A NEW SUGAR COMPLEX DESIGNED TO PROVIDE MAXIMUM RAW MATERIAL TO A PAPER INDUSTRY

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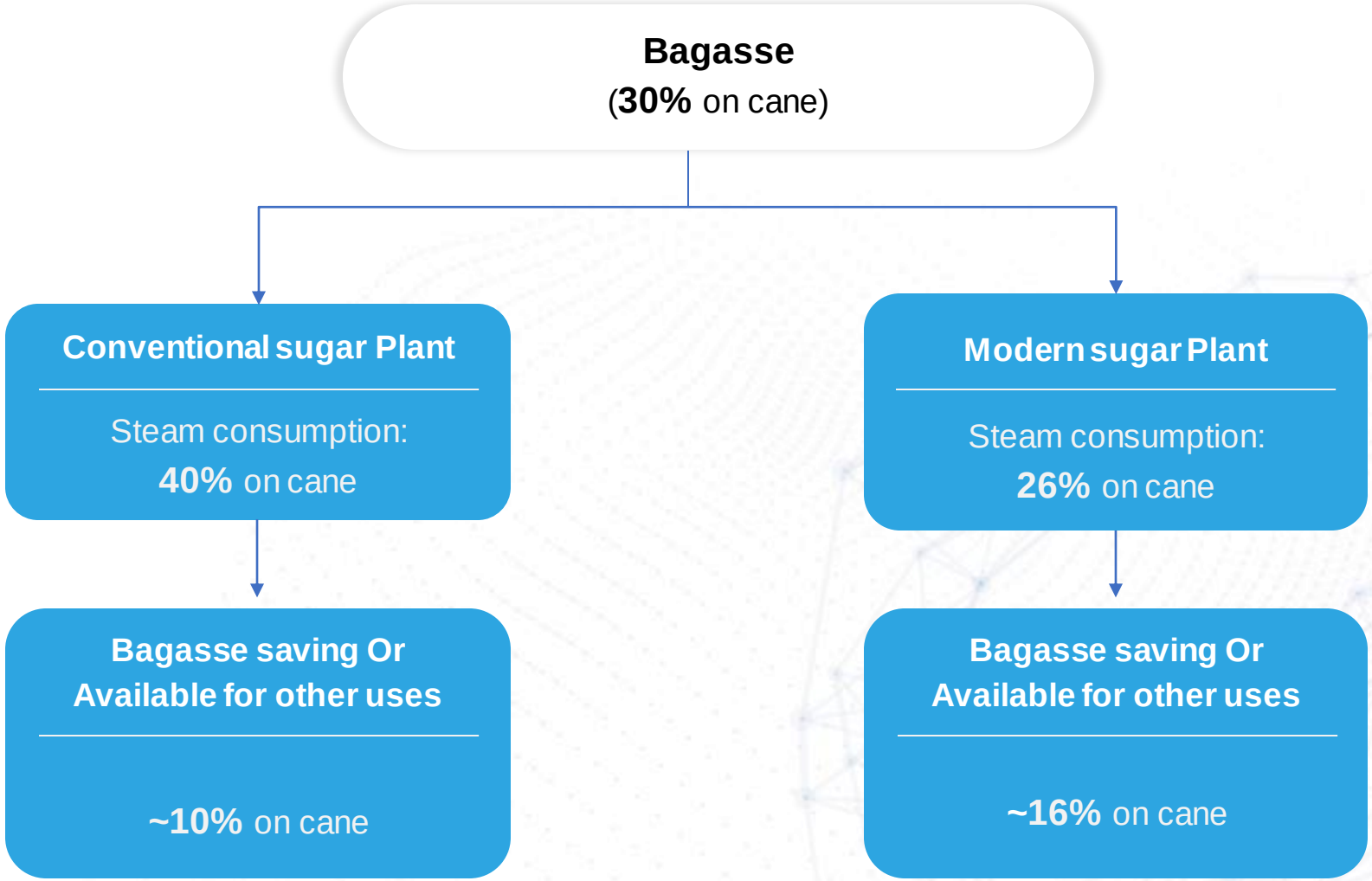
BAGASSE " AN ASSET of SUGAR MILLS

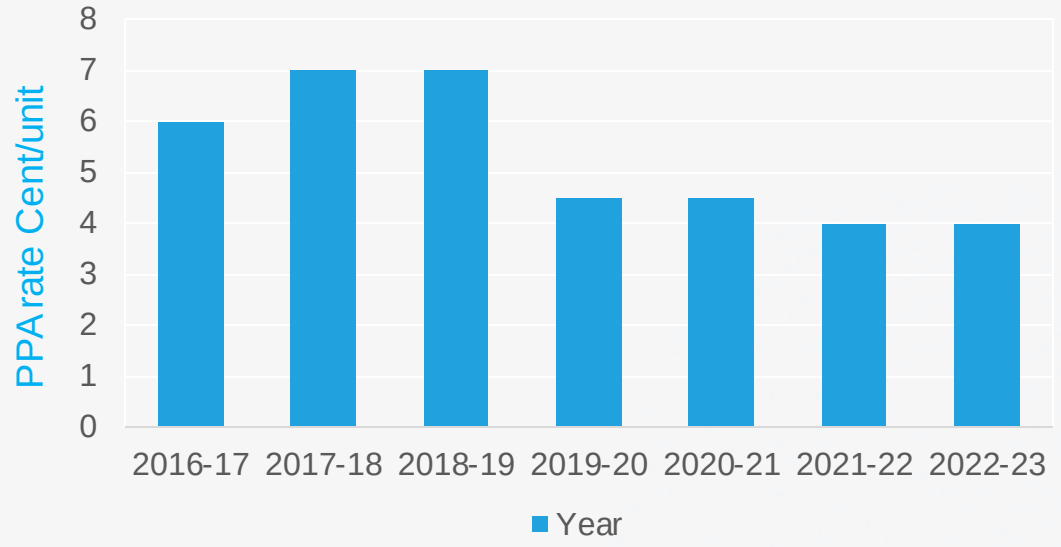
- The increase in global energy demand and environmental concerns is calling for a shift towards using renewable energy sources.
- Bagasse is one of the most promising biomass sources for renewable energy.
- It's use in paper industry, furniture industry and electricity generation keeps bagasse always in demand.
- Chemical, apparel, plastic, tableware, and the ethanol industry are the other new areas that are paying attention to bagasse.
- Bagasse demand is increased drastically due to throughout year consumption.
- On contrary, bagasse production is limited to 180 days per annum.
- This encourages saving of steam in sugar plants.
- To balance this production and consumption, We need to adopt/implement better schemes , better technologies for bagasse saving.

Isgec Heavy Engineering Limited is developing a new sugar complex to achieve a steam consumption of 26% on cane to maximise the saving of bagasse for use in a paper plant so reducing the dependence on other biomass for paper manufacturing.

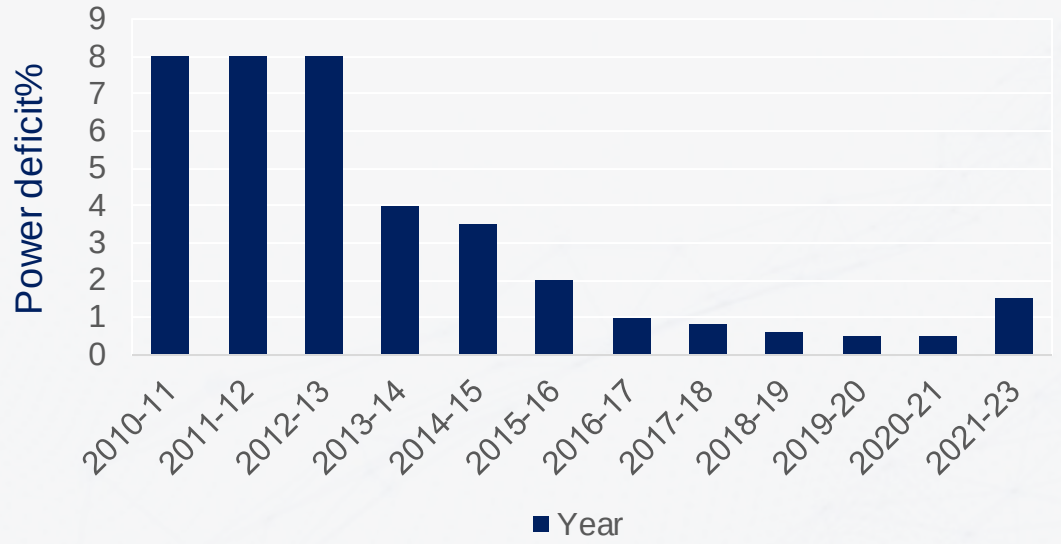
BAGASSE AVAILABILITY



FACTORS AFFECTING BAGASSE PRICE



Average power purchase value in Uttar Pradesh (India).

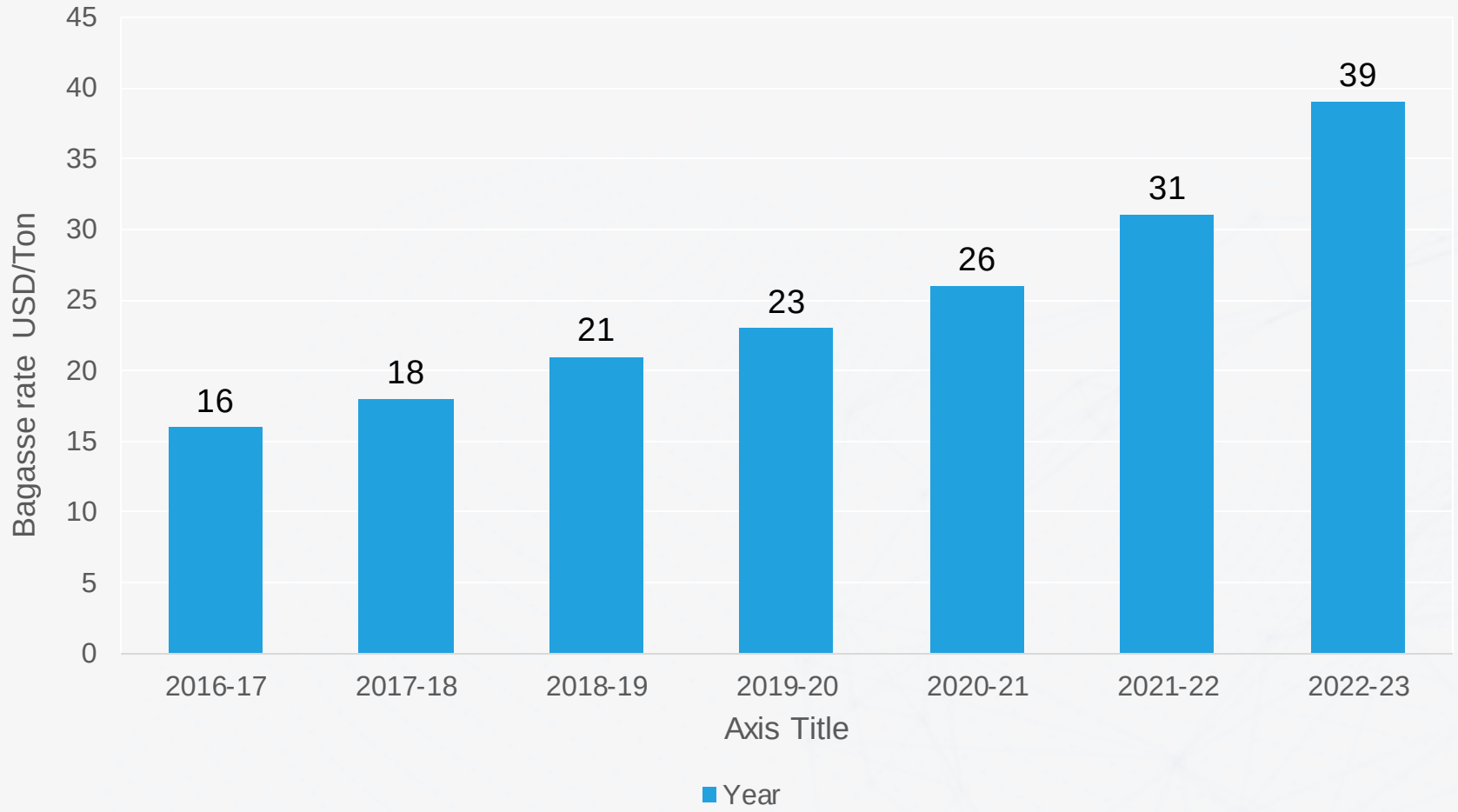


India's power deficit %.

- Adequate power supply
- Low power purchase agreement rate

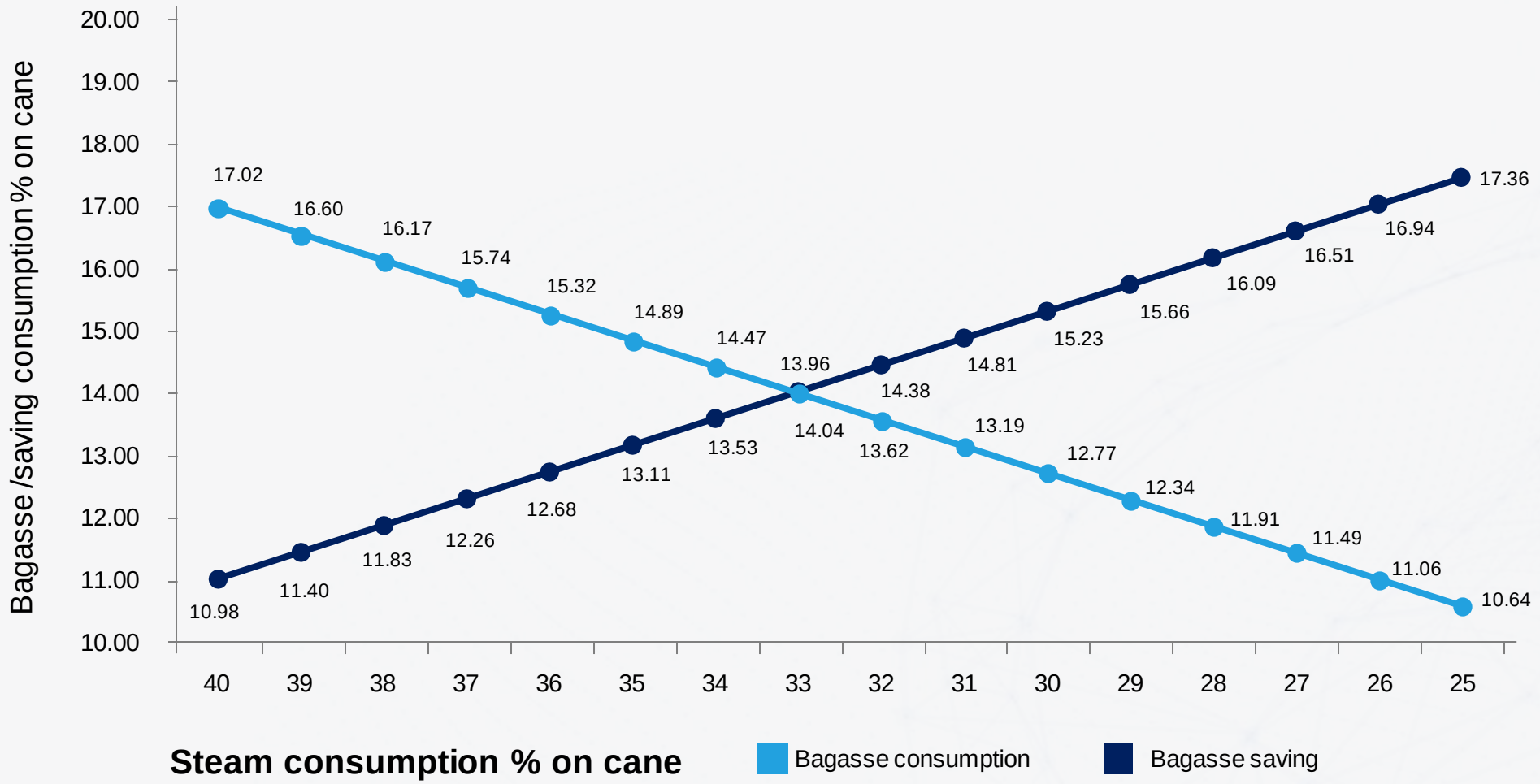
- Ethanol production throughout the year
- Paper Mills throughout the year

BAGASSE PRICE



Indian bagasse value (USD/t).

BAGASSE CONSUMPTION/SAVING Vs STEAM SAVING



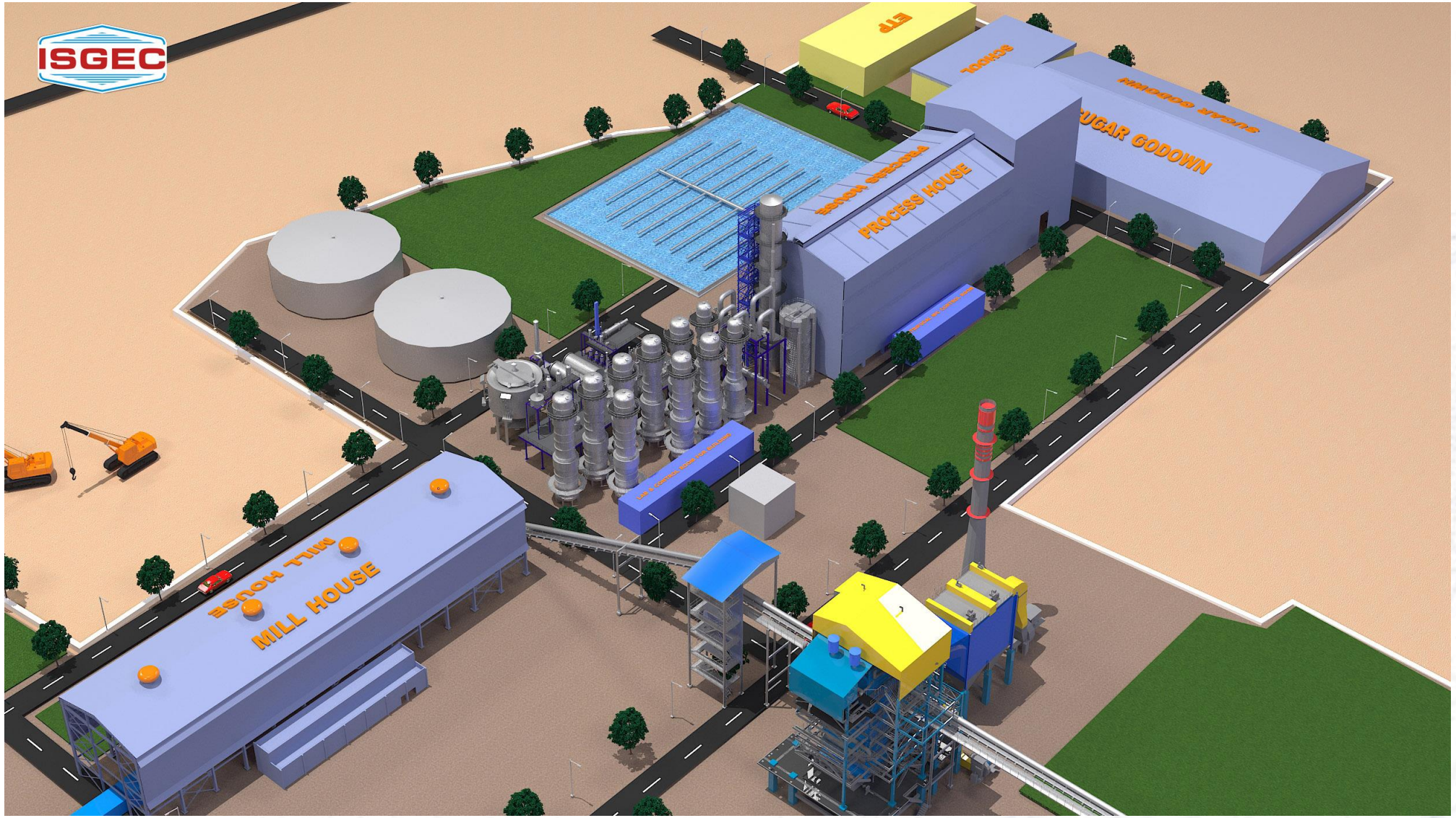
Steam fuel ratio:2.35

PLANT OVERVIEW

Crushing capacity	**7 500 t cane/day in Phase 1, 10 000 t cane/day with refinery in Phase 2**
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 MVR to use second-last effect vapour for pan boiling Two massecuite boiling: complete B heavy diversion to distillery, vertical continuous pan for B massecuite
Steam generation plant	100 t/h at 68 ata, 485±5°C, travelling grate boiler
Boiler fuel	100% bagasse; or 40% bagasse + 60% bagasse pith (weight basis); or 30% rice husk +70% bagasse pith (weight basis); or 25% woodchips+75% bagasse pith (weight basis)
Power plant	15 MW captive Backpressure turbine
Distillery capacity	120,000 L/day ethanol on B heavy feedstock
Incineration for vinasse	25 t/h , 45 ata vinasse fired incineration boiler with 2.5 MW power generation

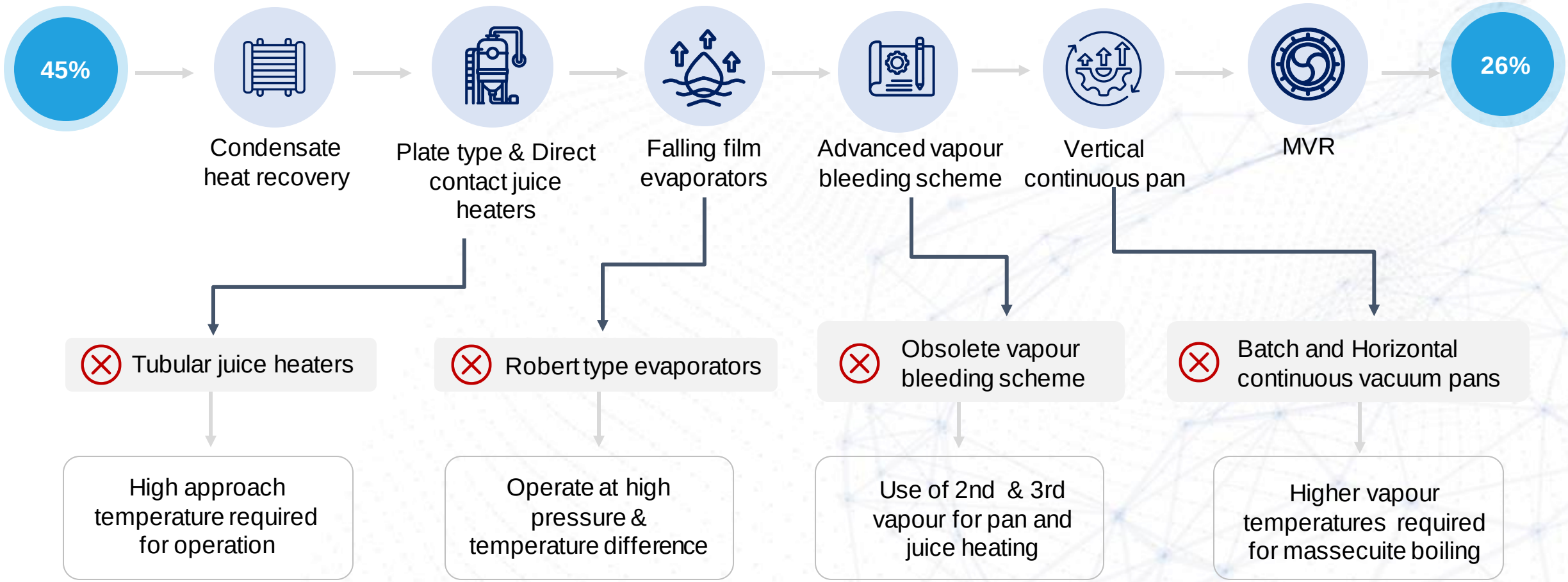
3D view of Plan

3D view of Plan



CONVENTIONAL VS. MODERNIZATION

Stepping towards better steam economy



SEPTUPLE EFFECT EVAPORATOR CONFIGURATION

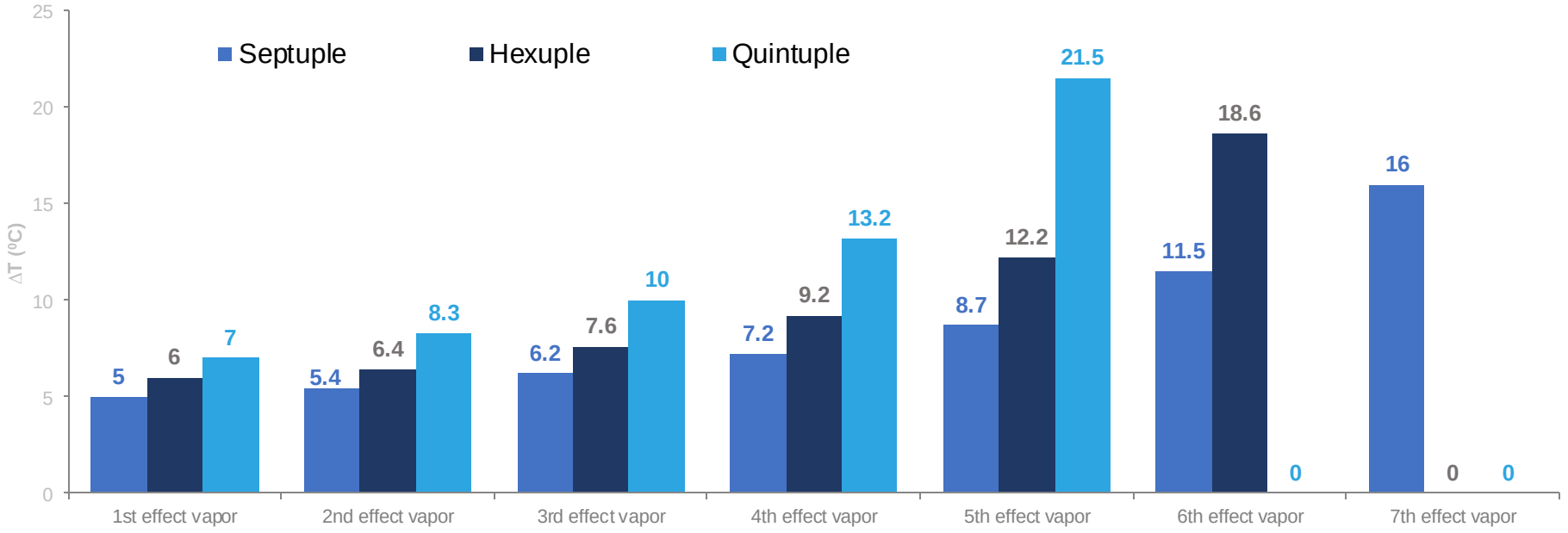
From the Rillieux principle,

In a multiple effect evaporator of " N " effects, one kg of steam will evaporate *N* kg of water.

Which concludes " higher the number of effects , lesser will be the steam consumption"

Overall Temperature difference limit across the multiple effect evaporator :60degC

COMPARISON: ΔT IN MULTIPLE EFFECT EVAPORATOR SET



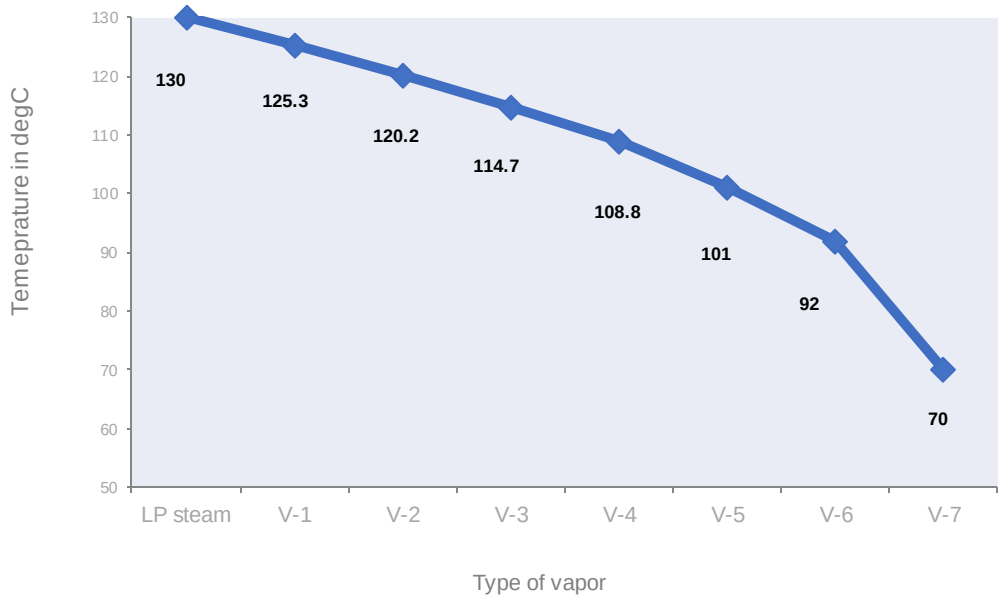
To increase the no. of effects it is necessary to choose evaporator body which can handle low dT.

HOW ΔT AFFECTING THE STEAM CONSUMPTION

Low ΔT → Higher vapour temperature at later effect → Maximum vapor bleeding from later effects → Less steam consumption

Due to Higher HTC values and low dT, falling film evaporator bodies are chosen

Vapour temperature profile in a septuple-effect evaporator set

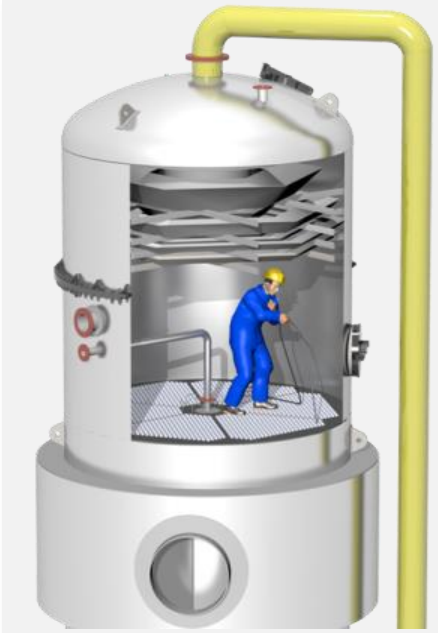


Expected overall heat transfer coefficient (W/m^2.K) profile in a septuple-effect evaporator set.

FEATURES OF ISGEC FFE

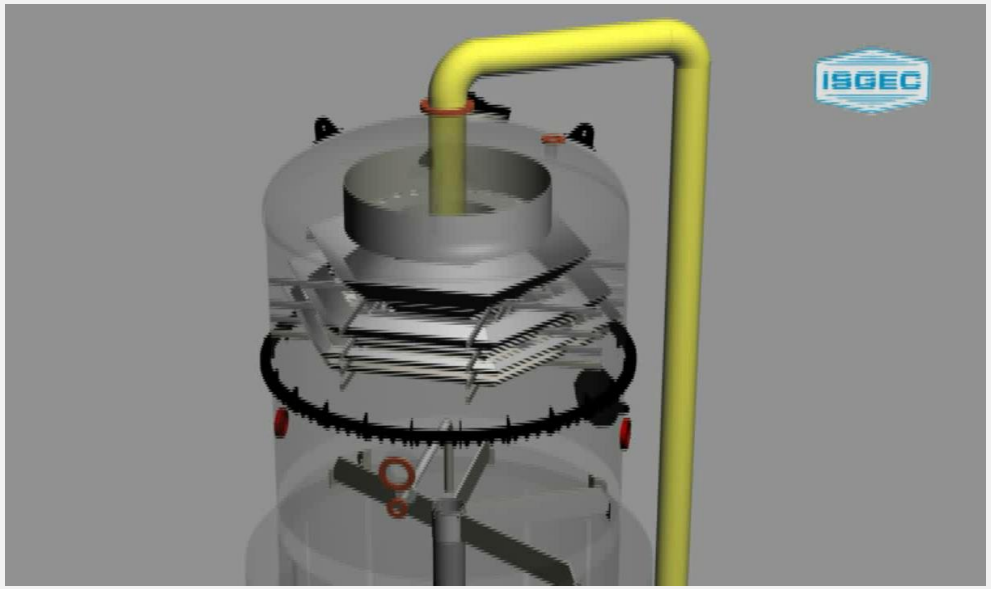
Inbuilt 5-stage cascade type, Maintenance friendly juice distributor that forms a uniform shower of juice across the entire cross section.

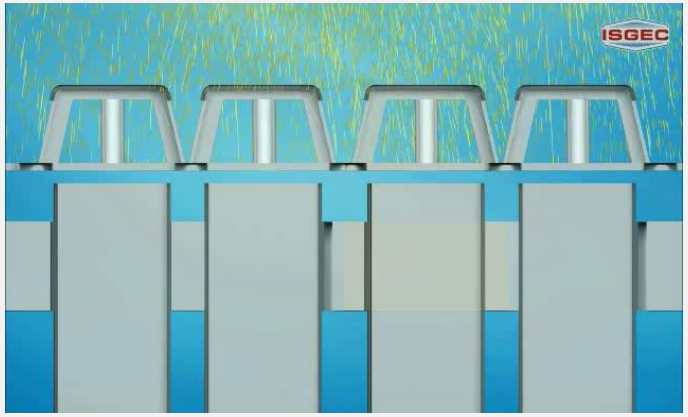
Segmented tray plate with individual tripod umbrellas located over each tube. These prevent short circuiting and also ensure equal and uniform wetting of each and every tube.



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

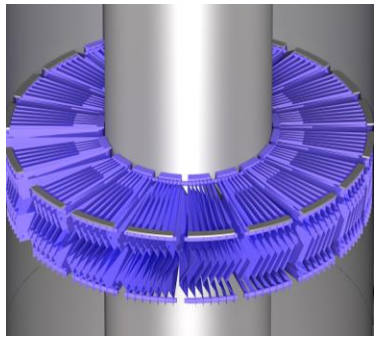


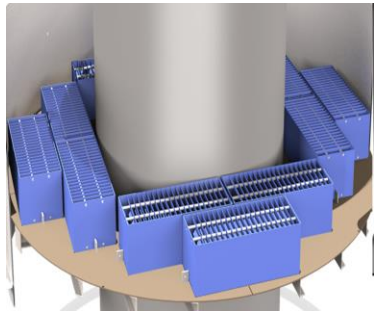


ISGEC DESIGN MODERN POLY BAFFLE ENTRAINMENT SEPARATOR FOR STRAIGHT DESIGN FFE

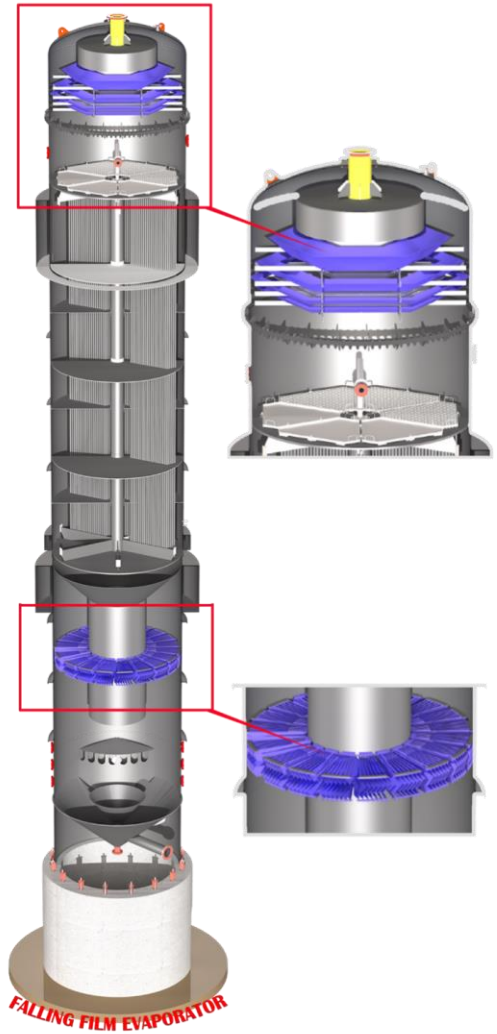
Isgec has made improvements & developed straight design FFE body so that poly baffle area can be high and entrainment chances can be negligible.

Old vs new Design polybaffles





New Design polybaffles



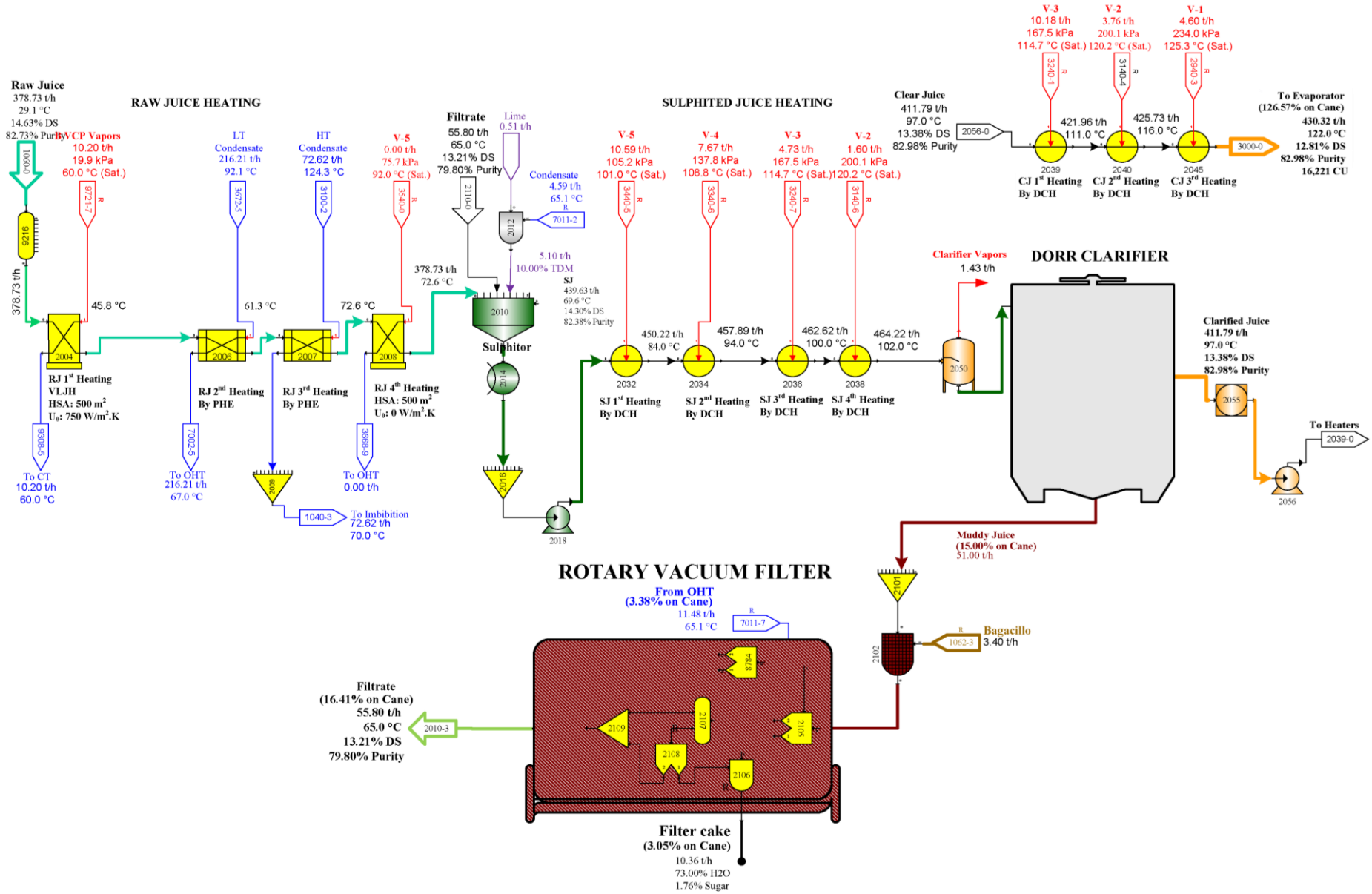
VAPOR BLEEDING SCHEME

1st effect	2nd effect	3rd effect	4th effect	5th effect	6th effect	7th effect
CJ3 heating (DCH) Pan washing Sugar dryer air heater	SJ4 heating (DCH) CJ2 heating (DCH) B sugar Melting	SJ3 heating (DCH) CJ1 heating (DCH) Molasses conditioning (DCH)	SJ2 heating (DCH)	SJ1 heating (DCH) B graining (Batch) A massecuite boiling (Batch) A1 massecuite boiling (Batch)	B massecuite boiling (VCP) RJ 4th heating (Tub)	Condenser

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

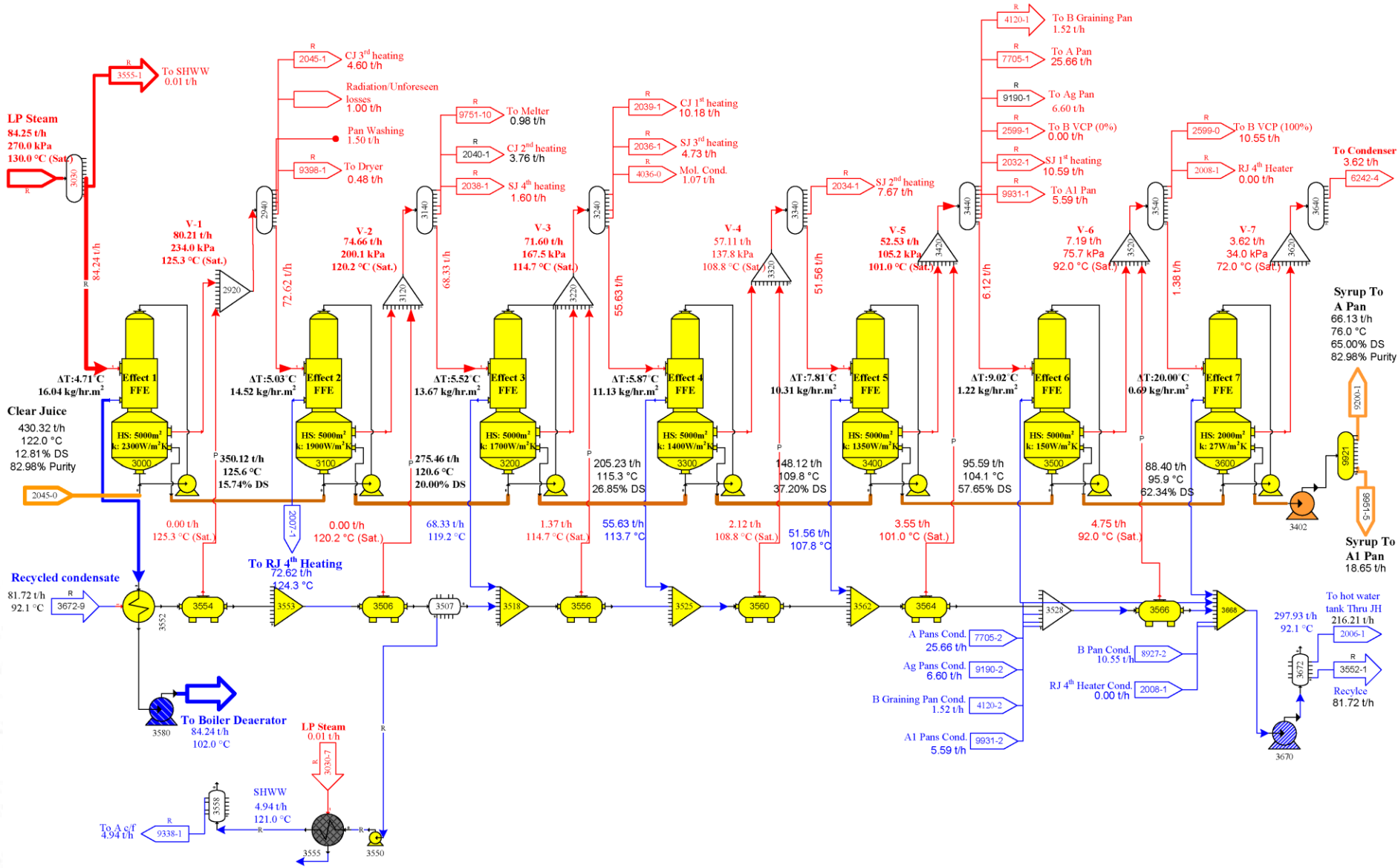
JUICE HEATING & CLARIFICATION

Isgec Scheme
Designed Crushing Capacity: 7500 TCD (340 TCH @22hrs basis)
Predicted Steam Consumption: 24.78%* on Cane



EVAPORATION

ISGEC Scheme
Designed Crushing Capacity: 7500 TCD (340 TCH @22hrs basis}
Predicted Steam Consumption: 24.78%* on Cane



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

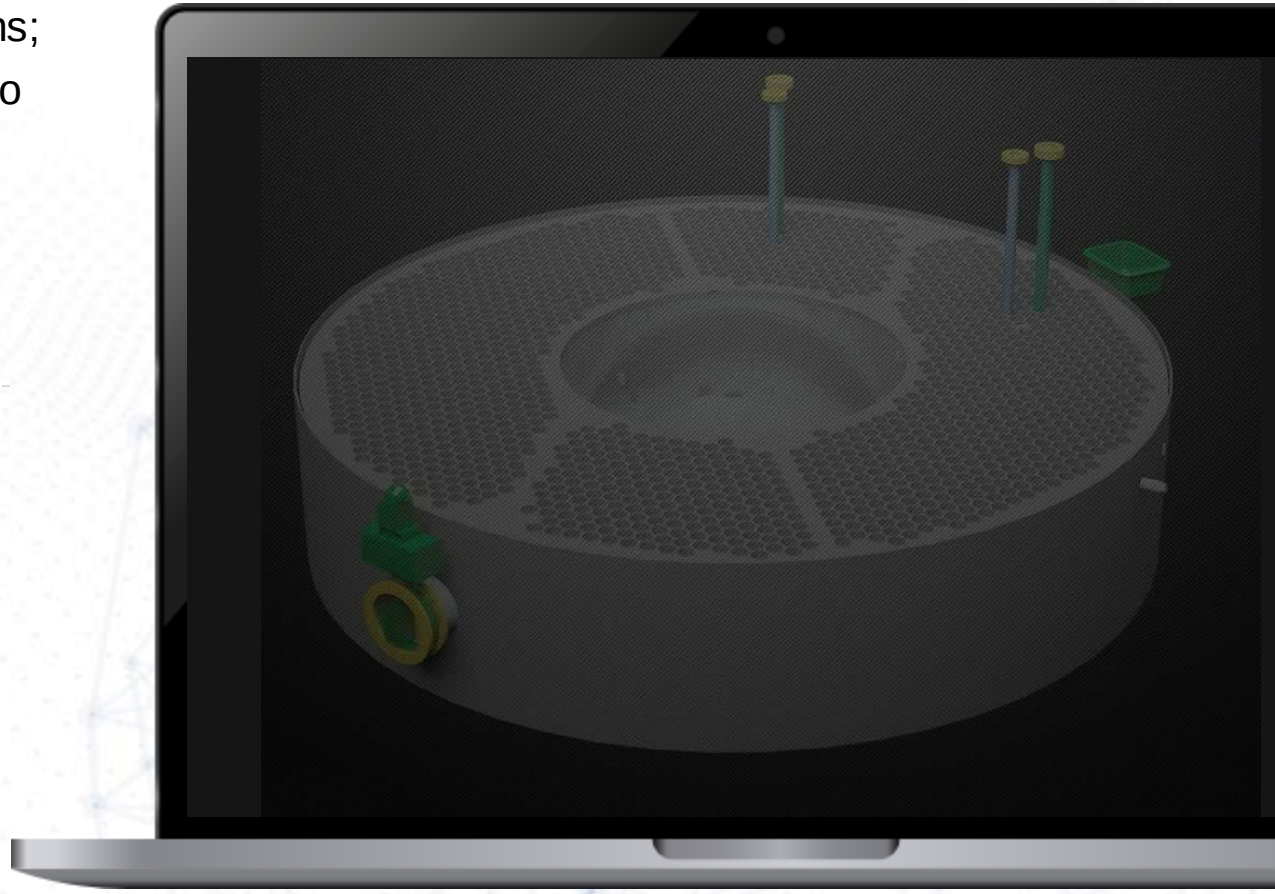
Partitioned module

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 boiling can be improved



DESIGN FEATURES OF i-VCP

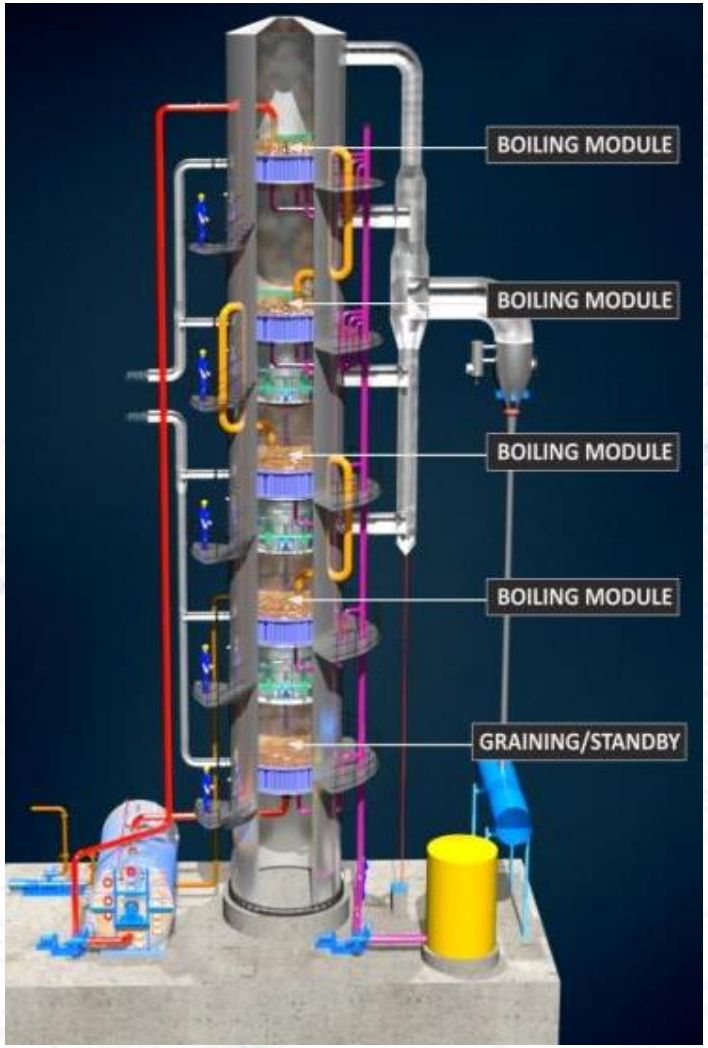
INBUILT GRAINING/STANDBY module: i-VCP is designed with bottom most module for graining and standby.

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 can be reduced.



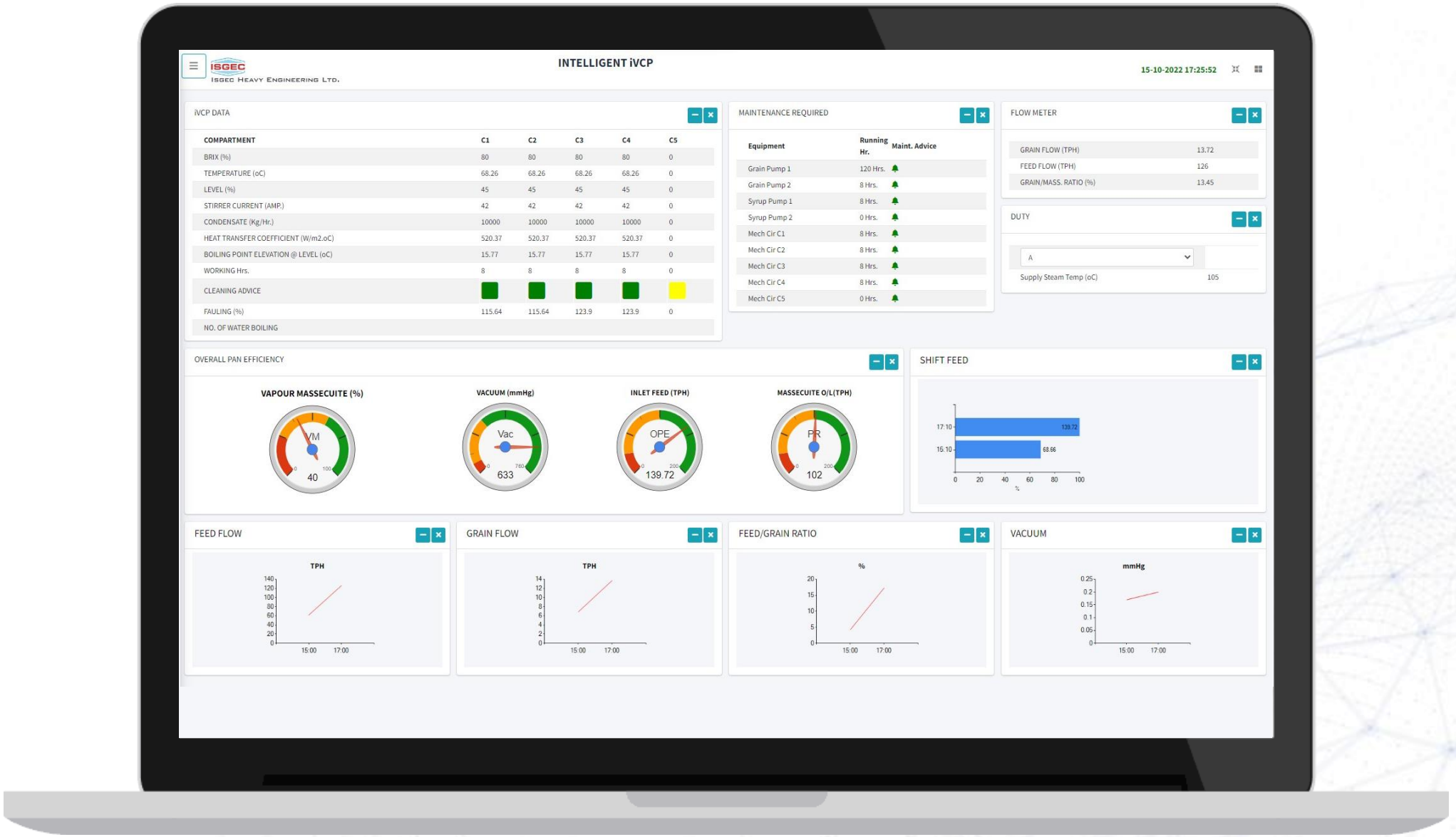
ARTIFICIAL INTELLIGENCE FOR VCP

Why?

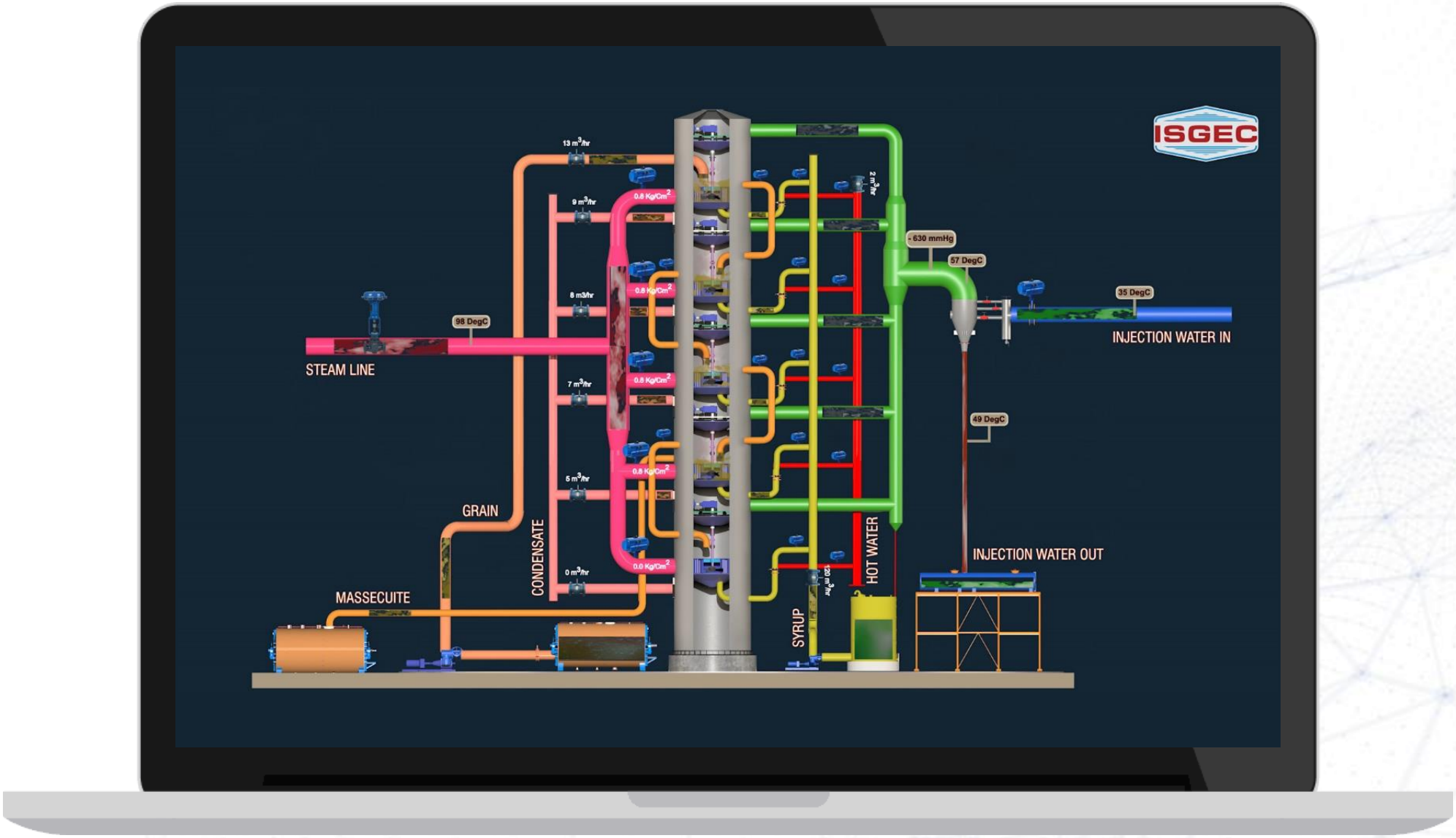
- When a machine becomes smart, it can understand a command, store and connect data, and draw conclusions.
- The idea behind AI is to make a smart system to increase productivity , efficiency and minimize downtime by simulating human behavior.

Advantages

1. Increase In Efficient Operation
2. Increase Productivity Using AI, systems can test hundreds of mathematical models of production and outcome possibilities, and be more precise in their analysis and results.
3. Minimize Downtime Sensors can track the conditions of equipment and analyze the data on an ongoing basis. The technology enables machines to evaluate their own conditions, Taking predictive maintenance one step ahead, algorithms based on big data can predict future equipment failures.
4. Proactive Maintenance Preventive and corrective maintenance involves regularly scheduled equipment upkeep to avoid sudden and unexpected equipment failure and resulting downtime.
5. To Minimize Manual Intervention (Reduce Manual Efforts)AI is automating your routine tasks, allowing you to complete them much faster. The output of industries also increased to several hundred times by using AI and saves lot of time.


ISGEC
Isgec Heavy Engineering Ltd.
INTELLIGENT iVCP
15-10-2022 17:25:52
iVCP DATA
COMPARTMENT C1 C2 C3 C4 C5
BRIX (%) 80 80 80 80 0
TEMPERATURE (oC) 68.26 68.26 68.26 68.26 0
LEVEL (%) 45 45 45 45 0
STIRRER CURRENT (AMP.) 42 42 42 42 0
CONDENSATE (Kg/Hr.) 10000 10000 10000 10000 0
HEAT TRANSFER COEFFICIENT (W/m2.oC) 520.37 520.37 520.37 520.37 0
BOILING POINT ELEVATION @ LEVEL (oC) 15.77 15.77 15.77 15.77 0
WORKING Hrs. 8 8 8 8 0
CLEANING ADVICE
FAULING (%) 115.64 115.64 123.9 123.9 0
NO. OF WATER BOILING
MAINTENANCE REQUIRED
Equipment Running Hr. Maint. Advice
Grain Pump 1 120 Hrs.
Grain Pump 2 8 Hrs.
Syrup Pump 1 8 Hrs.
Syrup Pump 2 0 Hrs.
Mech Cir C1 8 Hrs.
Mech Cir C2 8 Hrs.
Mech Cir C3 8 Hrs.
Mech Cir C4 8 Hrs.
Mech Cir C5 0 Hrs.
FLOW METER
GRAIN FLOW (TPH) 13.72
FEED FLOW (TPH) 126
GRAIN/MASS. RATIO (%) 13.45
DUTY
A
Supply Steam Temp (oC) 105
OVERALL PAN EFFICIENCY
VAPOUR MASSECUITE (%)
VM
40
VACUUM (mmHg)
Vac
633
INLET FEED (TPH)
OPE
139.72
MASSECUITE O/L(TPH)
PR
102
SHIFT FEED
17.10
15.10
139.72
68.66
FEED FLOW
TPH
GRAIN FLOW
TPH
FEED/GRAIN RATIO
%
VACUUM
mmHg

DESIGN FEATURES OF i-VCP



BAGASSE SAVING DUE TO STEAM SAVING IN THE PLANT

Parameter	Unit	Value
Crushing capacity	t cane/day	7500
Crop days	Days	180
Off-crop distillery days	Days	56
Total crushing	t	1, 399, 091
Net bagasse available	%	28.4
Steam consumption % cane in sugar plant	%	26.0
Boiler capacity	t/h	100
Incineration boiler capacity	t/h	25
Total bagasse consumption in sugar plant boiler and incineration boiler during crop and off-crop	t/h	43.5
Bagasse saved in crop	t	218, 698
Bagasse used in off crop distillery operation	t	3178
Bagasse for next season start up	t	1000
Bagasse available for paper plant / other use / sale	t	214, 520
Bagasse saving % on cane	% on cane	15.3

SURPLUS BAGASSE USES

Xylitol

Charcoal & activated carbon

Soft and hard boards

Cutlery

Paper industry

Electricity

2G ethanol

Apparel Fabric

Furfural

Bio-Plastic

USES OF SUGARCANE BAGASSE

SUGARCANE tops & leaves + SUGARCANE BAGASSE

Use as a fuel

- Cogeneration
- Charcoal
- Biogas/BioCNG+Manure

Fibrous products

- Bleached pulp
- Writing paper
- Fibre board
- Particle board
- Newsprint
- Food container
- Apparel fabric

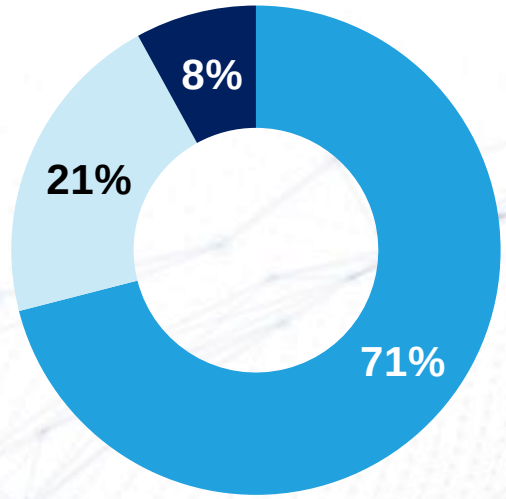
Chemicals

- Furfural + Derivatives
- Xylitol
- Plastics
- Activated carbon
- a-Cellulose

BAGASSE IN PAPER MILLS

- Paper Mills: **861 Installed**, 526 –operational, 27.15 million tonnes production capacity
- Lack of raw material
- In 2017, more than 125 factories in Gujarat and Maharashtra have closed due to a 35% increase in raw material cost.
- With India's forest wealth depleting, raw resources for the paper sector are in short supply.
- Regular paper is made from trees, which take at least 20 years to grow back, whereas sugarcane can be grown in 10-18 months.
- Paper products also contribute to 10% of deforestation globally which has dramatic negative consequences on the environment.
- Bagasse can replace other materials and help to protect natural resources.
- A substantial amount of bagasse is used as fuel in the sugar sector and is not made available to the paper industry, judicious use of bagasse should be encouraged, so the paper industry can use it also.
- As the raw material of paper making, bagasse per ton of bagasse can replace 0.5~0.8m3 in papermaking

Raw material %



Wastepaper / Recycled paper

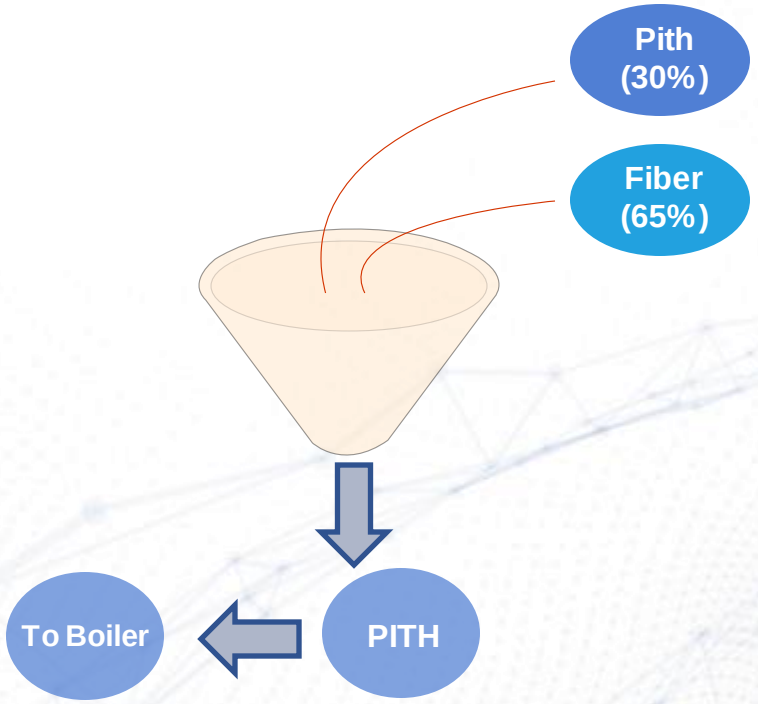
Wood/bamboo

Agro residue(Bagasse/wheat straw)

SURPLUS BAGASSE USES FOR PAPER PRODUCTION

Depithing of bagasse

- Since the cellulose from bagasse is the basic ingredient for paper production, the first step is to remove the non-cellulose part of bagasse by depithing – separation of the short pith material from the fibre of the bagasse.
- Pith cells in bagasse are **30% to 35%**, which makes trouble in papermaking fiber.
- So it is necessary to remove pith from bagasse.



Material	Gross energy value (kJ/kg)
Bagasse	8.929
Pith	7.580
Depithed bagasse	9.828
Mixture of pith and bagasse	8.777

PITH COMBUSTION IN BOILER

Challenge:

Because pith is a lighter fuel particle, there can be secondary combustion in the upper furnace and reasonably sized fuel particles can escape from the furnace without combustion.

Overcoming:

The furnace height is increased,

two goose necks along with high pressure secondary air nozzles are provided in the lower furnace to make a curtain so no unburnt fuel will escape,

and an additional soot blower is provided

Co-firing of pith with whole bagasse at a ratio of less than 1:3..

BIOPLASTIC

- As single-use plastic is banned, everyone is switching to paper-made disposable foodware and packaging materials, but switching from plastic to paper is not as easy as it may seem given deforestation impacts.
- Bagasse is a promising raw material that can help to adopt the paper-based materials without deforestation.
- Bioplastic from sugarcane bagasse, also called sugarcane bioplastic, is one of today's main types of biobased plastics.
- Sugarcane polyethylene is manufactured into a host of different plastic products, from food utensils to medical devices.
- The utilisation of biomass fibre, cellulose and starch to replace petrochemical materials for the production of plastics is a widely accepted strategy to establish a sustainable society (Grebe et al. 2015).

NATURALL BOTTLE ALLIANCE

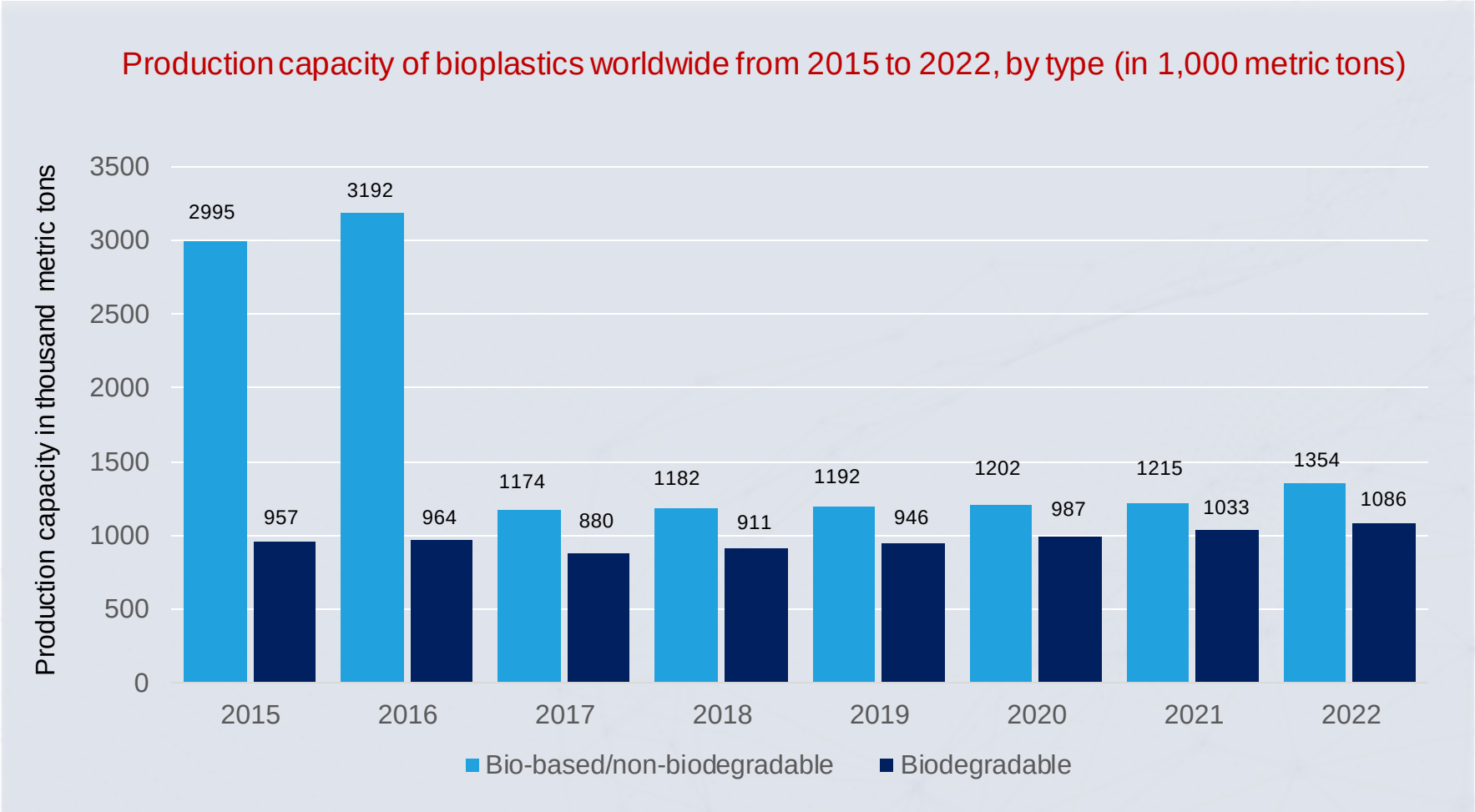
green dot BIOPLASTICS

ARKEMA

NOVAMONT

BIOPLASTIC

According to a PR Newswire, a report by Markets and Markets, the biodegradable plastics market is consequently expecting growth from USD 3.O2 billion in 2018 to USD 6.12 billion by 2023, at a CAGR of 15.1%. Also, bioplastics represent approximately 1% of the global polymer market (359 million tons) as of 2020.



Additional Information: Worldwide:nova-institute; European Bioplastics;2015 to 2017

Sources: Plastics New s:nova-institute:European Bioplastics

SOFT AND HARD BOARDS FROM BAGASSE

- Bagasse fibre is used to manufacture hard board, insulation board, particle board etc.
- Fine particle bagasse is used to make hard boards that are used for making furniture such as chairs, tables, beds, panel board, windows, doors etc.
- In the near future projected demand of bagasse-based board will increase by 5% given its use as a substitute for wood.
- The industrial paper segment is expected to grow at 10-11% in the next few years.
- The demand is dependent on the growth of industrial production, which is expected to average around 8.5-9%.
- Bring the bagasse, especially the long fiber pulp, crushed it like cotton wool. Mix the glue and chemicals with the bagasse together into the dryer. After that, transfer into a compress machine with a steam and heat.
- Finally, medium density fiberboards are obtained. There is no import of ply board, there is scope of export of ply board as well as wood board is there.

PHASE-2: Plans

PLANS	STRATEGY
Cane crushing enhancement : 10000 Tons cane per day	**Reduction in steam consumption by installation of:**
Process conversion from double sulphitation to sulphurless sugar backend refinery	A VCP for raw massecuite boiling
No new addition in boiler and power plant so **the same quantity of steam will be used for the expanded capacity**.	MVR on A VCP
	MVR on 5th effect vapor for other pan boiling

PHASE-2: MECHANICAL VAPOR RE-COMPRESSION (MVR)

How MVR is helpful?

- By MVR, Increase in vapor temperature ~ 9.5degC
- So, By using a MVR at the 5th effect, the temperature is increased to 99°C which can be used to operate pan boilings for A grain, B grain, refined massecuite boiling

Steam saving with mechanical vapour recompression (MVR)

Process	Unit	Without MVR	With MVR
Pan boiling (A grain, A boiling and B grain)		V5	V6 at 89.8 C
After MVR temperature of heating vapour	°C		99.0
Vapour quantity required for pan boiling	t/h	31.88	30.00
Steam saving due to vapour bleeding	t/h	22.75	25.70
Make-up vapour (at 99.9°C)	t/h		1.88
Steam saving due to makeup steam	t/h		1.35
Net steam saving (d2-d1+f)	%		4.28
Steam saving at 7 500 t cane/day			1.26

CONCLUSION

Bagasse no longer will be seen in the light of 'cost economics of power' but instead as a raw material for paper, ethanol and allied industries

It also encompasses the vision of turning sugar factories into sugar complexes having many products under the one umbrella, with energy efficiency being central to this vision.

There are still several challenges to overcome but current resolution (septuple effect, MVR) can be implemented in different setups of sugar mills.


Thank You!