saving** | **Lakhs/Season** | **3866** | |

# ETHANOL PLANT

# STEAM SAVING IN DISTILLERY OPERATION

ISGEC
ISGEC HEAVY ENGINEERING LTD.

## RECTIFIER VAPOUR BASED DEHYDRATION

- The total steam consumption for wash to ethanol is 2.25 kg/lit of alcohol for Syrup as feedstock.
- With Integration of various vapors it can be reduced to 1.75 kg/lit of alcohol with following integrations:

1. Through vapour integration from various source available in the Distillery process plant by doing MSDH section vapour utilizing in the Analyser column re boiler.

2. Rectifier column in liquid phase & fed to recovery column for vaporisation & alcohol vapours further superheated in Super Heater before feeding to Molecular sieve beds.

Advantages:

- In this system Recovery Column & Recovery Column Reboiler is not required.
- Rectified spirit can be also drawn from Rectifier Column as per requirement.
- Lower CAPEX - No recovery column & its reboiler accessories
- 35 – 40% reduction in steam consumption of dehydration system (around 0.25 kg/L)
- Rectified spirit can be drawn as a product as and when desired
- Flexibility of standalone operation of dehydration system using rectifier column

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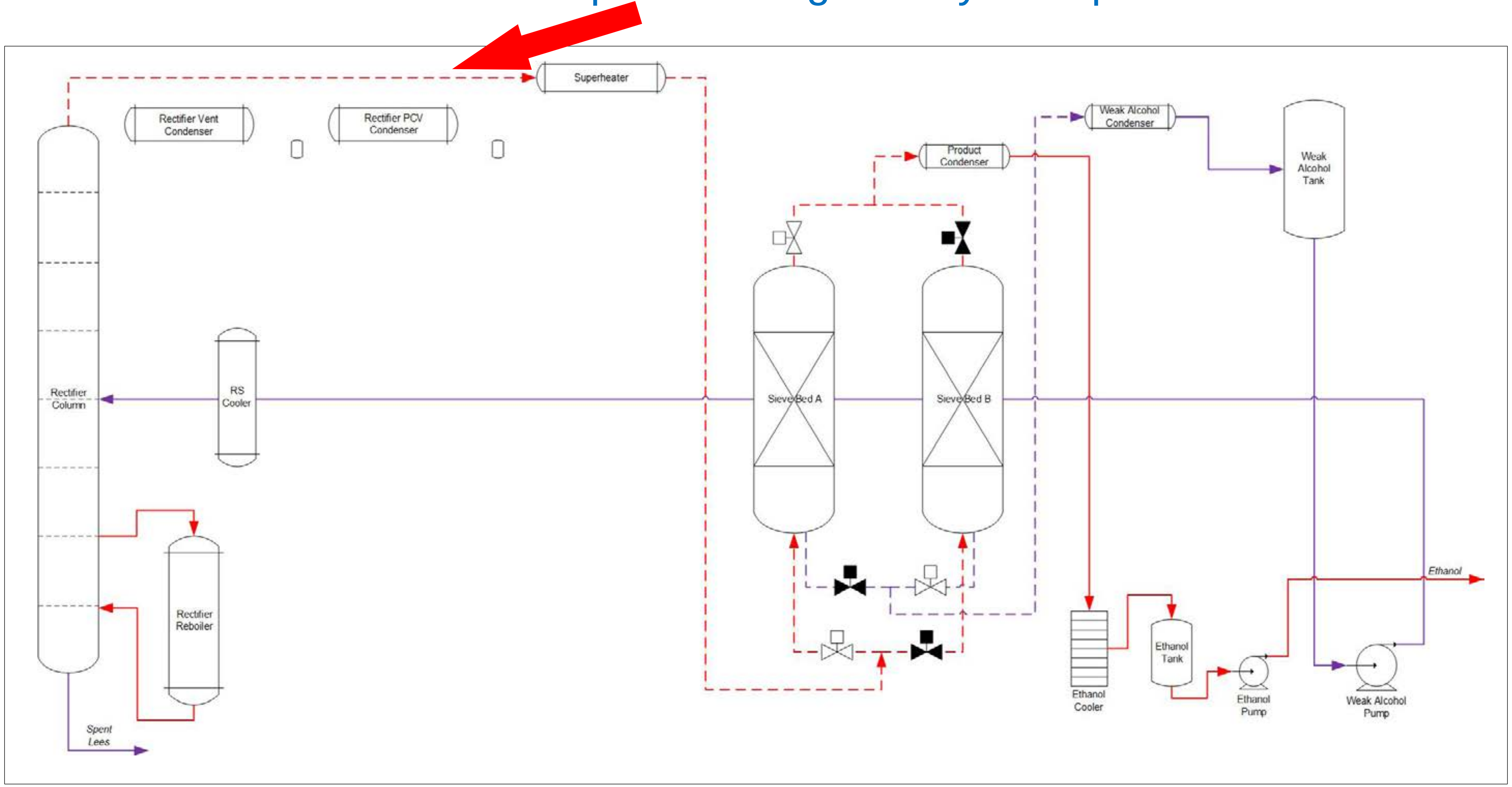
# STEAM SAVING IN DISTILLERY OPERATION

## RECTIFIER VAPOUR BASED DEHYDRATION

Rectifier column vapour feeding directly to Super heater



# STEAM SAVING IN DISTILLERY OPERATION

## RECTIFIER VAPOUR BASED DEHYDRATION

| Particulars | Conventional Process | With integration | Unit |
|---|---|---|---|
| Plant Capacity | 300 | 300 | KLPD |
| Steam consumption | 2.25 | 1.75 | Kg/lit of alcohol |
| | 28.125 | 21.875 | TPH |
| Saving in steam consumption | | 6.25 | TPH |
| | | 150 | TPD |
| Steam Fuel Ratio | 2.2 | 2.2 | |
| Bagasse Saving | | 68 | TPD |
| | | **20400** | **T/Season (@300 days )** |
| **Revenue from bagasse saving @ 3000 / - per ton of bagasse** | | **612** | **Lakhs** |

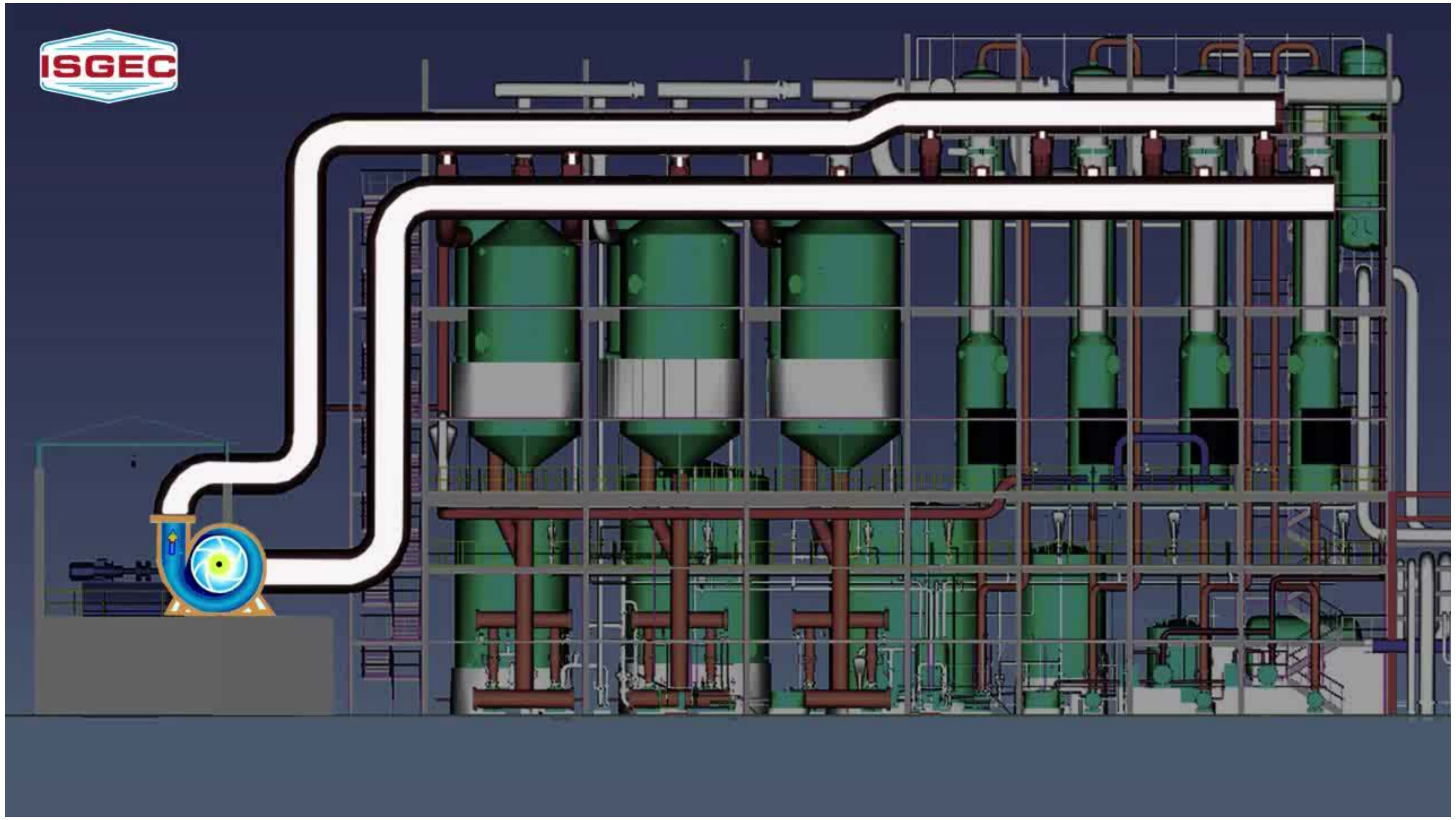
# MVR USE AT DISTILLERY

## AT SPENTWASH EVAPORATOR

ISGEC
ISGEC HEAVY ENGINEERING LTD.

- All evaporators will get steam from a common header, delivers generated vapor to another common header which is connected to MVR suction and after compression, increased enthalpy vapor will be given to feed steam header.

- It also requires make-up steam equivalent to 5-6% of total evaporation, to maintain the desired temperature and also to compensate condensation loss, if any.
- Reduces steam & water consumption therefore reducing boiler and cooling tower capacity



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# MVR USE AT DISTILLERY

## AT SPENTWASH EVAPORATOR

MVR Installation  at Swaraj Agro

# MVR USE AT DISTILLERY: SAVINGS

## AT SYRUP BASED DISTILLERY PLANT

ISGEC
ISGEC HEAVY ENGINEERING LTD.

| S. No | Description | UOM | Value |
|---|---|---|---|
| 1 | Plant capacity - Distillery | KLPD | 300 |
| 2 | Steam consumption for conventional evaporator process @ 1.10 kg/lit in case of syrup | TPH | 13.75 |
| 3 | Steam consumption with MVR (Only for make up) | TPH | 2.0 |
| 4 | Net Steam saving (S.No:2 – 3) | TPH | 11.75 |
| 5 | Net Steam saving per day | TPD | 282 |
| 8 | Net bagasse saving | TPD | 128 |
| 9 | Extra revenue generation @ 3000 / - per ton of bagasse @ 300 days (Season) | Lakhs | 1152 |
| 10 | Increasing power (1000 kW) consumption for MVR @ 3.50 / - per kW @ 300 days (Season) | Lakhs | (-) 252 |
| 11 | Overall saving | Lakhs | 900 |
| 12 | Cost of MVR | Lakhs | 700 |
| 13 | Return of investment | Year | < 1.0 |

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# MVR USE AT DISTILLERY: SAVINGS

## AT GRAIN BASED DISTILLERY

ISGEC
ISGEC HEAVY ENGINEERING LTD.

| S. No | Description | UOM | Value |
|---|---|---|---|
| 1 | Plant capacity - Distillery | KLPD | 300 |
| 2 | Steam consumption for conventional Grain based Distillery Plant @ 3.75 kg/lit in case of Maize | TPH | 46.785 |
| 3 | Steam consumption for MVR Grain based Distillery Plant @ 2.90 kg/lit in case of Maize | TPH | 36.250 |
| 4 | Net Steam saving (S.No:2 – 3) | TPH | 10.535 |
| 5 | Net Steam saving per day | TPD | 253 |
| 8 | Net bagasse saving | TPD | 115 |
| 9 | Extra revenue generation @ 3000 / - per ton of bagasse @ 300 days (Season) | Lakhs | 1035 |
| 10 | Increasing power (1800 kW) consumption for MVR @ 3.50 / - per kW @ 300 days (Season) | Lakhs | (-) 453 |
| 11 | Overall saving | Lakhs | 582 |
| 12 | Cost of MVR | Lakhs | 700 |
| 13 | Return of investment | Year | < 1.2 |

# MVR USE AT DISTILLERY – GRAIN AS FEED STOCK

## AT vapour integrated in Distillation Section and Evaporation using multistage MVR

| Particulars | Conventional Process | With integration / With MVR | Unit |
|---|---|---|---|
| Plant Capacity | 300 | 300 | KLPD |
| Steam consumption | 3.75 | 2.90 | Kg/lit of alcohol |
| | 46.785 | 36.250 | TPH |
| Saving in steam consumption | | 10.535 | TPH |
| | | 253 | TPD |
| Steam Fuel Ratio | 2.2 | 2.2 | |
| Bagasse Saving | | 115 | TPD |
| | | **34500** | **T/Season (@300 days )** |
| **Revenue from bagasse saving @ 3000 / - per ton of bagasse** | | **1035** | **Lakhs** |

# STEAM SAVING IN DISTILLERY OPERATION

## STEAM CONSUMPTION OF MODERN PLANT

| PARAMETER | FEEDSTOCK | CONVNETIONAL PLANT VALUE(IN KG/LITRE OF ALCOHOL) | MODERN PLANT VALUE(IN KG/LITRE OF ALCOHOL) | MODERN PLANT WITH SYRUP PLANT VAPOUR INTERGRATION AND MVR |
|---|---|---|---|---|
| Total Steam consumption (RS Distillation + Dehydration + Spent wash evaporation up to 60% w/w) | Final Molasses | 5.0 – 5.20 | 3.7 | **2.1** |
| | B-heavy Molasses (10 – 20 % spent wash recycle) | 4.30 – 4.50 | 2.8 | **1.1** |
| | Cane Syrup (60˚Bx) (30% - 50 %spent wash recycle) | 4.0 | 2.3 | **1.0** |
| Total steam consumption in Grain based Distillery plant (RS Liquefaction + Distillation + Dehydration + DDGS Dryer and Evaporator up to 30 – 35 % w/w ) | Grain (Maize) | 5.0 – 6.0 | 3.75 | **2.9** |

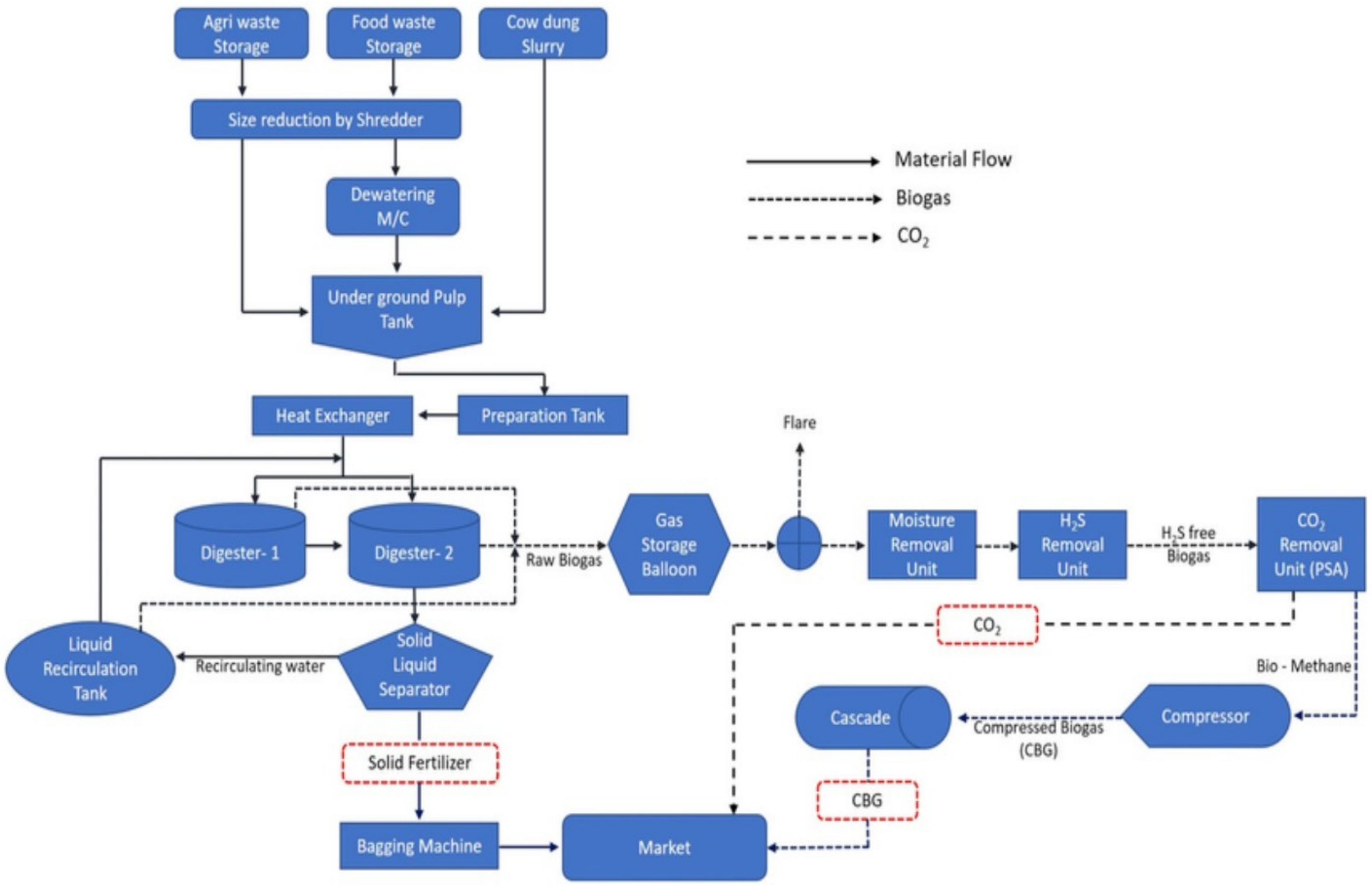
# BIOGAS

**Biogas** is a mixture of methane, $CO_2$ and small quantities of other gases produced by anaerobic digestion of organic matter in an oxygen-free environment. The precise composition of biogas depends on the type of feedstock and the production pathway

| Composition | Biogas | Bio-CNG/CBG |
|---|---|---|
| Methane | 55-65% | >90% |
| Carbon Dioxide | 30-40% | <4% |
| Hydrogen Sulfide | 0.1-4% | <16 ppm |
| Nitrogen | 3% | <0.5% |
| Oxygen | 0.1-2% | <0.5% |
| Moisture | 1-2% | 0% |
| Calorific Value | 19.5 MJ/kg | 47-52 MJ/kg |

| Fuel | Equivalent quantity to 1 m3 of biogas |
|---|---|
| Kerosene | 0.62 lit. |
| Firewood | 3.50 kg |
| Cattle dung cake | 12.3 kg |
| Charcoal | 1.46 kg |
| Furnace oil | 0.40 lit. |
| Electricity | 1.25 kW |
| LPG | 0.43 kg |
| Diesel | 0.52 lit. |
| Coal | 1.6 kg |

# BIOGAS




Process flow diagram of compress biogas (CBG) plant

## Main Technologies

**Bio-digesters**: These are airtight systems (e.g. containers or tanks) in which organic material, diluted in water, is broken down by naturally occurring micro-organisms. Contaminants and moisture are usually removed prior to use of the biogas.

**Landfill gas recovery systems**: The decomposition of municipal solid waste (MSW) under anaerobic conditions at landfill sites produces biogas. This can be captured using pipes and extraction wells along with compressors to induce flow to a central collection point.

**Wastewater treatment plants:** These plants can be equipped to recover organic matter, solids, and nutrients such as nitrogen and phosphorus from sewage sludge. With further treatment, the sewage sludge can be used as an input to produce biogas in an anaerobic digester.

## Key Market Drivers

- Production of "Syngas / Bio-CNG (CBG)" for Oil Marketing Companies (OMC)
- Market Price: Rs 71.60/kg, with a subsidy of Rs 4Cr per 4,800 kg of CBG per day generated from 12,000 m3 of biogas / day.
- By-product: Organic Manure – Solid & Liquid, Briquettes
- Government is providing Central financial assistance.

# BIOGAS:BYPRODUCTS

ISGEC
ISGEC HEAVY ENGINEERING LTD.

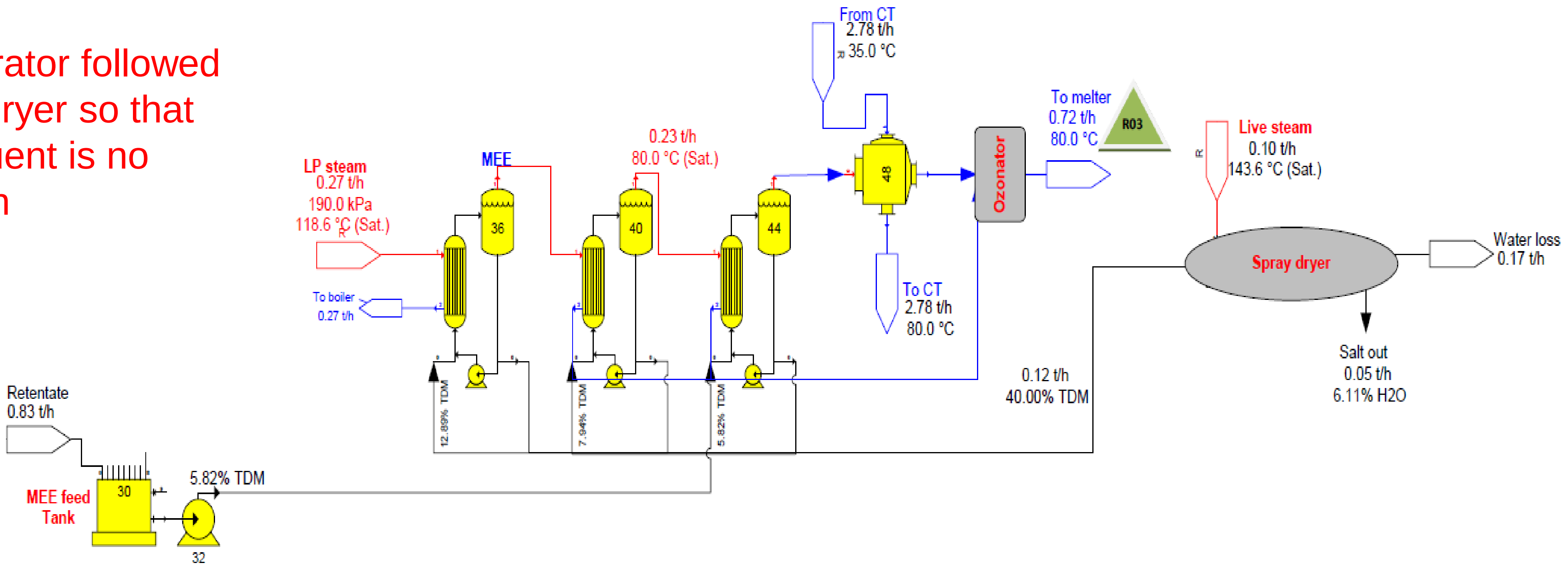
## SOLID EFFLUENT

**Digestate** is **a nutrient-rich substance** ,used as a fertilizer which **improves the soil fertility, soil structure and yields of crops.**

| No | Parameter | Amount |
|---|---|---|
| 1 | Total nitrogen (%) | 1.40–1.84 |
| 2 | Total phosphorus (%) | 1.10–1.72 |
| 3 | Total potash (%) | 0.84–1.34 |
| 4 | Organic carbon (%) | 35.0–38.4 |
| 5 | Zinc (mg/kg) | 103–116 |
| 6 | Copper (mg/kg) | 51–68 |
| 7 | Manganese (mg/kg) | 231–295 |

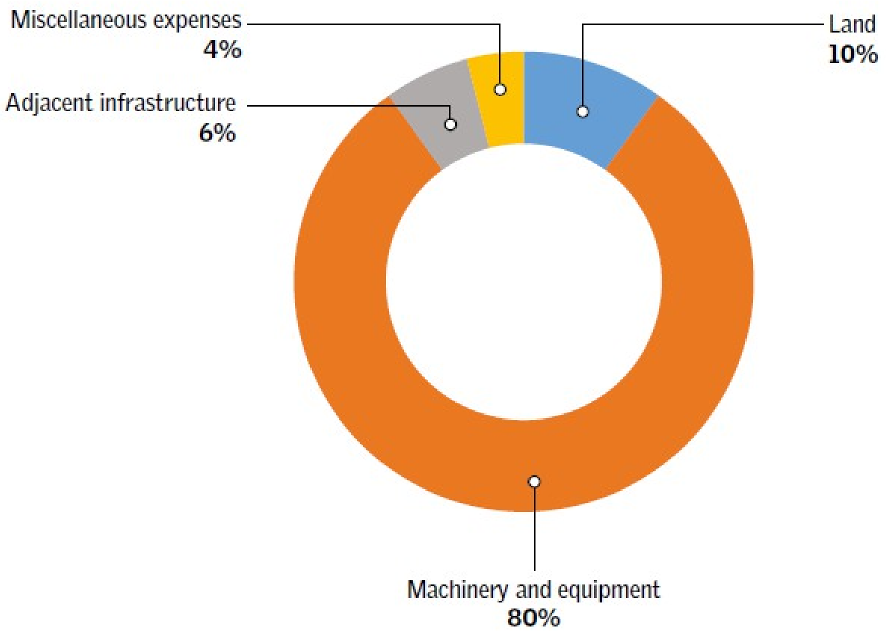
## LIQUID EFFLUENT TREATMENT

Multiple effect evaporator followed by agitated thin film dryer so that problem of liquid effluent is no more point of concern

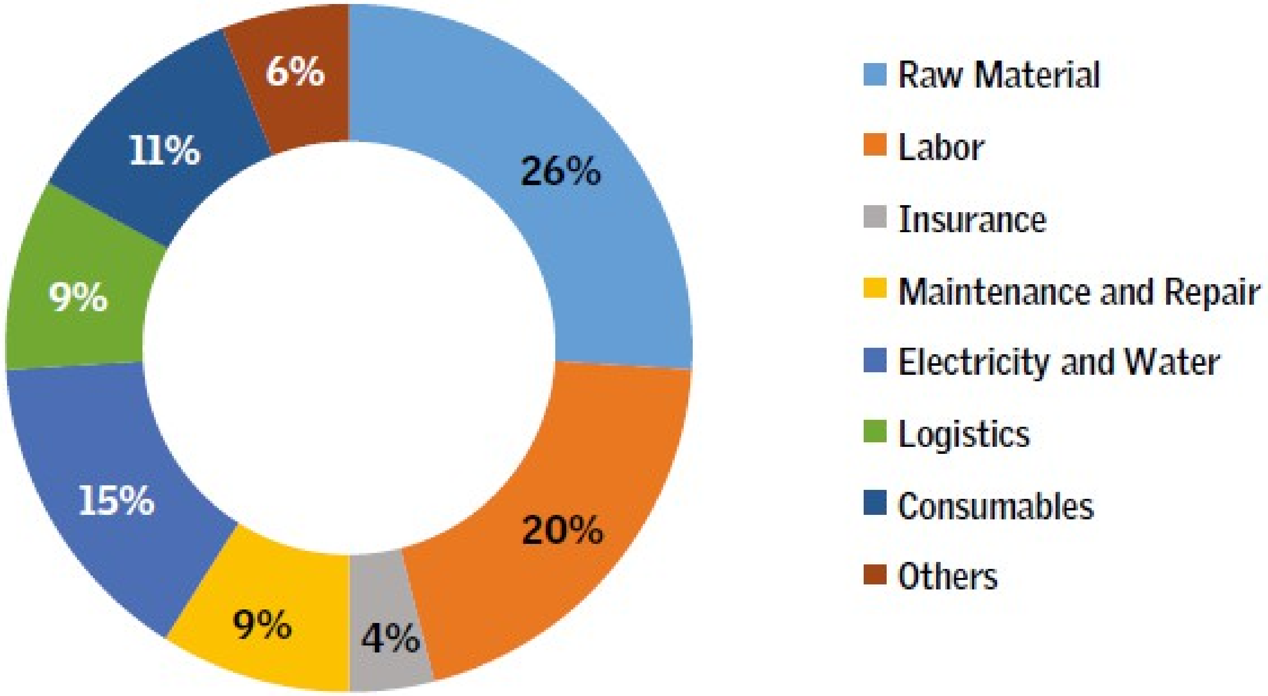


# BIOGAS PLANT SETUP

## CAPEX




## OPEX




| Fuel | Calorific value in KJ/Kg | Rate |
|---|---|---|
| Bio-CNG | 52000 | 76.59/- |
| Petrol | 48000 | 94.72/- |
| Diesel | 44000 | 87.62/- |
| LPG | 49789 | 57.7/- |

*As on dated 25.7.2024 in Delhi*

# BIOGAS

## SUGAR PLANT POTENTIAL

| Description | Value | Unit |
|---|---|---|
| Cane crushed (2023-24) | 3129.8 | Lakh T |
| Filter cake production | 3.5 | % on cane |
| | 109.5 | Lakh T |
| 100T press mud produces | 3.25 | T CBG |
| | 2806.6 | m3 CBG |
| Sugar plant potential to generate biogas | 30,74,34,424 | m3 biogas |
| 1 m3 CBG | 1.08 | litre of petrol |
| So saving on petrol | 332 | Mn litres |
| **So saving on crude oil** | **704** | **Mn litre crude oil** |

# BIOGAS

ISGEC
ISGEC HEAVY ENGINEERING LTD.

- Isgec has signed a technical partnership with **GPS renewables** to provide end to end solution for CBG plants on EPC basis

- Feedstocks
    - Press Mud Cake
    - Distillery Spent wash
    - Biomass like cane trash
    - Napier Grass

- GPS renewables has vast technical expertise in CBG vertical with 6 executed projects and around 15 projects under execution

- India has huge potential in CBG with almost 535 sugar plants.

- There are many GOI initiatives like Sustainable Alternative Towards Affordable Transportation (**SATAT**) Scheme, MNRE: **Waste to Energy** Scheme, **GOBAR** (Galvanizing Organic Bio-Agro Resources) **DHAN** Scheme, Agro Infrastructure Fund (**AIF**), State Specific Incentives, **Carbon Credits,** Corporate Social Responsibility (**CSR**) Funds, **Priority Sector Lending**

# BIOGAS PLANT INSTALLED

## 20 TPD CBG plant in Barabanki,UP

**Feedstock used:**

- ✓ Press Mud Cake
- ✓ Paddy Straw
- ✓ Cane Trash
- ✓ Cow Dung

# BIOGAS PLANT INSTALLED

## 20 TPD CBG plant in Indore, MP

**Feedstock used:**
- ✓ Municipal Waste

# CONCLUSION

ISGEC HEAVY ENGINEERING LTD.

- Adoption of efficient and modern technologies helps to reduce cost of production, research & development is a continuous process so we should always be ready to think out of the box.
- Future is of green energy so it is time to take step towards utilization of renewable resources.
- Diversification towards the different products is very important to increase revenues.
- Decarbonization technology and applications are necessary for sustainability and growth of sugar industry.

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# THANK YOU
# FOR YOUR ATTENTION