EVOLUTION Incinerator → TDP

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Date: 09th Aug 2023

MY BACKGROUND

WASTE MANAGEMENT

Phuket 700TPD
MSW Incineration Power Plant

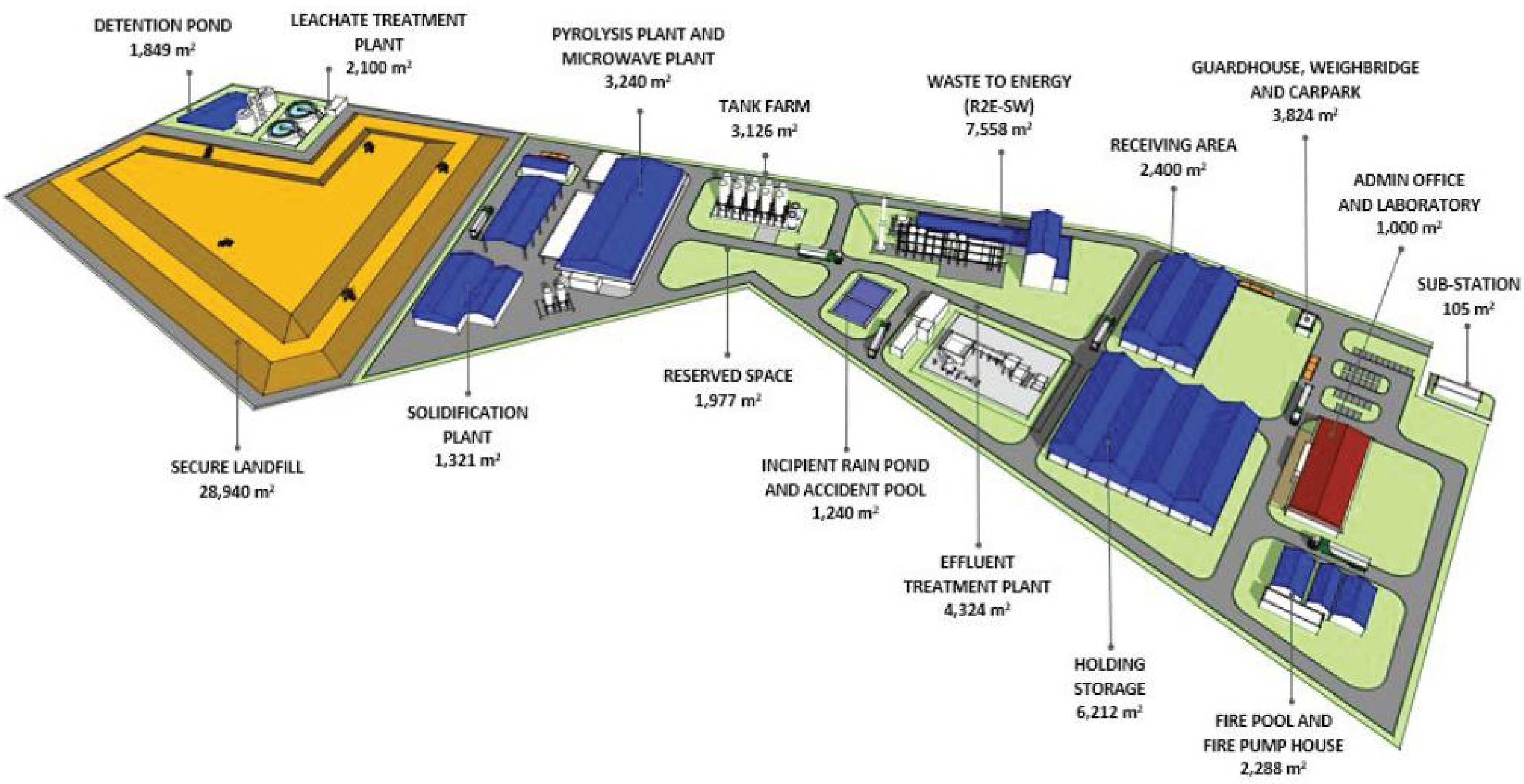
China 300TPD MSW to Fertilizer Plant

Malaysia 100TPD SW Incineration Power Plant

Surabaya 750TPD
MSW Incineration Power Plant

Malaysia
3rd SW Treatment Centre

CONCEPTUAL DESIGN



CHALLENGES

FACED BY POM

Empty Fruit Bunches

Wet Decanter Cake

EQ CAR 2014

Obligation to comply

4. (2) An owner of every existing premises, including that which is not subject to any condition on limit values for air pollutants whether on the licence issued or approval granted for the operation of the existing facility, shall, on or before the expiry of five years from the date on which these Regulations come into operation, take such measures as may be necessary to comply with the opacity and limit values as specified in regulations 12 and 13.

P.U. (A) 151

Made 23 April 2014
[AS(U)91/110/611/077 Jld. 10; PN(PU2)280/XV]

DATUK SERI PALANIVEL A/L GOVINDASAMY
Minister of Natural Resources and Environment

4 Jun 2014 *4 June 2014* P.U. (A) 151	WARTA KERAJAAN PERSEKUTUAN *FEDERAL GOVERNMENT GAZETTE*
PERATURAN-PERATURAN KUALITI ALAM SEKELILING (UDARA BERSIH) 2014 *ENVIRONMENTAL QUALITY (CLEAN AIR) REGULATIONS 2014*	

EQ CAR 2014

SECOND SCHEDULE
[Regulation 13]

LIMIT VALUES AND TECHNICAL STANDARDS (GENERAL)

(I) Control of fuel burning equipment, incinerators and crematoria

1. Control of fuel quality for fuel burning equipment and incinerators not covered by the First Schedule:

Fuel type	Fuel	Fuel quality parameter
Liquid	All	Sulphur content < 500 ppm (per weight)
Solid	Coal	Sulphur content < 1% (per weight)
	Biomass	Wood, agricultural waste, *etc.*: air dry and in its natural composition (e.g. wood without coating, paint or other treatment)
		Residues from wood-based industries: without wood preservatives

EQ CAR 2014

The CO_2 reference content is 12%.

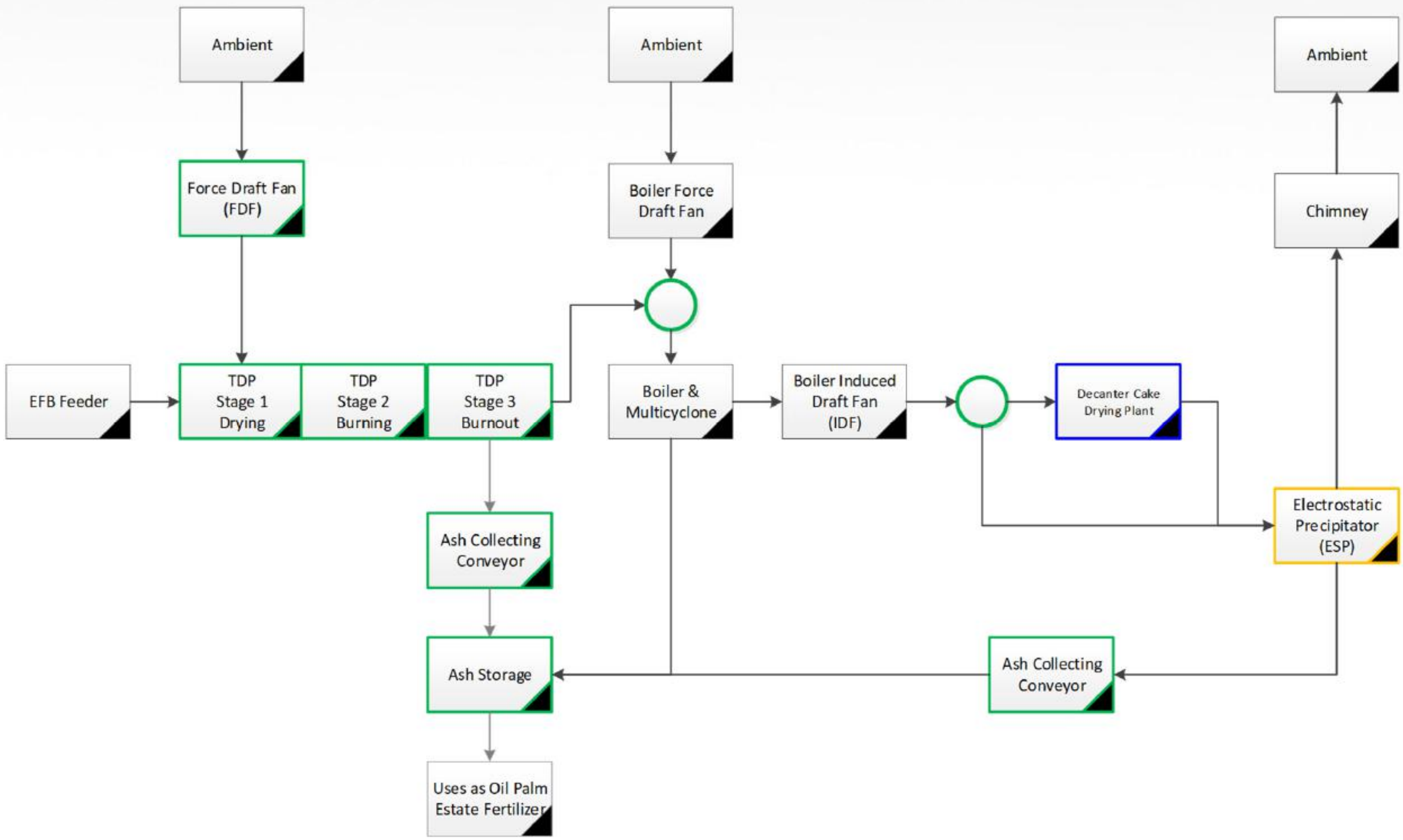
Fuel type	Pollutant	Limit value	Monitoring
Solid	Total particulate matter (PM) Where dust load emitted: *(a)* > 0.44 < 1.0 kg/h *(b)* ≥ 1.0 < 1.5 kg/h *(c)* ≥ 1.5 < 2.0 kg/h *(d)* ≥ 2.0 < 2.5 kg/h *(e)* ≥ 2.5 kg/h	150 mg/m^3	 Once/year 2 times/year 3 times/year 4 times/year Continuous*
	Carbon monoxide (CO)	1000 mg/m^3	Periodic

*Averaging time for continuous monitoring is 30 minutes

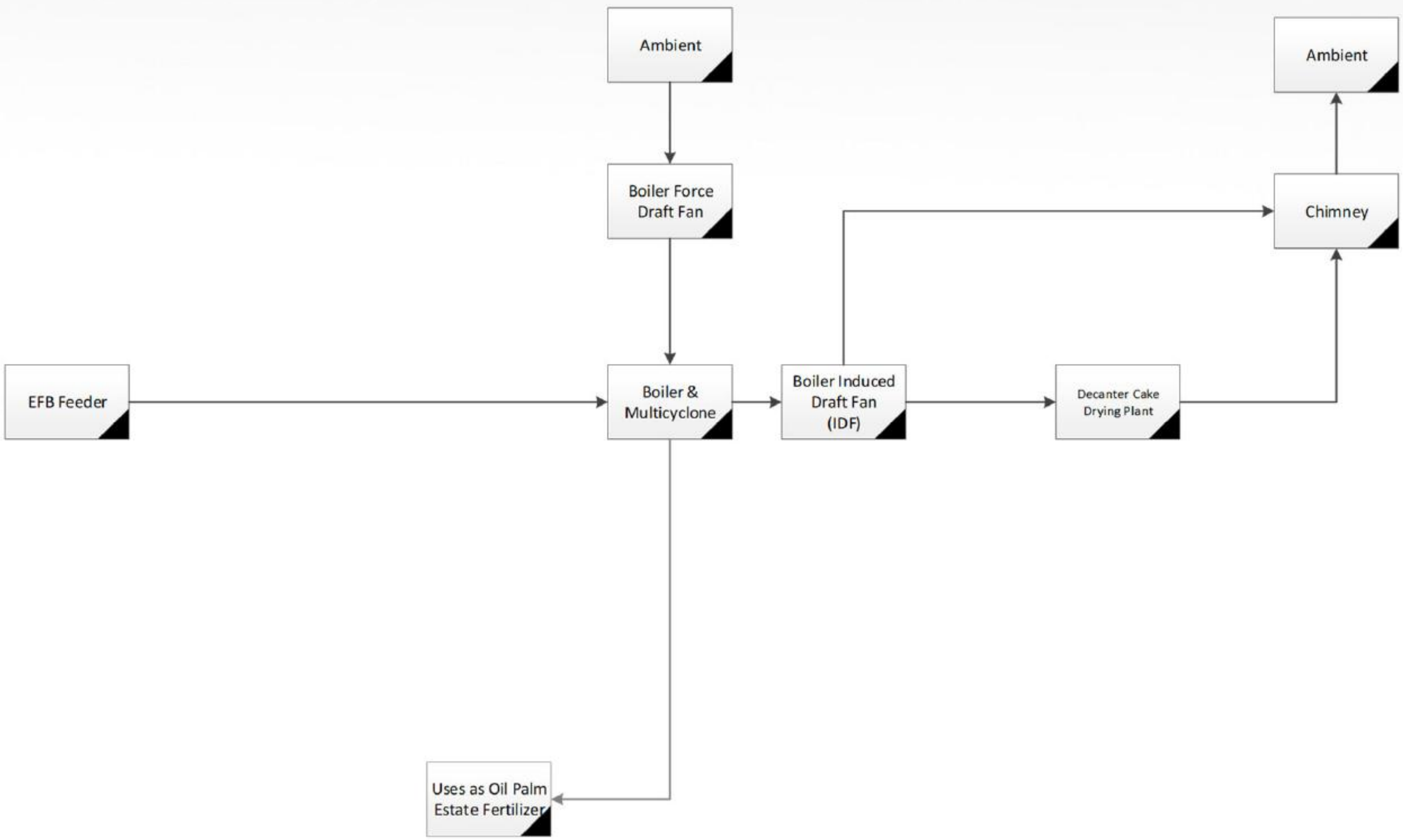
INNOVATION

Thermal Decomposition Plant

TDP TRIAL @ MJM



ORIGINAL SET UP @ MJM



TDP CALCULATION

1 INPUT

1.1 Ultimate Analysis

Element	C	H	O	N	S	Cl
Percentage	36.97%	5.12%	33.52%	0.34%	0.35%	0.00%

1.2 Proximate Analysis

Element	Moisture	Ash	Combustible	Density	HHV, kJ/kg
Percentage	20.00%	3.70%	76.30%	0.50	14,794

1.3 Throughput

FFB Throughput = 70 t/h
EFB: FFB Ratio = 23%
EFB Throughput = 16.1 t/h (Before press)
Moisture Content @ 75% [Based on Test Report]

Throughput = 4.83 t/h (After drying)
Moisture Content @ 20% [Design to control]
= 4,830 kg/h

2 CALCULATION

2.1 CALORIFIC VALUE

2.1.1 LHV = 81C + 246H + 26S - 26O - 6W
= 3,273 kCal/kg
= 13,700 kJ/kg

Total Heat Output = 66 GJ/h

2.1.2 HHV = LHV + 600 (W + 9H)
= 3,669 kCal/kg
= 15,360 kJ/kg

< 5%

2.2 AIR REQUIREMENT

2.2.1 Excess air factor = 1.8

2.2.2 Air Required, L_0 = $[8.89C + 26.7H + 3.33S - 3.33O] \times 10^{-2}$
= 3.55 Nm^3/kg
= 30,867 Nm^3/h

2.2.3 Air Required, L_0 = $[11.6C + 34.78H + 4.35S - 4.35O] \times 10^{-2}$
= 4.63 kg/kg
= 40,236 kg/h

2.3 FLUE GAS

2.3.1 Wet Flue Gas, L_v = $(m - 0.21)L_o + 1.867C + 0.7S + 0.8N + 11.2H + 1.24W + 0.62Cl$
= 7.16 Nm^3/kg
= 34,594 Nm^3/h

Normal Condition		
P_1	-	Pa
V_1	34,594	Nm^3/h
T_1	0	°C
Actual Condition		
P_2	-	Pa
V_2	116,961	m^3/h
T_2	650	°C

2.3.2 Air Moisture Content

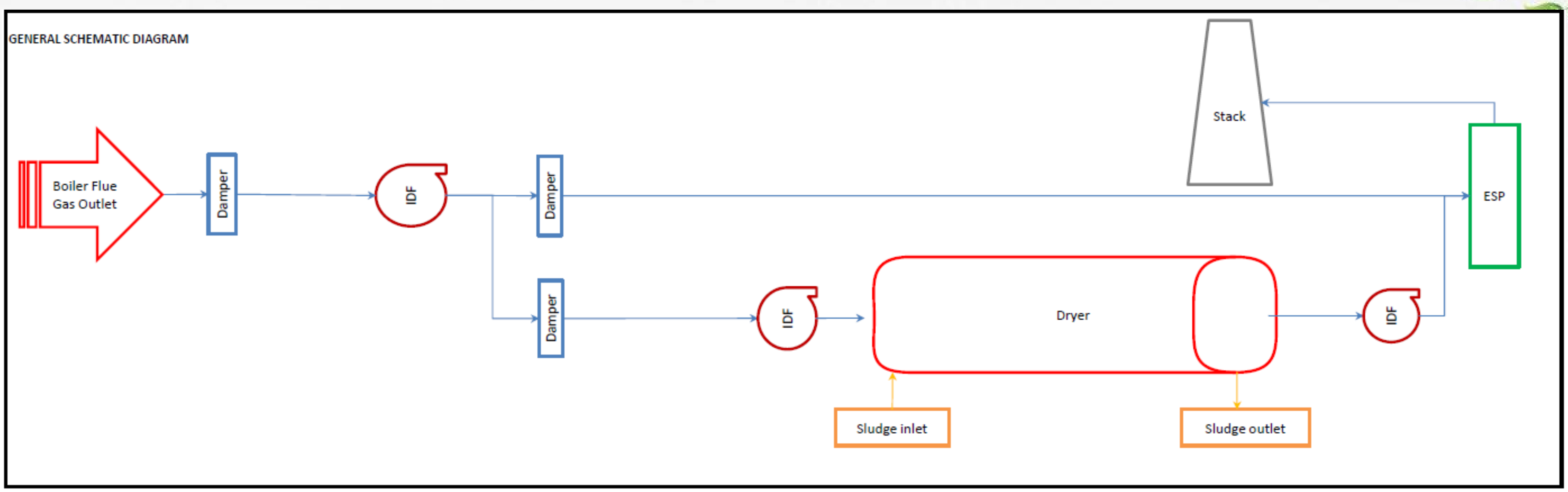
2.3.2.1 Content = 1.5%

2.3.2.2 L_m = 0.0959 Nm^3/kg

2.3.3 Dry Flue Gas (Flow) = $L_v - L_m - W - 9H$
= 6.41 Nm^3/kg
= 30,938 Nm^3/h

2.3.4 Dry Flue Gas (Mass) = $(m-0.2)L_0 + 3.667C + 2S + N + 9H + W + 1.03Cl$
= 7.71 kg/kg
= 37,229 kg/h

DRYER CALCULATION



SLUDGE DRYING PROCESS

MASS BALANCE

INLET			OUTLET		
Mass flowrate	4	t/h	Mass flowrate	1,111	kg/h
Moisture content	75%		Moisture content	10%	
Temprature	40	°C	Temperature	60	°C
Dry matter flowrate	1000	kg/h	Water content	111	kg/h
Water content	3,000	kg/h			

ENERGY BALANCE

ASSUMPTION			CALCULATION		
Specific heat of water	4.182	kJ/kg.K	Water evoporated	2,889	kg/h
Latent heat of water	2,230	kJ/kg	Energy to heat up water	9,293	kJ/h
Specific heat of sludge	0.8	kJ/kg.K	Energy to heat up sludge	16,000	kJ/h
			Energy to evaporate water	7,167,102	kJ/h
			Total energy	7,192,396	kJ/h

COLOUR NOTES

- Input Assumption
- Value from Psychrometric Chart

FLUE GAS DRYING PROCESS

MASS BALANCE

INLET		
Temprature	300	°C
Relative Humudity	0.20%	
Enthalpy	689.778	kJ/kg
Humidity Ratio	125.6609	g/kg
Specific Volume	1.953	m³/kg
Moisture per m³ flow	0.0643	kg/m³

OUTLET	Estimated	For Reference Only		
Temperature	110	110	130	°C
Relative Humudity	17.92%	20.00%	9.08%	
Enthalpy	689.78	782.55	689.78	kJ/kg
Humidity Ratio	214.28	248.82	204.06	g/kg
Specific Volume	1.46	1.52	1.519	m³/kg
Moisture per m³ flow	0.1468	0.1637	0.1343	kg/m³
Flow rate required	35,050	29,077	41,273	m³/h

ENERGY BALANCE

INLET CONDITION		
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Specific Energy	689.778	kJ/kg
Relative Humudity	0.20%	
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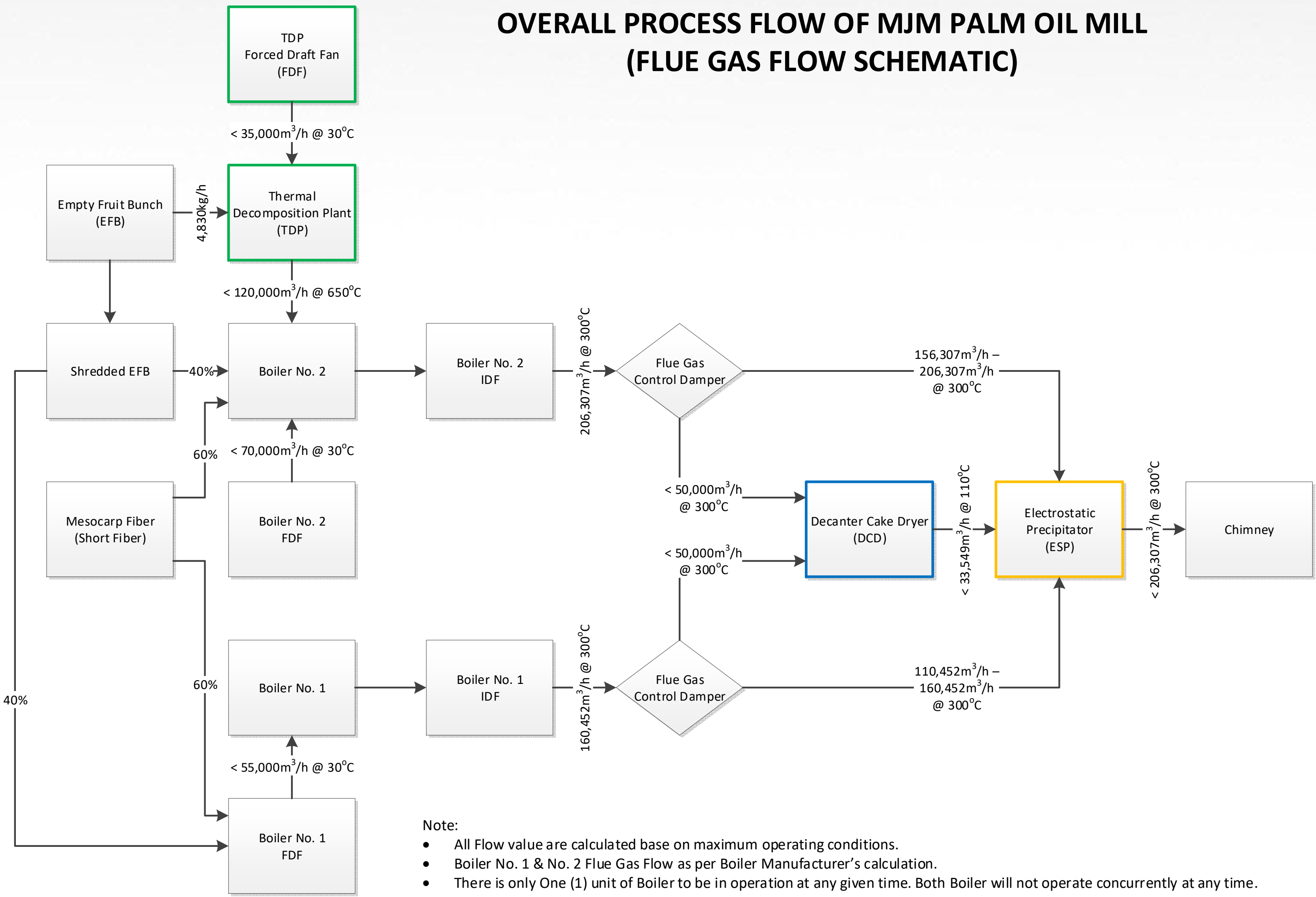
OUTLET CONDITION	Estimated	For Reference Only		
Temperature	110	110	130	°C
Specific Energy	689.78	782.55	689.78	kJ/kg
Specific Volume	1.46	1.52	1.519	m³/kg
Without evaporation				
Humidity Ratio	125.6609	125.6609	125.6609	g/kg
Enthalpy	448.85	448.85	475.11	kJ/kg
Net Energy differences	240.93	333.70	214.67	kJ/kg
Energy per m3 flow	165.02	219.54	141.32	kJ/m³
Flow rate required	43,584	32,761	50,893	m³/h

DETAIL SCHEMATIC

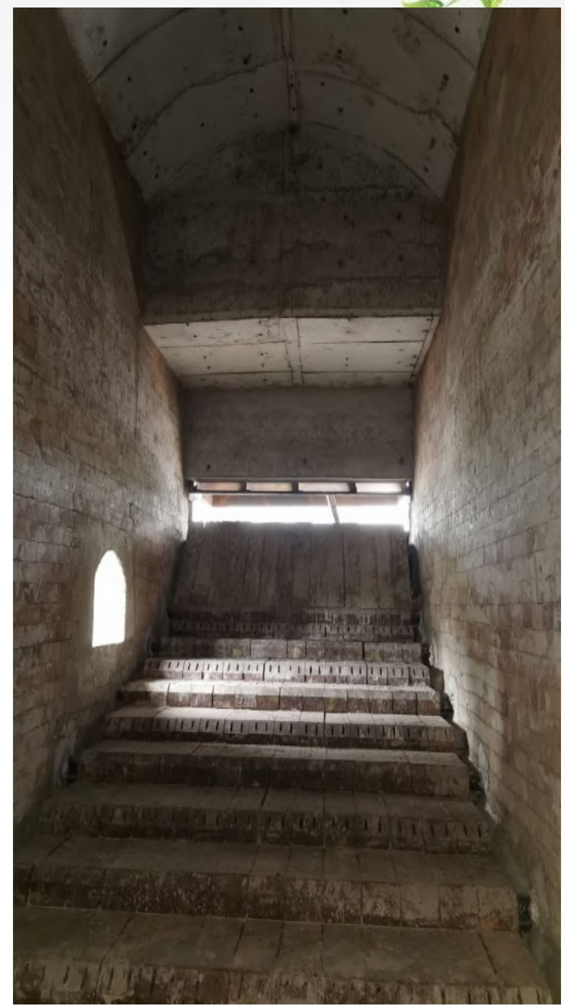
OVERALL PROCESS FLOW OF MJM PALM OIL MILL (FLUE GAS FLOW SCHEMATIC)



Note:

- All Flow value are calculated base on maximum operating conditions.
- Boiler No. 1 & No. 2 Flue Gas Flow as per Boiler Manufacturer's calculation.
- There is only One (1) unit of Boiler to be in operation at any given time. Both Boiler will not operate concurrently at any time.

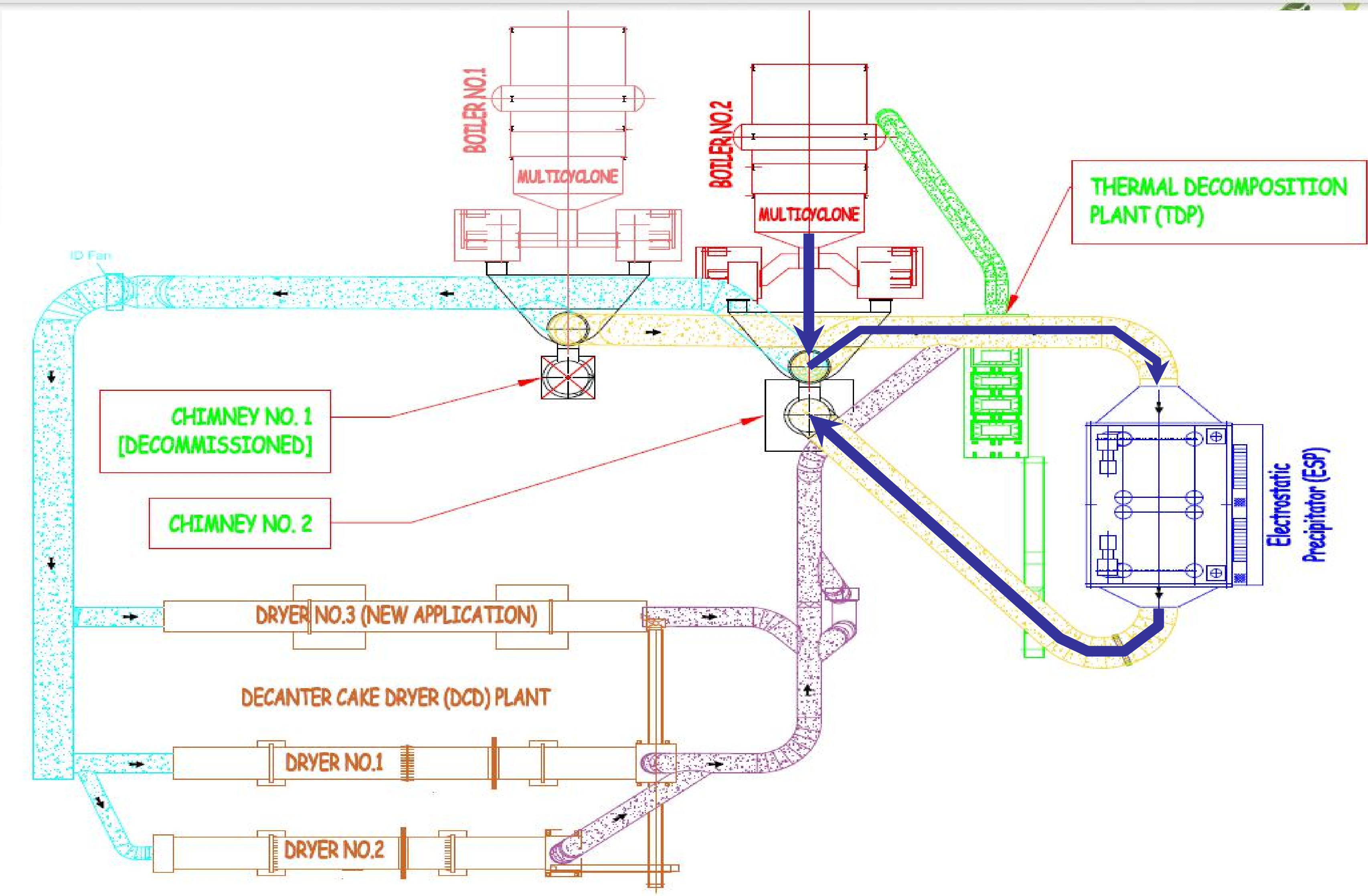
TDP CONSTRUCTION



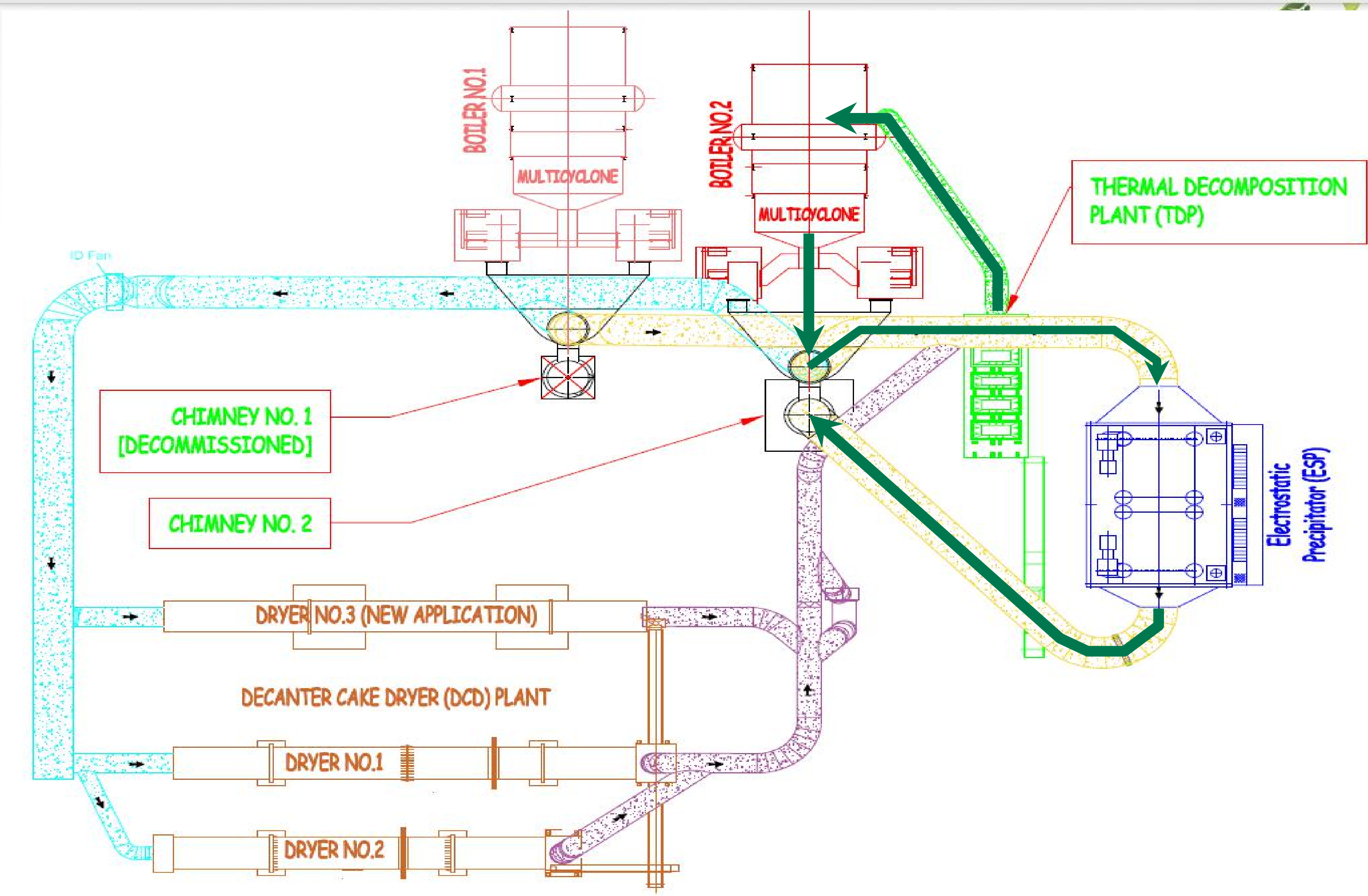
TDP

PILOT PLANT TEST RESULT

NORMAL CASE


BOILER NO.1
MULTICYCLONE
BOILER NO.2
MULTICYCLONE
THERMAL DECOMPOSITION PLANT (TDP)
ID Fan
CHIMNEY NO. 1 [DECOMMISSIONED]
CHIMNEY NO. 2
Electrostatic Precipitator (ESP)
DRYER NO.3 (NEW APPLICATION)
DECANTER CAKE DRYER (DCD) PLANT
DRYER NO.1
DRYER NO.2

NORMAL + TDP



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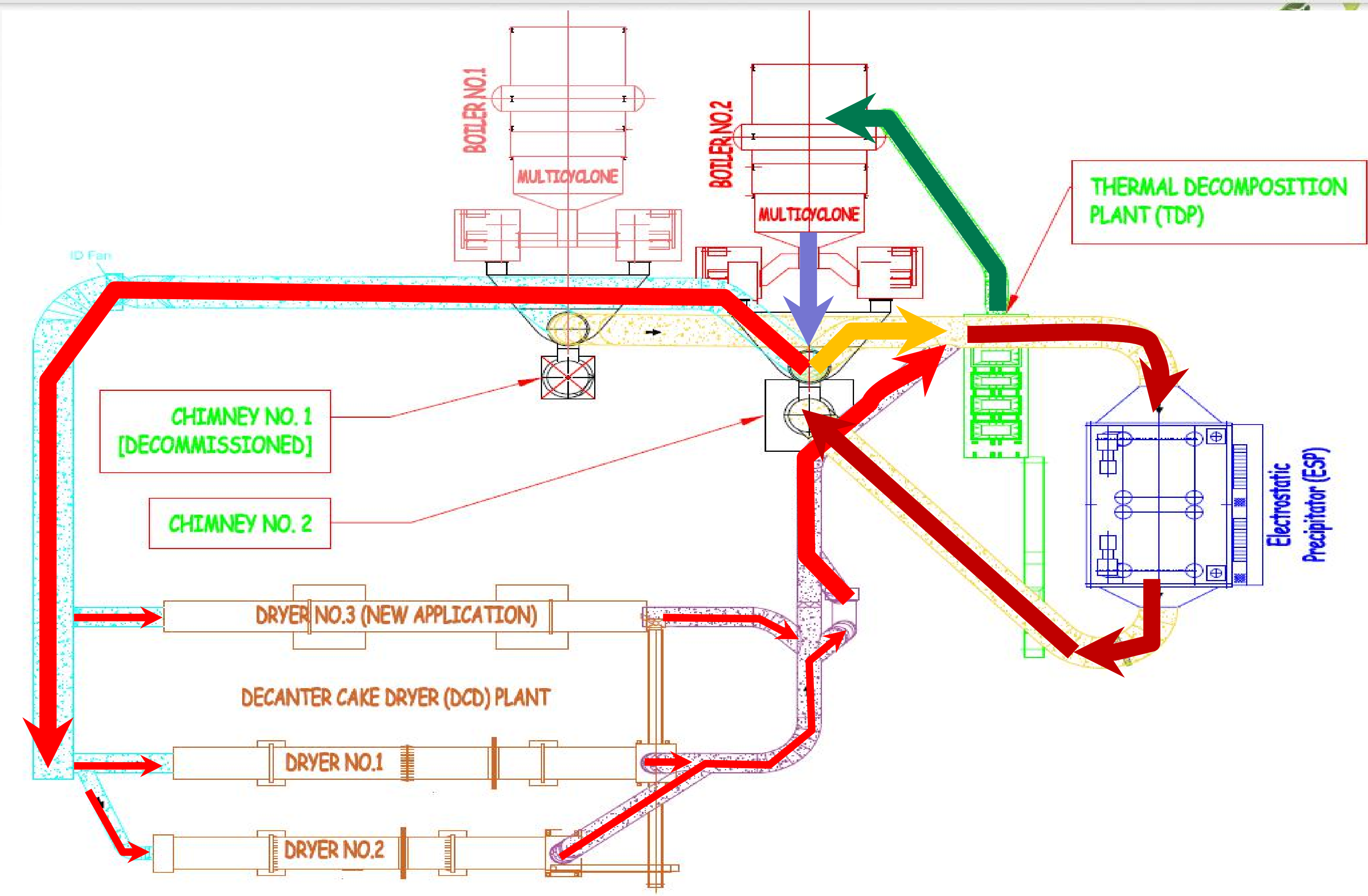
DRYER NO.1
DRYER NO.2

NORMAL + TDP + DCD



STACK SAMPLING TEST

Client	MJM (PALM OIL MILL) SDN BHD (MJM PALM OIL MILL)		
Report Reference	SBTC/MJMPOM/22(01)		
Date	22nd April 2022		
Description	**Units**	**B2-A Value (as given / measured)**	**B2-B Value (as given / measured)**
Starting Time	-	09:30 hrs	11:00 hrs
Ending Time	-	10:30 hrs	11:36 hrs
Dust Particulate Emission	mg/Nm^3, dry, @ 12% CO_2	**28.938**	**226.753**
Standard Limit (Imposed by Department of Environment)	mg/Nm^3	**400.0**	**400.0**
Description	**Units**	**B2-C Value (as given / measured)**	**B2-D Value (as given / measured)**
Starting Time	-	12:00 hrs	13:00 hrs
Ending Time	-	12:36 hrs	13:36 hrs
Dust Particulate Emission	mg/Nm^3, dry, @ 12% CO_2	**65.333**	**73.571**
Standard Limit (Imposed by Department of Environment)	mg/Nm^3	**400.0**	**400.0**

EMISSION TEST RESULT

No.	Scenarios Description	Stack Sampling Result Dust Concentration (mg/m^3@12%CO_2)	Remarks
1	In Operation: Boiler 2 + ESP Not In Operation: TDP, DCD	73.571	NORMAL CASE (with ESP)
2	In Operation: TDP + Boiler 2 + ESP Not In Operation: DCD	65.333	NORMAL CASE + TDP
3	In Operation: TDP + Boiler 2 + DCD + ESP	29.938	NORMAL CASE + TDP + DCD
4	In Operation: TDP + Boiler 2 + DCD Not In Operation: ESP	226.753	NORMAL CASE (without ESP)

* Sampling & Tested by Accredited 3rd Party

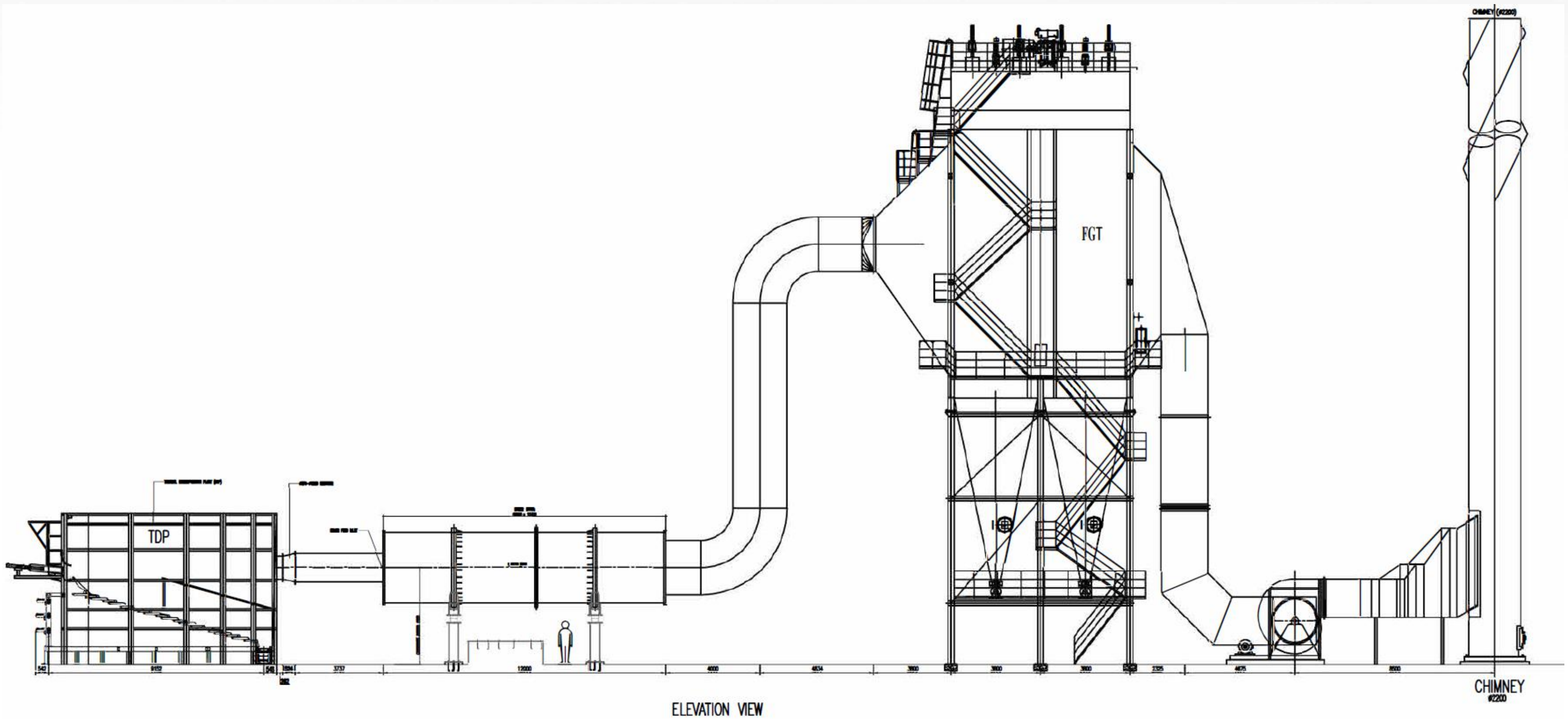
FUTURE

PLAN FORWARD

CONDITION of CONCEPT

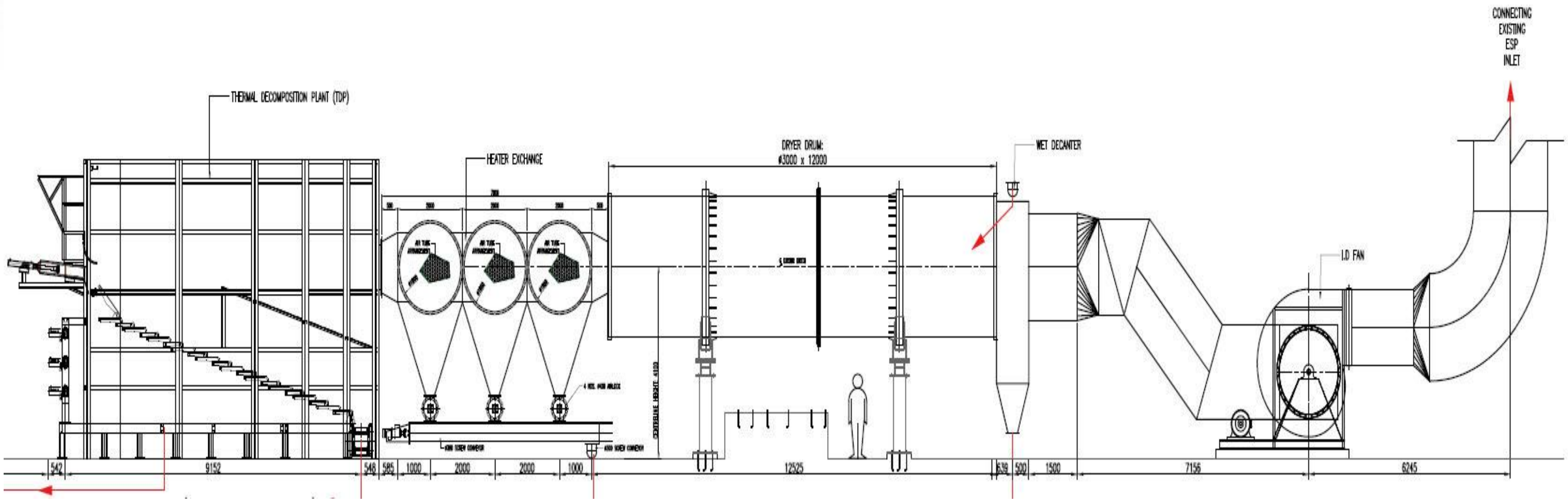
- TDP **NEAR** to existing boiler
- IDF of existing boiler was **OVERSIZED**
- **SPACE** availability is sufficient
- Throughput **LIMITED** by existing IDF

FULLY STANDALONE TDP



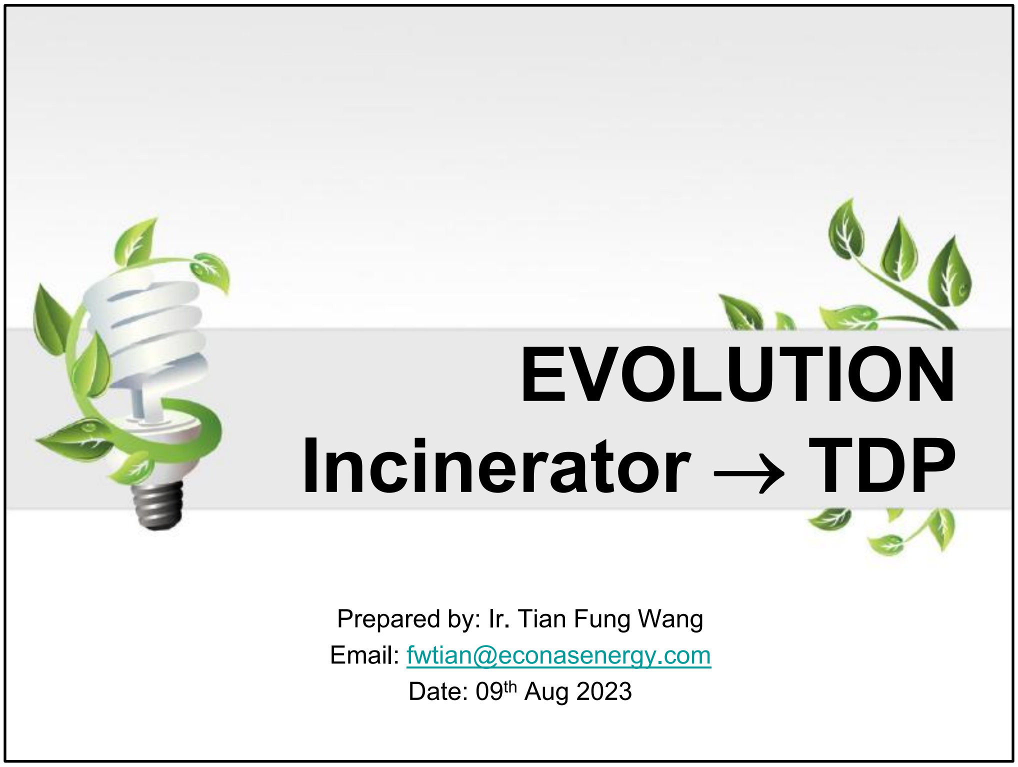
TDP DCD FGT IDF

PARTIAL STANDALONE



TDP HEX DCD IDF

SARAWAK's EFB TREATED via SARAWAK INNOVATION



Good afternoon, ladies & gentlemen.

My topic of discussion today is Evolution from Incinerator to TDP.

Honestly, I am not an expert in Palm Oil industry. My specialty is thermal treatment of municipal waste & hazardous waste.

My apology, if there is any error of facts in relation to Palm Oil industry, and please feel free to correct me.

Before I present in detail of TDP, I wish to explain a bit of my background which lead to the idea of evolving existing Natural Draft incinerator to TDP.

I had completed:

1. Thailand 1st Large Scale Municipal Waste Incineration Power Plant,
2. China, Xi An Municipal Waste to Fertilizer Plant,
3. Malaysia 1st Hazardous Waste Incineration Power Plant and
4. Indonesia 1st Large Scale Municipal Waste Gasification Power Plant.

All of these projects utilizing thermal treatment for waste disposal purpose.

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Surabaya 750TPD
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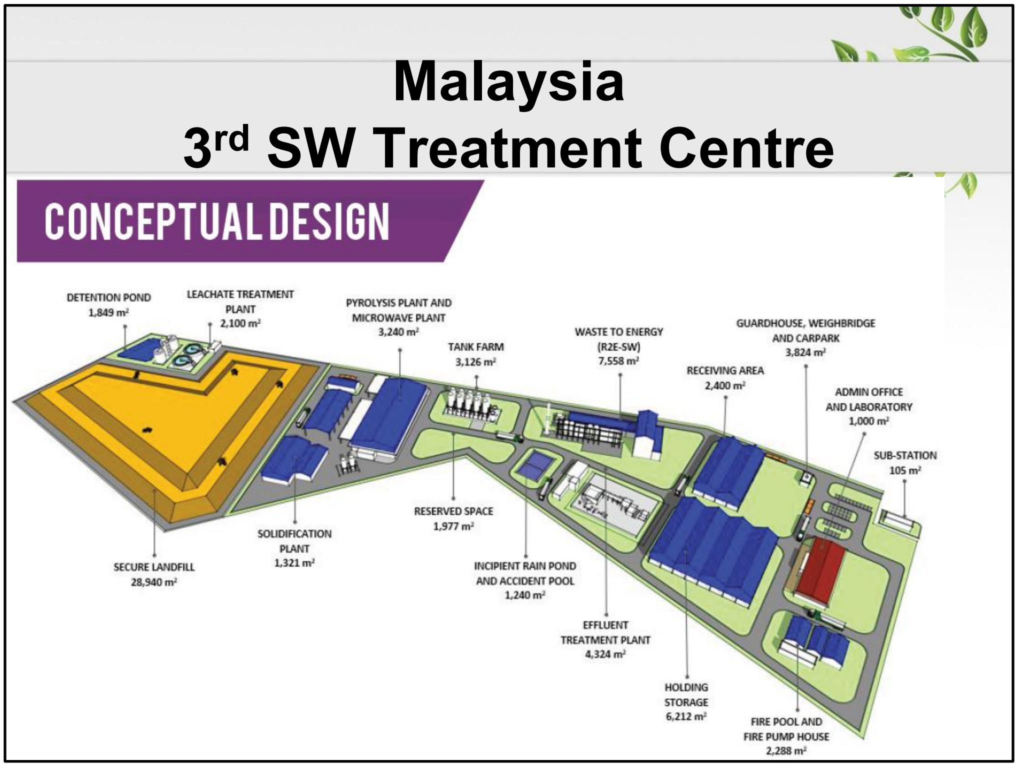

Nowadays, myself and partners are in the mid of developing Malaysia 3rd Scheduled Waste treatment center in Johor mainly to serve industry at southern part of Malaysia, generally serving whole Malaysia.

From the experience of municipal waste & hazardous waste incineration, it led to the idea of implementing the high efficiency combustion concept in Empty Fruit Bunch treatment for Palm Oil industry.

From my understanding, most of Sarawak Palm Oil Mill facing several challenges such as:

1. Empty Fruit Bunch disposal using low combustion efficiency natural draft incinerator
2. Difficulty in disposal of wet decanter cake
3. Enforcement of Environmental Quality Clean Air Regulations 2014

Empty Fruit Bunches

Wet Decanter Cake

EQ CAR 2014

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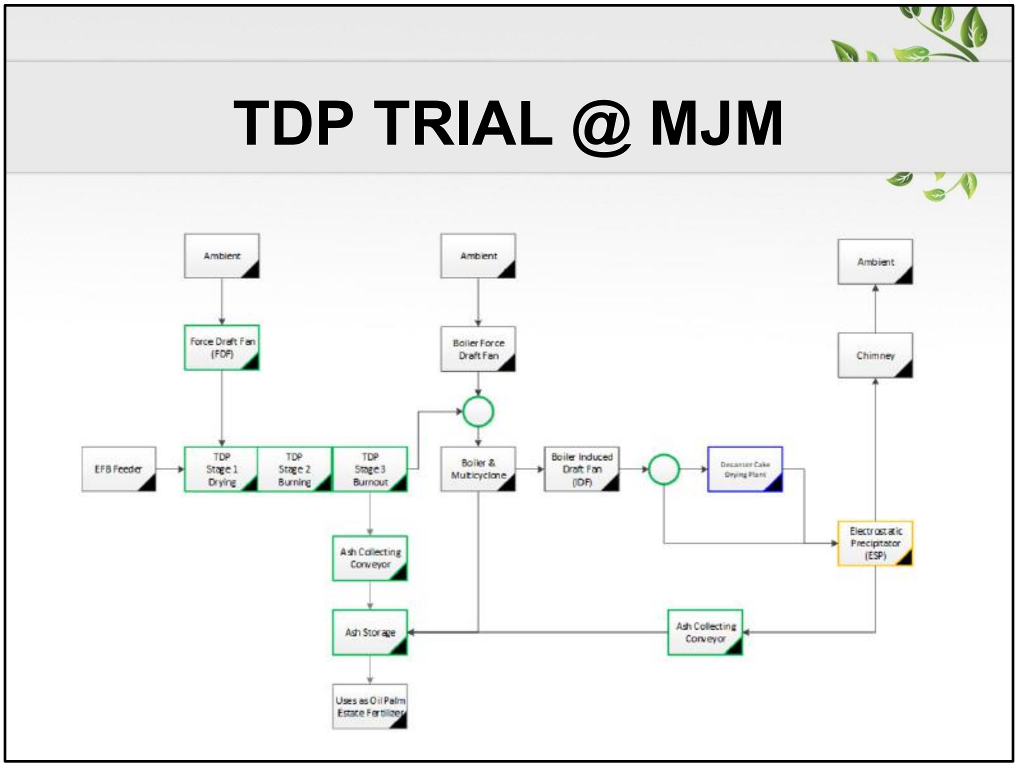
	Carbon monoxide (CO)	1000 mg/m³	Periodic

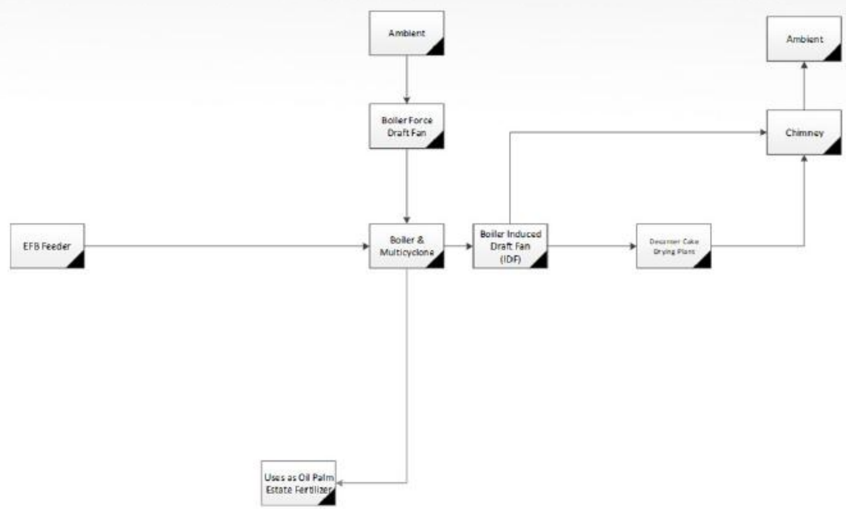
*Averaging time for continuous monitoring is 30 minutes

Due to the above, I was given a task by my brother to propose a high combustion efficiency concept in disposing EFB. Thus, it come to the innovation of TDP known as Thermal Decomposition Plant.



We had completed a Pilot Plant in MJM Palm Oil Mill by retrofitting the current Boiler set up to incorporate TDP into the overall process flow. Basically, we added a high efficiency combustion chamber that is able to burn 100% EFB couple with the current boiler operation mainly for EFB disposal. From the Pilot Plant, we found that the Ash generated consist of 25-30% potassium content which can be used as fertilizer.

ORIGINAL SET UP @ MJM



TDP CALCULATION

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Moisture Content @ 75% [Based on Test Report]

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Moisture Content @ 20% [Design to control]

= 4,830 kg/h

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= 3,669 kCal/kg

= 15,360 kJ/kg

< 5%

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= 7.16 Nm^3/kg

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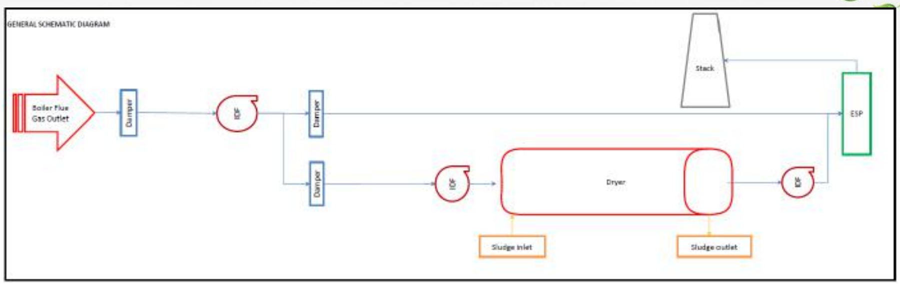
Here is calculation for TDP & Dryer during the design stage as it is important because the whole process was interlinked.

DRYER CALCULATION



SLUDGE DRYING PROCESS

MASS BALANCE

INLET			OUTLET		
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COLOUR NOTES

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FLUE GAS DRYING PROCESS

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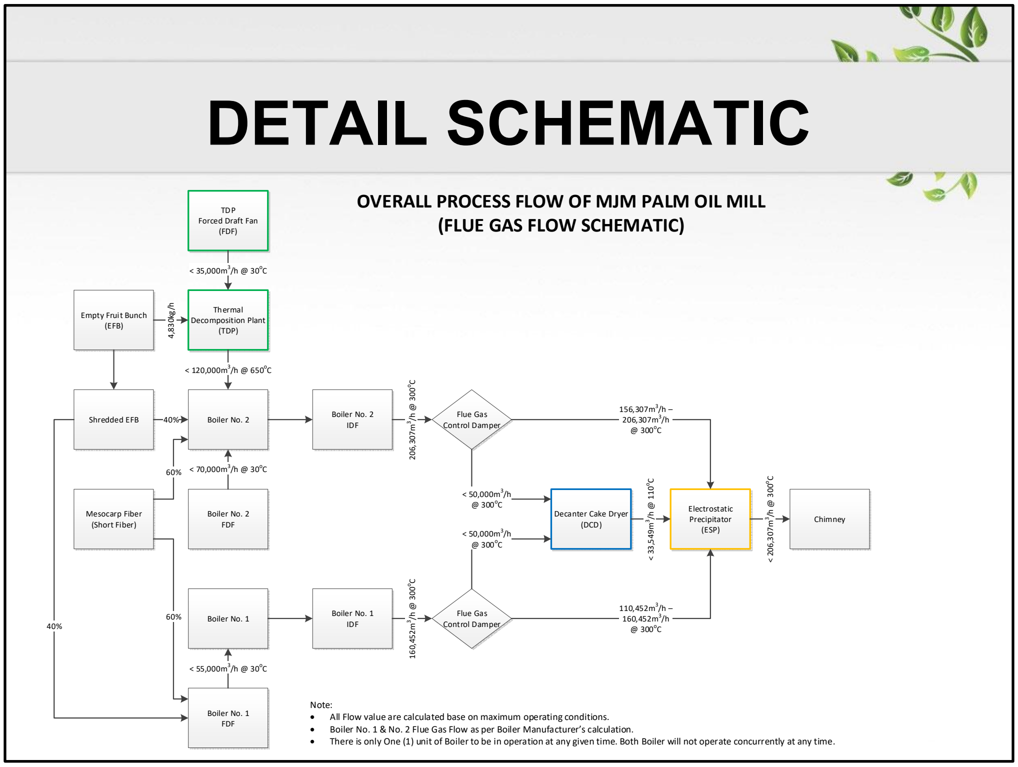
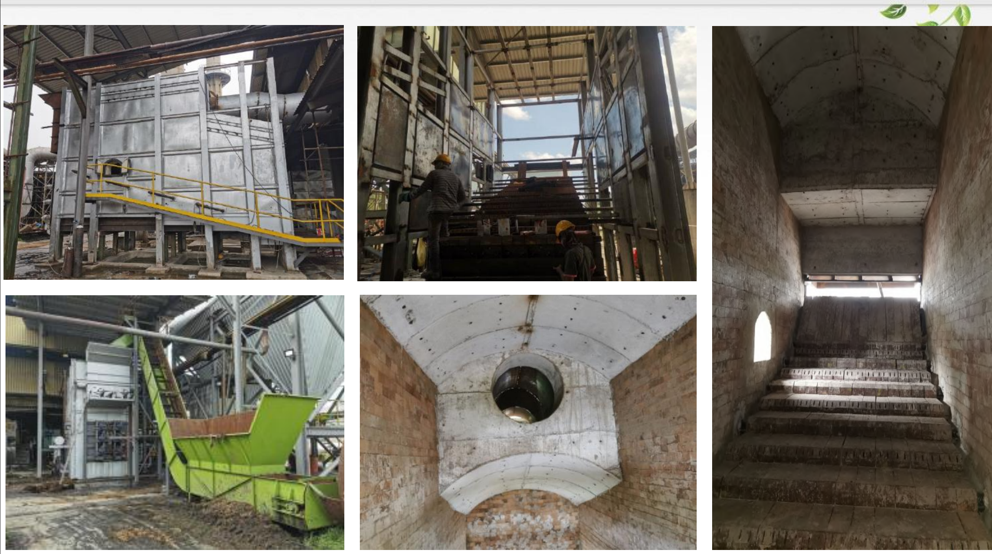
Flow rate required	43,584	32,761	50,893	m^3/h



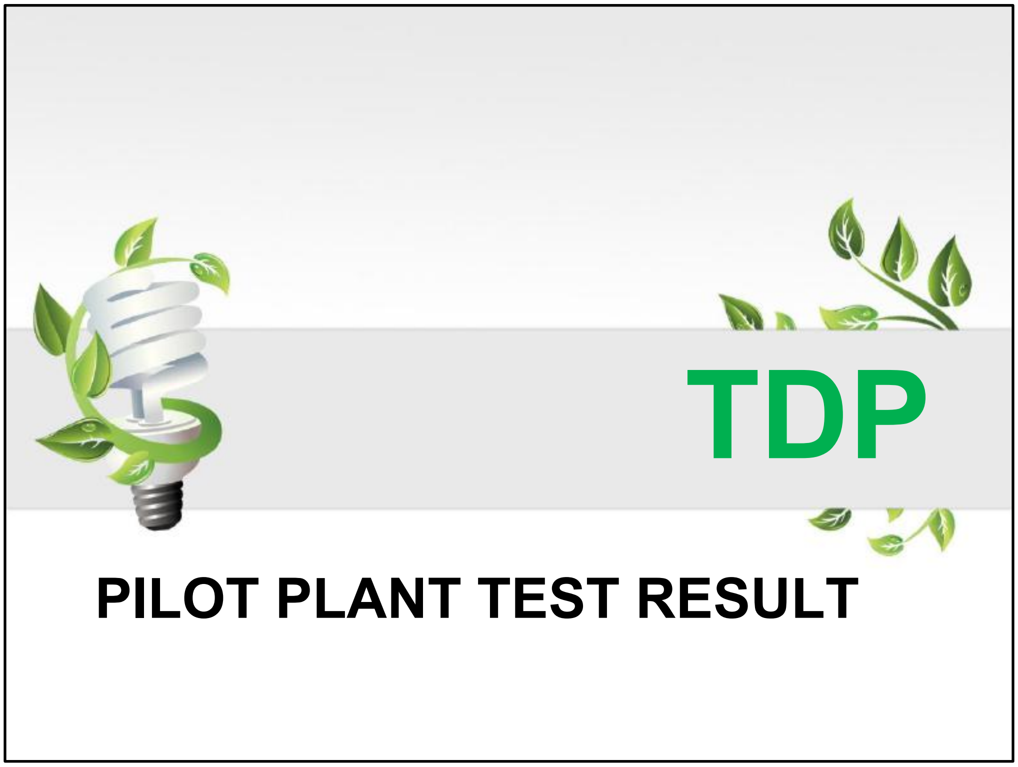
Hot flue gas from TDP channeled into Boiler may help to reduce the need of burning PKS in the boiler.

Since MJM Plant also facing Wet Decanter cake issue, the hot flue gas from boiler was used to dry up the wet decanter cake for other purpose which give additional income stream to the Palm Oil Mill.

TDP CONSTRUCTION



Here are some photos of TDP during construction.

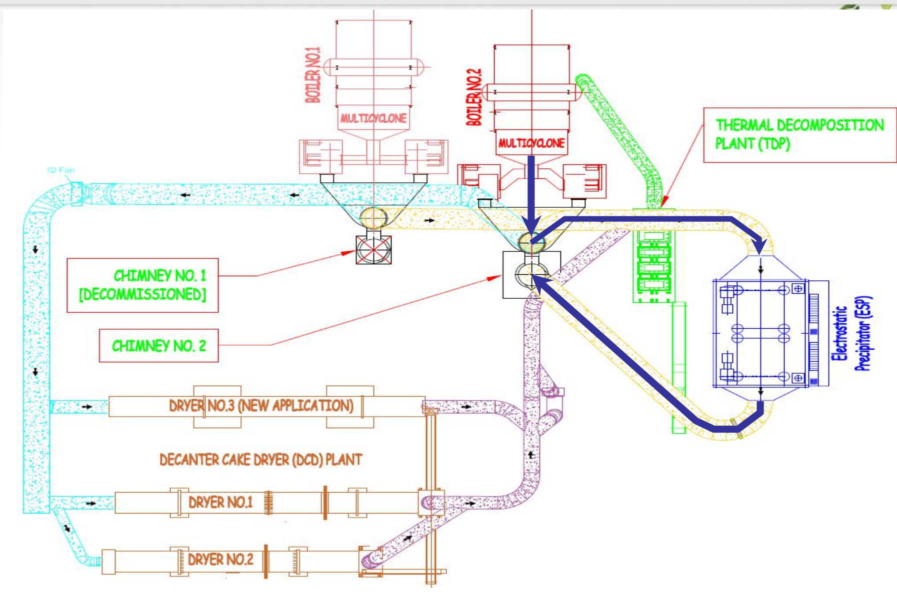


Please allow me to present you the Pilot Plant third party sampling result on TPM for your reference.

Since the plant consist of existing Boiler, TDP and DCD, we categorize the operating condition as

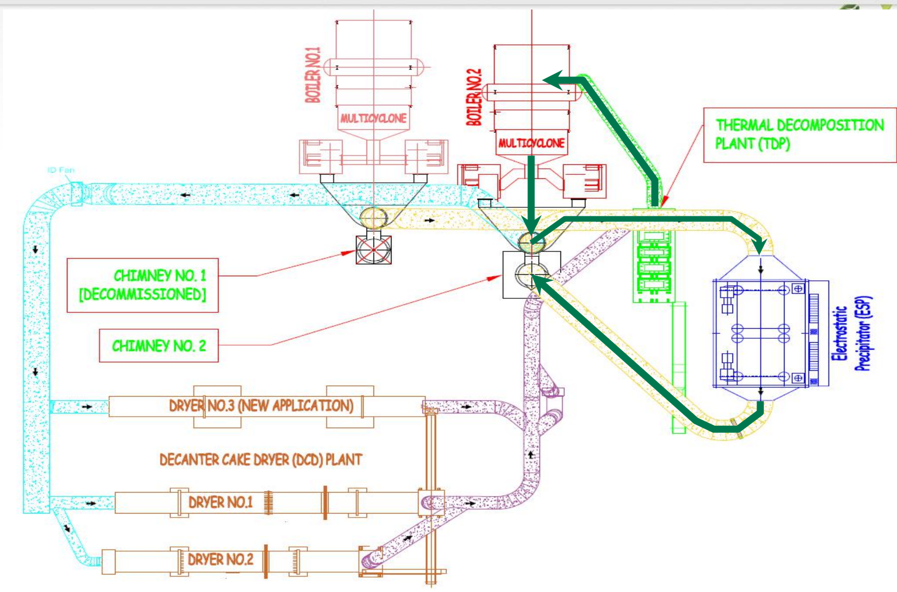
1. Normal Case – Only Boiler is in Operation
2. Normal Case + TDP – Boiler & TDP is in Operation
3. Normal Case + TDP + DCD – Boiler, TDP & DCD are all in operation

NORMAL CASE

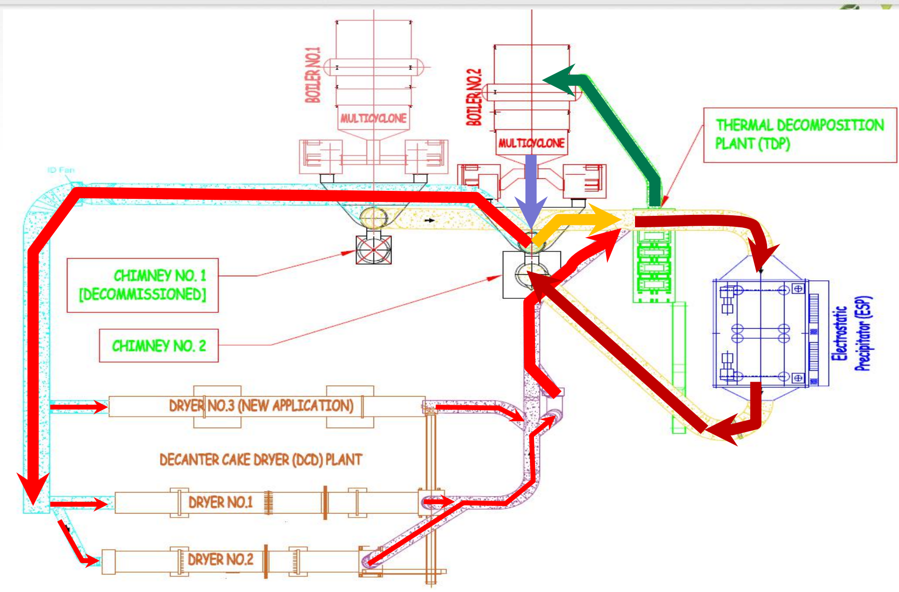


BOILER NO.1
MULTICYCLONE
BOILER NO.2
MULTICYCLONE
THERMAL DECOMPOSITION PLANT (TDP)
CHIMNEY NO. 1 [DECOMMISSIONED]
CHIMNEY NO. 2
Electrostatic Precipitator (ESP)
DRYER NO.3 (NEW APPLICATION)
DECANTER CAKE DRYER (DCD) PLANT
DRYER NO.1
DRYER NO.2

NORMAL + TDP


BOILER NO.1
MULTICYCLONE
BOILER NO.2
MULTICYCLONE
THERMAL DECOMPOSITION PLANT (TDP)
ID Fan
CHIMNEY NO. 1 [DECOMMISSIONED]
CHIMNEY NO. 2
Electrostatic Precipitator (ESP)
DRYER NO.3 (NEW APPLICATION)
DECANTER CAKE DRYER (DCD) PLANT
DRYER NO.1
DRYER NO.2

NORMAL + TDP + DCD



STACK SAMPLING TEST

Client	MJM (PALM OIL MILL) SDN BHD (MJM PALM OIL MILL)		
Report Reference	SBTC/MJMPOM/22(01)		
Date	22nd April 2022		
Description	**Units**	**B2-A Value (as given / measured)**	**B2-B Value (as given / measured)**
Starting Time	-	09:30 hrs	11:00 hrs
Ending Time	-	10:30 hrs	11:36 hrs
Dust Particulate Emission	mg/Nm^3, dry, @ 12% CO_2	**28.938**	**226.753**
Standard Limit (Imposed by Department of Environment)	mg/Nm^3	**400.0**	**400.0**
Description	**Units**	**B2-C Value (as given / measured)**	**B2-D Value (as given / measured)**
Starting Time	-	12:00 hrs	13:00 hrs
Ending Time	-	12:36 hrs	13:36 hrs
Dust Particulate Emission	mg/Nm^3, dry, @ 12% CO_2	**65.333**	**73.571**
Standard Limit (Imposed by Department of Environment)	mg/Nm^3	**400.0**	**400.0**

Third party sampling was done for these operating conditions.

EMISSION TEST RESULT

No.	Scenarios Description	Stack Sampling Result Dust Concentration (mg/m^3@12%CO_2)	Remarks
1	In Operation: Boiler 2 + ESP Not In Operation: TDP, DCD	73.571	NORMAL CASE (with ESP)
2	In Operation: TDP + Boiler 2 + ESP Not In Operation: DCD	65.333	NORMAL CASE + TDP
3	In Operation: TDP + Boiler 2 + DCD + ESP	29.938	NORMAL CASE + TDP + DCD
4	In Operation: TDP + Boiler 2 + DCD Not In Operation: ESP	226.753	NORMAL CASE (without ESP)

* Sampling & Tested by Accredited 3rd Party

We found that,

1. ESP is able to achieve 73ppm at Normal case as compare to 226ppm without ESP.
2. During TDP in operation, the dust particulate emission reduces a little bit as the combustion had been shifted in front gives more room for dust settling.
3. During DCD in operation, the dust particulate emission reduces significantly because temperature of the flue gas was dropping and the ESP now become oversized in terms of flow rate and yield better efficiency.

Next, I wish to share some of the plan forward in treating EFB via TDP.

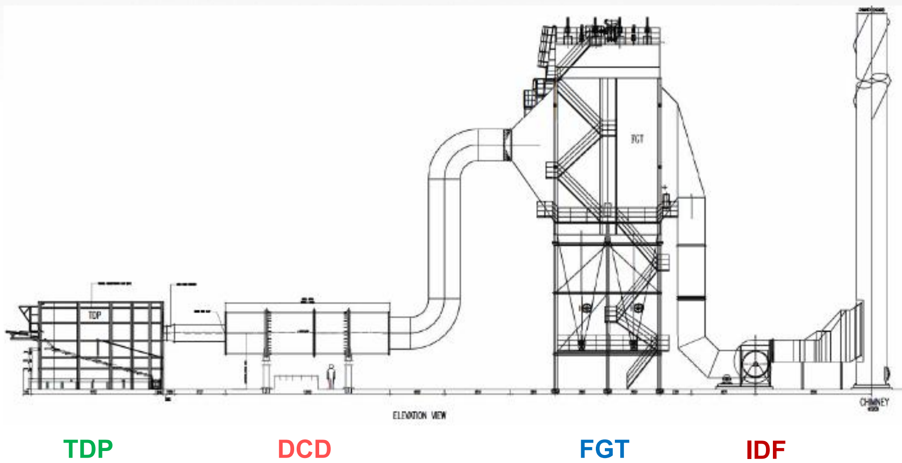
CONDITION of CONCEPT

- TDP **NEAR** to existing boiler
- IDF of existing boiler was **OVERSIZED**
- **SPACE** availability is sufficient
- Throughput **LIMITED** by existing IDF

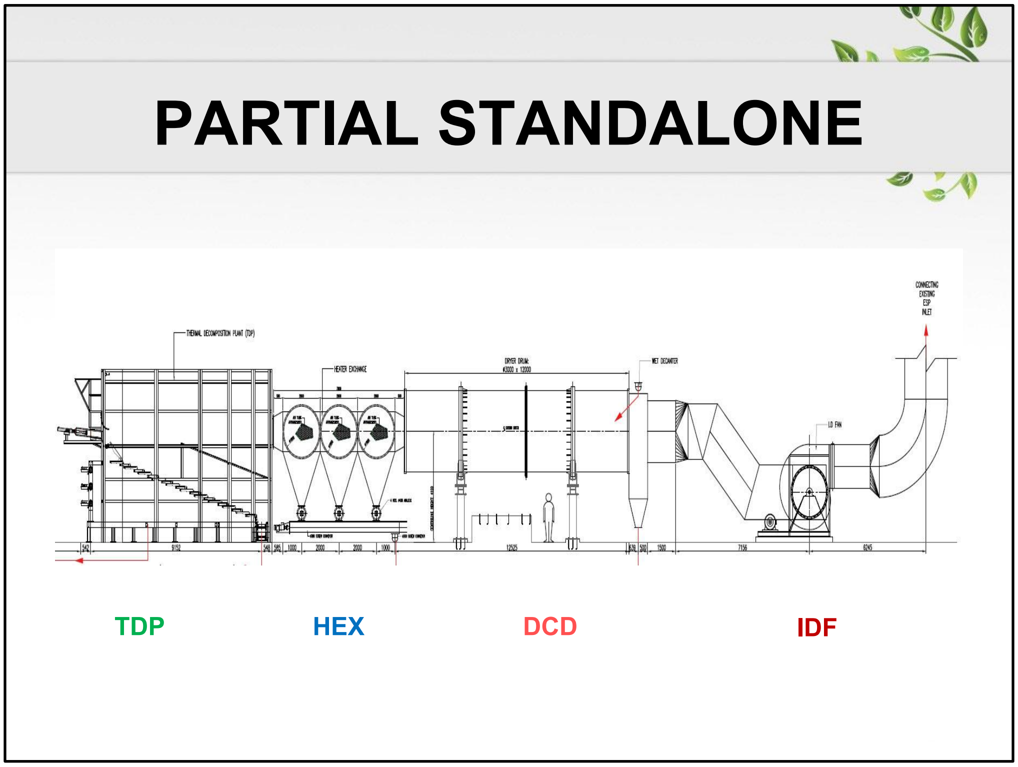
Since the TDP in Pilot Plant was couple with existing boiler, there are some limitations in scaling up of this concept:

1. In terms of layout, TDP need to be near to existing Boiler
2. In terms of capacity, IDF of existing boiler need to be oversized or still have room for speeding up.
3. Normally, there is no space beside existing boiler for most of the Palm Oil Mill.
4. Throughput of TDP will be limited by the Boiler IDF as it relying on IDF in controlling the negative pressure in combustion chamber.

FULLY STANDALONE TDP



Due to the above limitation, the solution is to have a fully standalone unit like this OR



partially standalone unit like this where the throughput of EFB disposed was not limited.

Last but not least, I think we need to put effort to resolve our own challenges within Sarawak because the nature of the commercial environment in Sarawak might be different from the other states.

For example, other states in Malaysia may apply Feed In Tariff for EFB Power Plant and get good revenue while generating electricity from EFB and export to the national grid. Unfortunately, Feed In Tariff in Sarawak might not be that attractive as compare to other states for the moment. Thus, converting EFB to fertilizer probably give better ROI in Sarawak.

This ends my today's presentation. Thank you for your passion and I wish you all the best.