III CONGRESO PALMERO

GUATEMALA

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2 AL 4 DE OCTUBRE
SANTO DOMINGO DEL CERRO
LA ANTIGUA GUATEMALA

Empty Fruit Bunch (EFB) – As The Main Fuel For Palm Oil Mill Boilers

BY

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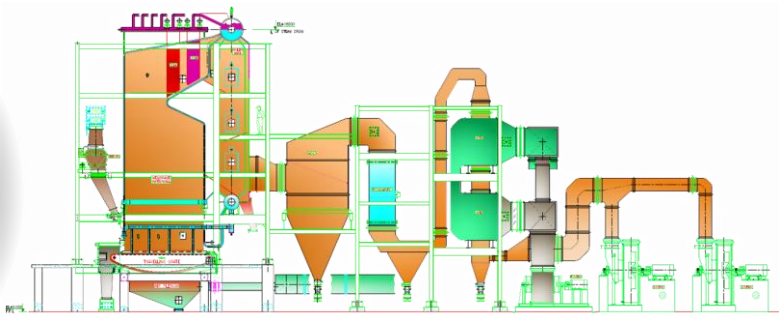
OCTOBER 2019

EFB Fired Boilers

Benefits of Burning EFB Fiber

Fuel Preparation and Delivery System

Design and Construction Of Boiler



Benefits Of EFB For Power Generation

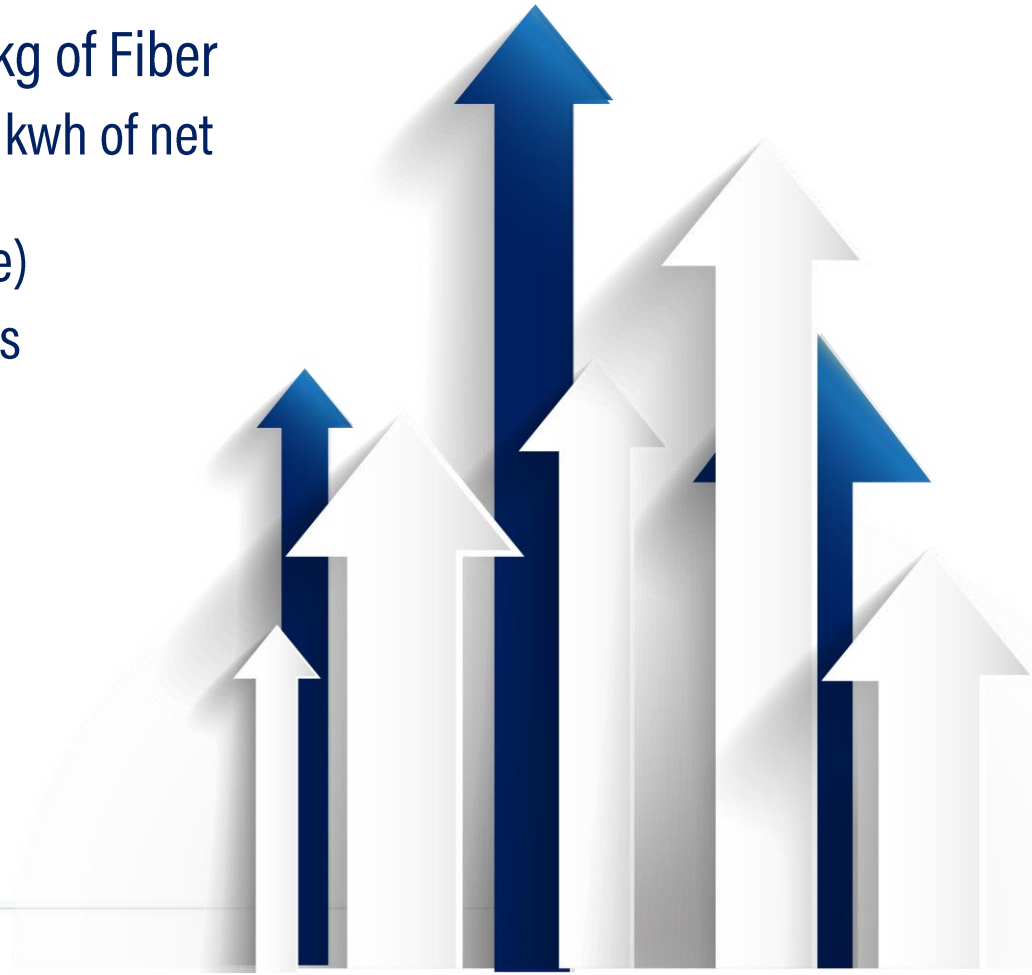
Premise

- EFB content per MT of FFB – 230 kg@ 70-75% Moisture
- GCV of EFB at 75% moisture – 1225 Kcal/kg
- Typical Uses of EFB:

Benefits Of EFB as Boiler Fuel

Benefits

- EFB utilized as a fuel has a potential to generate about 2.4 TPH of steam (when EFB moisture content is reduced to 50%)
- 1 MT of EFB used as fuel can save 430 kg of shell or 790 kg of Fiber
- Each MT of EFB has the potential to generate about 230-250 kwh of net power
  (@ $0.09/kwh this represents $21 per MT of electrical revenue)
- EFB Fiber sells at $ 15.00/MT while PK shell is $75.00/MT. Sales price as a function of per MT of EFB
  - 0.13MT of EFB Fiber @ $15/MT = $1.95
  - 0.06MT of PK shell @ $75/MT = $4.50



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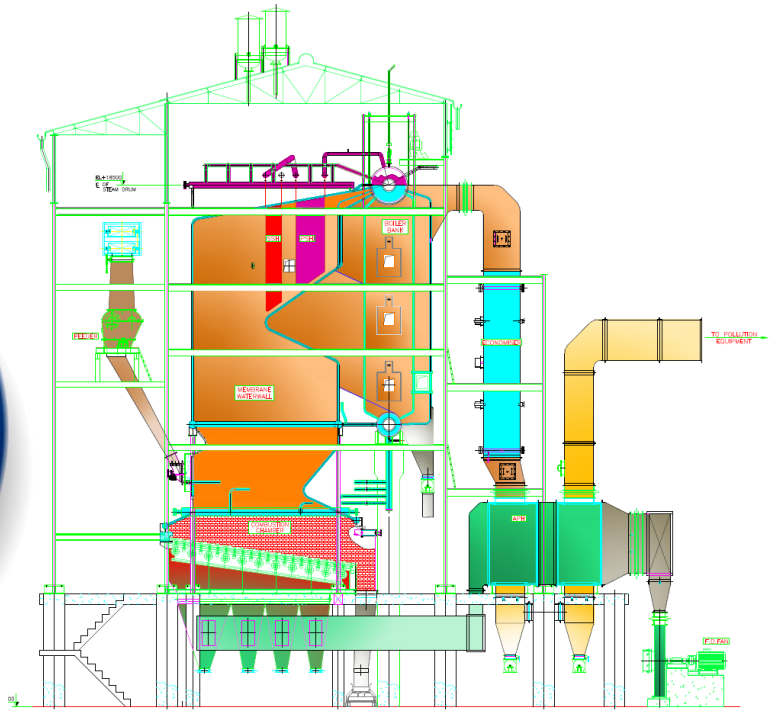


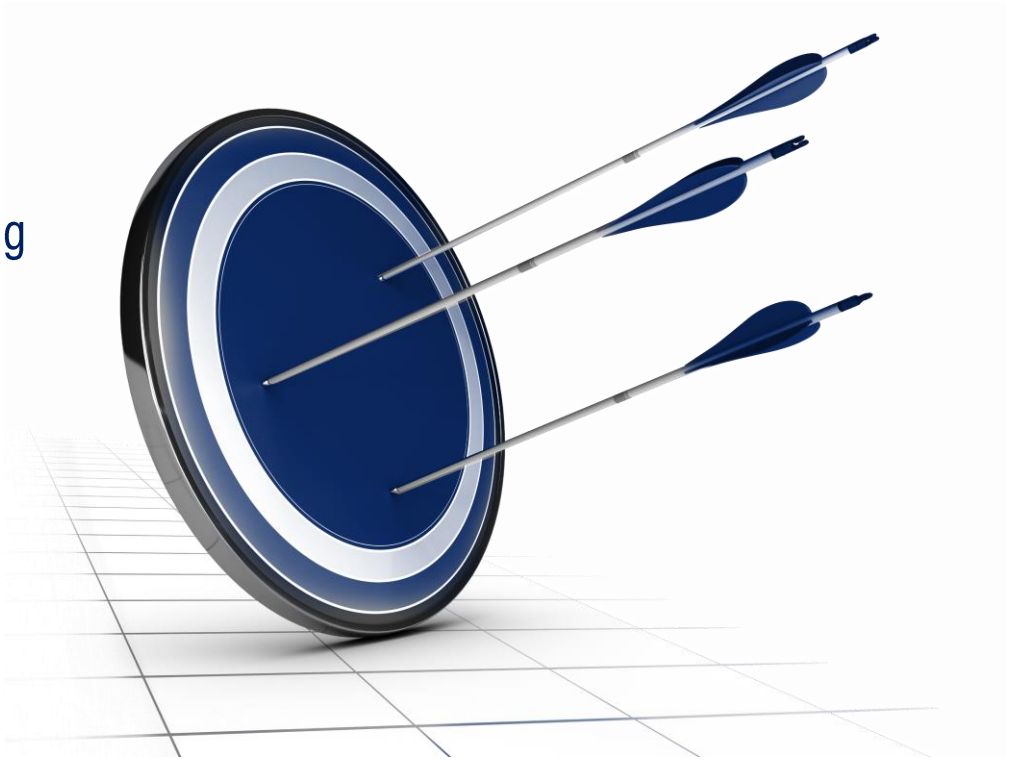
Fuel Preparation and Delivery System

EFB Fuel Preparation Objectives:

- Produce homogenized Fiber – 50mm to 100mm long
- Reduce moisture content from 70% to about 50%
- Extract 50% of residual CPO in EFB

EFB Delivery System

- Deliver a consistent flow of EFB Fiber to the Boiler



EFB Fuel Preparation and Delivery System

EFB Crusher

- To eliminate Green Bunches
- Typical capacity 10-12MT EFB/Hr
- Power consumption – 20HP

EFB Press and Cutter

- To reduce humidity from 70% to about 50%
- To extract residual CPO (about 50% of CPO loss in EFB)
- To produce fiber 50-100mm long
- Capacity 8-10MT EFB/Hr
- Power consumption – 100HP

EFB Fuel Preparation and Delivery System

The EFB Station pays itself with CPO Recuperation

Assuming 200,000 MT of RFF/Year

CAPEX
$250,000
Press + ancillary equipment all installed

OPEX
$100,000/year
(labor, power, spare parts)

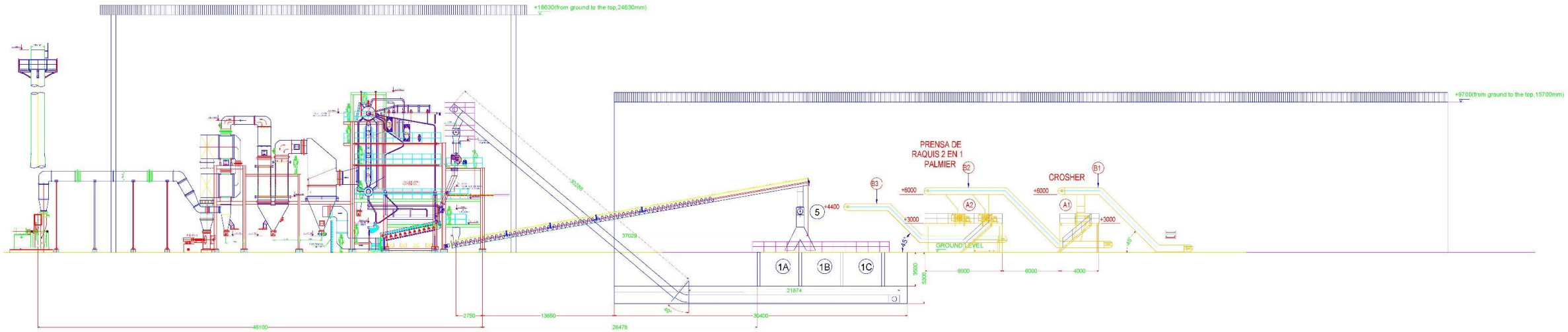
CPO Revenue
$550,000
(OER .53%/FFB @ $520/T)

ROI
150%

Fuel Retrieval and Delivery System

- EFB Storage – Approx 30-40MT of EFB Fiber Storage or 2.5 – 3 hours of fuel for a 30T boiler
- Even Distribution of Fuel Over Discharging Opening by Dosing Roller

Fuel Preparation and Delivery System



ITEM	DESCRIPTION	QTY
5	RETURN SCREW CONVEYOR NO:2 Ø0.6M X L:14M	1 UNIT
4	RETURN SCREW CONVEYOR NO:1 Ø0.6M X L:37.6M	1 UNIT
3	FUEL DISTRIBUTION SCREW CONVEYOR Ø0.6M X 24M	2 UNITS
2	INCLINE CONVEYOR W:0.9M X H:0.76M X L:56,000M	2 UNITS
1	MOVING FLOOR W:4M X H:3.5M X L:11M	3 SETS

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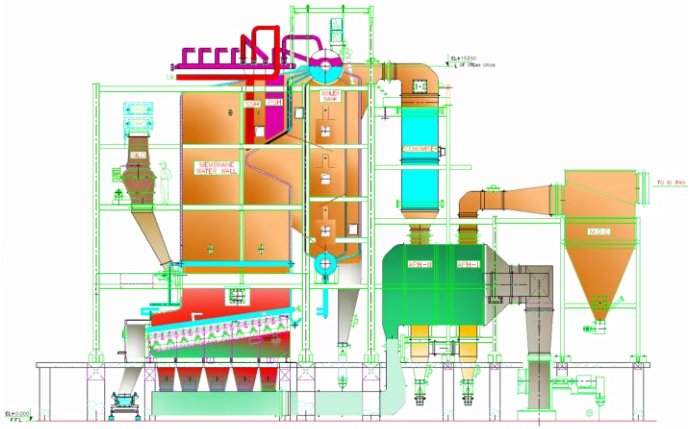


Design and Construction of EFB Boilers

End-User Input

Design Considerations

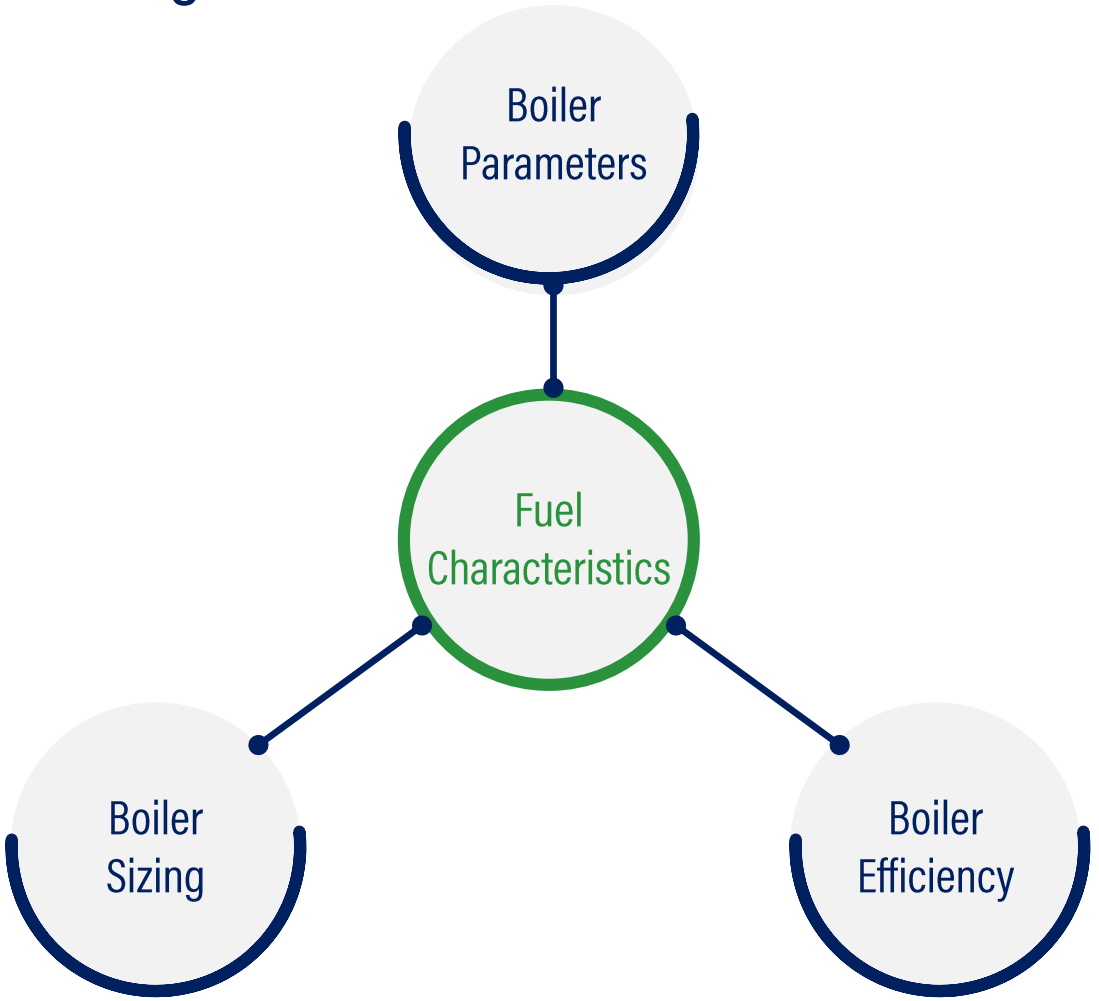
Design and Construction of EFB Boilers

End-User Inputs

- Type and Amount Of Fuel Available
- Process Steam Requirement
- Power Requirement
- Environmental Requirements

Design and Construction of EFB Boilers

Design Considerations: Fuel is the Core



Fuel Characteristics

Proximate Analysis & Ultimate Analysis

Ash Characteristics

Physical Characteristics

Proximate and Ultimate EFB Characteristics ...

Proximate Analysis – Determines How Much Of The Fuel Will Burn

		Empty Fruit Bunch
Fixed Carbon	% wt.	8.53
Volatile Matter	% wt	37.83
Total Moisture	% wt	50.00
Ash	% wt	3.64
Higher Heating Value	kcal/kg	2445

Ultimate Analysis – Provides Air Requirement, Gas Generation, And Boiler Efficiency

% Weight	EFB
Total Carbon	20.4
Hydrogen	3.18
Oxygen	18.39
Nitrogen	0.31
Sulphur	0.08
Moisture	50.0
Ash	3.64
Gross Calorific Value (kcal/kg)	2445

Ash Characteristics...

To Understand a fuel's impact on boiler components

- Quantity
- Alkali
- Cl^- Chlorides
- Fusibility Temperature

EFB Ash Characteristics...

Ash Analysis – Fusibility Temperatures

		Palm Fiber	PK Shell	Empty Fruit Bunch
Initial Deformation Temperature	^{o}C	1120	1070	930
Softening temperature	^{o}C	1180	1130	990
Fluid temperature	^{o}C	1280	1290	1210

Conclusion – Need Larger Furnace to keep furnace temperature lower and minimize ash melt

EFB Ash Characteristics...

Elemental Ash Analysis-

	Empty Fruit Bunch
SiO_2	34.70
Al_2O_3	1.20
CaO	3.30
Fe_2O_3	1.80
MgO	2.90
Na_2O	0.80
K_2O	40.10
SO_3	8.00
CO_2	----
Others	Balance

Impact: Higher level of fouling of heat transfer surfaces.
Solution: need to design heat transfer sections suitably

Typical Chlorine/High Alkali Attack

Ash Deposits On Super Heater Coils

Corrosion On Super Heater Tube (Gas Side)

Physical Characteristics Of Fuel

Important For Fuel Feed Control

- Sizing
- Bulk Density
- Angle of Repose

Typical Requirement Of EFB Sizing

Recommended Sizing for spreader stoker with Travelling Grate :
Shredded Linear Sizing

- 100% < 125 mm
- 90 % < 50 mm
- 50 % < 30 mm

Recommended Sizing for air assisted gravity feeding with Reciprocating Grate :

- 100% < 300 mm
- 90 % < 200 mm
- 75 % < 150 mm

EFB Bulk Density

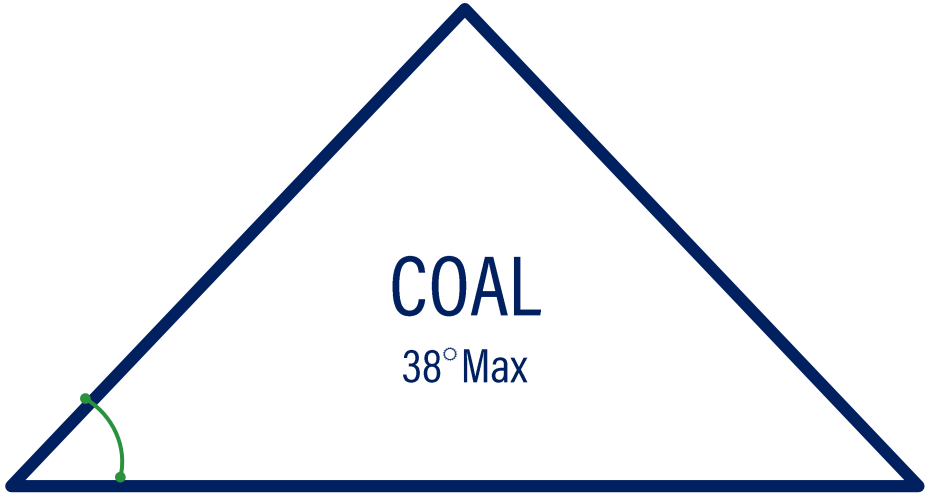
Bulk density:

- varies between 150 to 250 kg/m3.
- Impacts Feed Silo Sizing

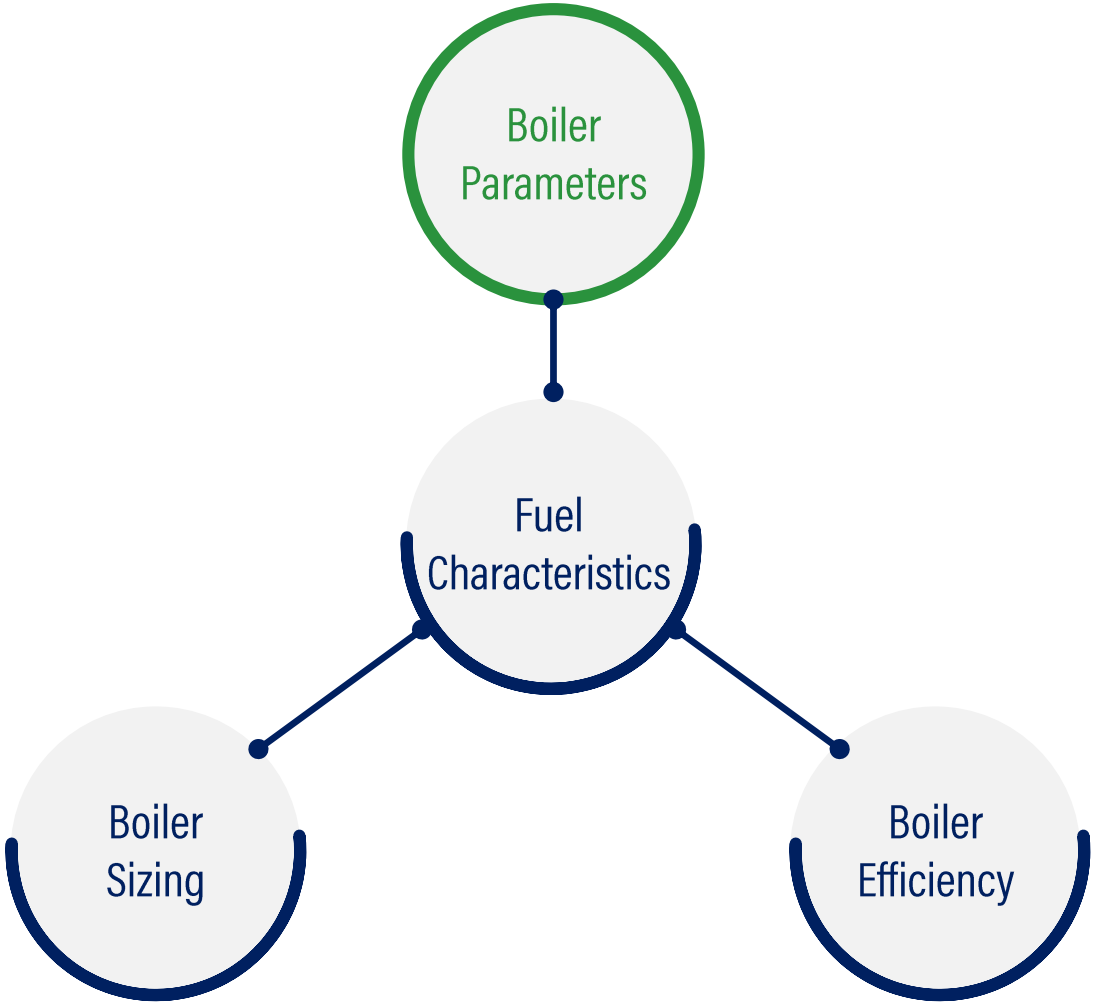
Angle of Repose

Storage Management & Conveying

Max storage of EFB at the boiler front can only be 2-3 minutes.



Design and Construction of EFB Boilers



Based on EFB fuel characteristics we recommend the following parameter

Type of Combustion

- < 45MT/Hr Reciprocating Grate with Air Assisted Gravity Feeding
- > 45MT Travelling Grate with Pneumatic Spreader Stoker

Max Steam Temperature of 300 to 380ºC

Higher steam temp. not advised due to Cl presence in EFB

Pressure - 21 / 31 / 41 Bar(g)

Based on Temperature Limitations

Feed Water Temperature - 105 to 120 ° C

120°C is better suited to manage sulphur /chlorine corrosion issues

Boiler Efficiency: Influencing Factor

How Do We Optimize Boiler Efficiency Burning EFB Fiber

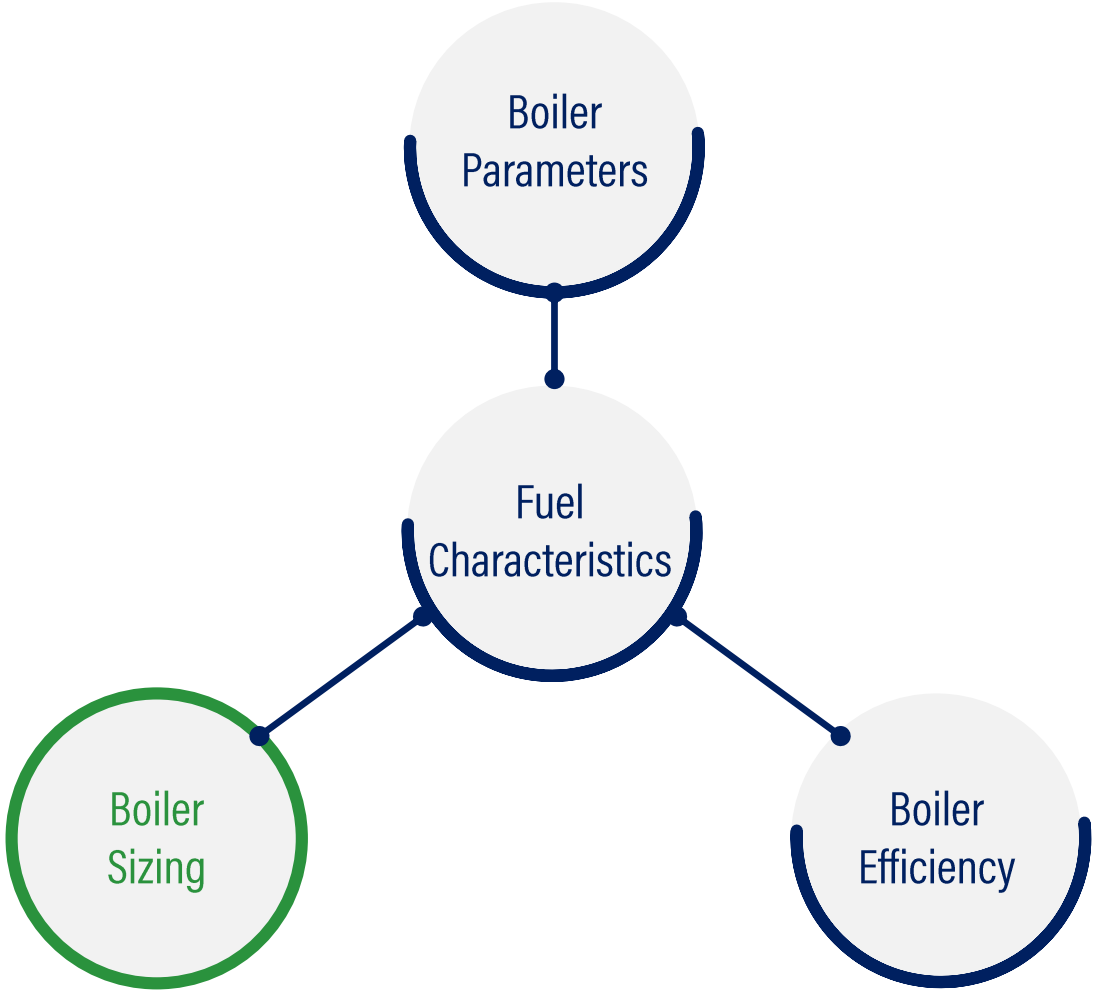
The efficiency on EFB firing is lower than other palm waste considering the following reasons:

- Fuel Granulometry: Boiler combustion system sizing with higher excess air.
- Fuel / Ash Composition: Large furnace and optimal heat transfer section sizing to manage slagging and fouling

Typical efficiencies on palm waste

- Mesocarp firing: 70-71% on GCV of fuel (at 38% moisture)
- PK shell : 80-81% on GCV of fuel (at 14% moisture)
- EFB fibre: 66-67% on GCV of fuel (at 50% moisture)

Design and Construction of EFB Boilers



Design Considerations For Boiler Sizing

Burning EFB Fiber Impacts Sizing As Follows...

EFB Characteristic	Design Consideration
Sticky Deposits due to high Alkali	• Optimal spacing of superheater & bank tubes to reduce ash fouling • Superior Steam Soot blowing System
Low softening point of Ash	• Large furnace with conservative volumetric loading • Low furnace outlet gas temperature to reduce ash deposition
Increase in fouling and corrosion due to presence of Chlorine	• Lower Superheater Steam Temperature

Conclusions

EFB Offers Tangible Values As A Fuel

Proper Fuel Preparation and Feeding Is Critical

EFB Fuel Characteristics Require Careful Attention To Design and Sizing Of The Boiler

THANK YOU