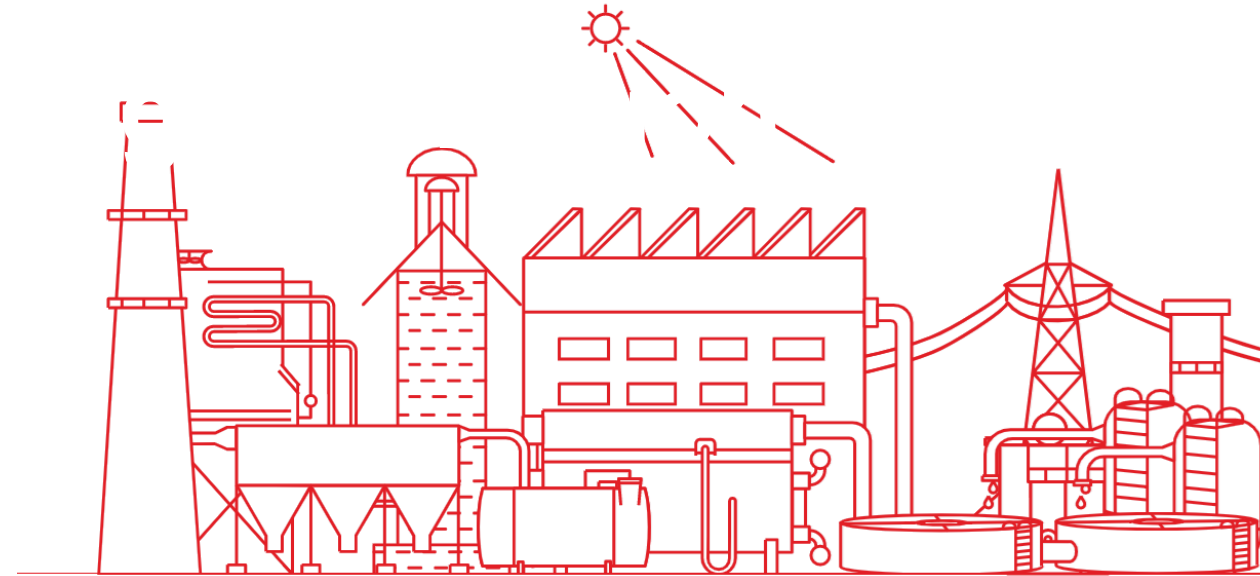




Upscaling, R&D in High Ash Coal Gasification

Thermax-Trusted Partner in Energy Transition



Thermax-Trusted Partner in Energy Transition



Power



Heating



Cooling



Water Treatment



Chemical

Utilities



Raw Material

Desired Product

Waste

Hazardous Waste Treatment



Wastewater Treatment



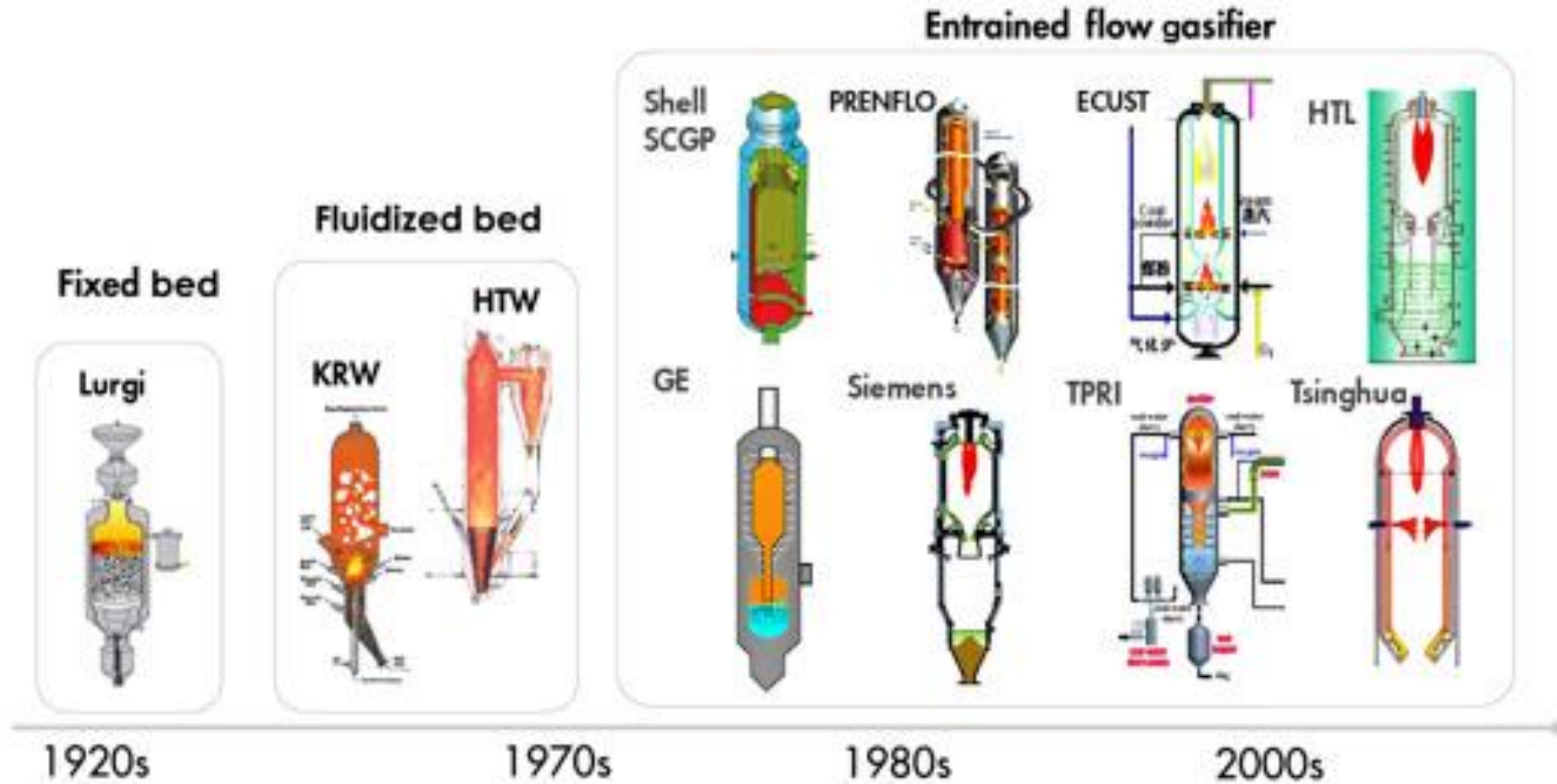
Air Pollution Control



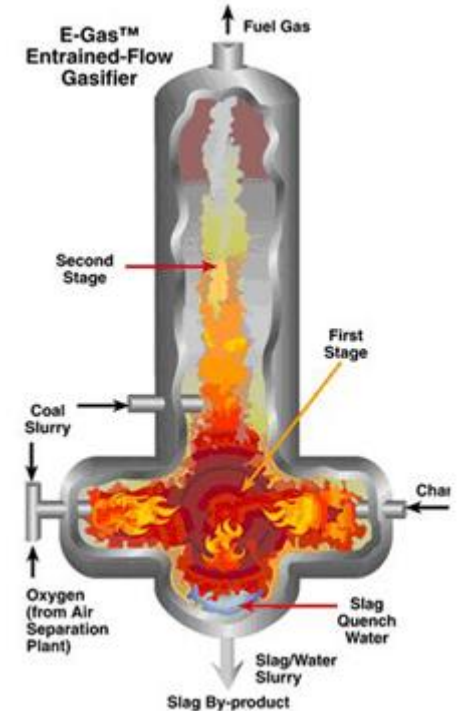
Waste to Energy Generation



Gasifier Worldwide



RIL India



CB&I E-Gas
ConocoPhillips

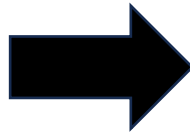
KRW : Kellogg-Rust-Westinghouse
HTW: High Temp Winkler
PRENFLO : Kopper and Uhde

TPRI : Thermal Power Research Institute, China
ECUST: East China University of Science and Technology
HTL: China Aerospace Science and Technology Corporation
Tsinghua: Tsinghua University's Institute of Thermal Engineering

Fluidized bed Gasification : Technically Feasible Solution For High Ash Indian Coal

Indian Coal

High ash coal (35-45% ash)
Low GCV fuel (<4300 kcal/kg)
High ash fusion temp. (>1300 DegC)
Medium reactivity ($R_{CO_2} \sim 2 \text{ hr}^{-1}$)



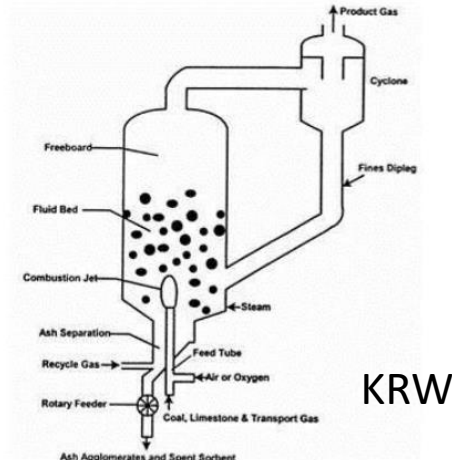
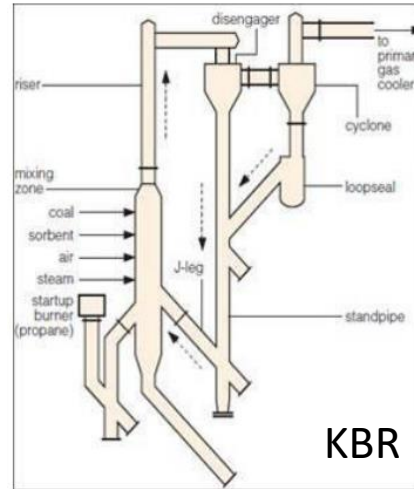
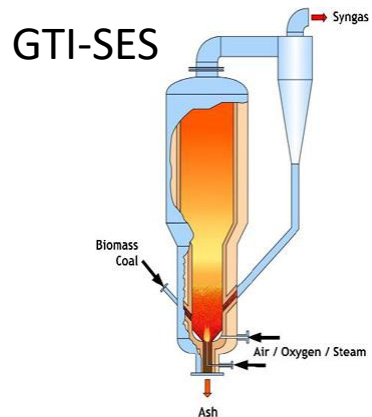
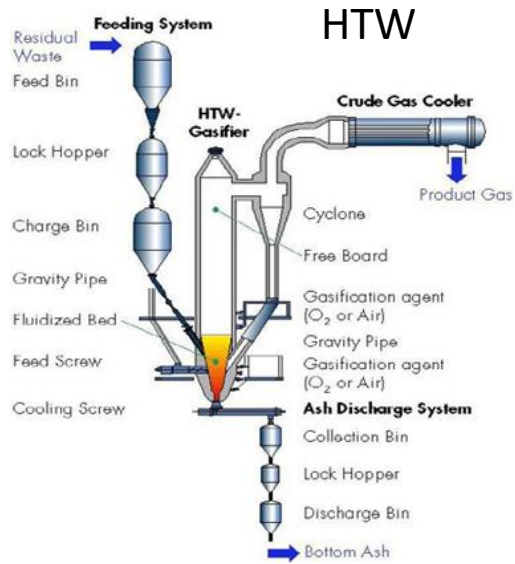
Suitability of Fluidized bed Gasifier

- Offer Fuel flexibility
- Operating Temp. <1050 degC
- No ash melting required
- Lower Oxygen demand than Entrained flow gasifier
- Medium pressure (<6 bar)
- No pulverization (Coal size <6mm)
- No Tar Oil emissions
- Coal Feed +2mm to -6mm

R_{CO_2} : CO₂ reactivity at 950 DegC

GCV: Gross Calorific Value

FBG: Global and Indian Scenario



Indian Scenario:
Indigenous Efforts

Thermax & IITD
Air blown : 4 TPD
Oxy Blown: 6 TPD
Methanol : 1 TPD

BHEL
Air blown : 18 TPD and 168 TPD
Oxyblown: 1,2 TPD
Methanol : 0.25 TPD

CIMFR
Air blown : 0.5 TPD
Oxyblown: 1.5 TPD
Methanol : 0.25 TPD

KRW : Kellogg-Rust-Westinghouse
HTW: High Temp Winkler
KBR: Kellogg, Brown, & Root (KBR) Transport Gasifier
GTI: Gas Technology Institute
SES: Synthesis Energy System

Indigenously developed Indian CTM Pilot Plant

- **Coal:** High Ash Indian Coal
- **Gasification Technology:**
 - Fluidized Bed Coal Gasification Plant
 - 6 TPD coal firing / 4 TPD CO₂/ 1 TPD Methanol
 - Upto 6 bar fire side pressure
- **Location :** Thermax Ltd., Chinchwad Pune



Project sponsored by DST & Supported by NITI Aayog

Fluidized Bed (6 TPD) Gasifier

- Bubbling fluidized Bed (With and without solid recycle)
- Oxy-blown
- Medium Pressure : <6 bar
- Flat plate distributor
- Uniform bed temp. : 950-1000°C
- Reduced tar/HC generation due to high temperature
- Good carbon conversion
- Stable and Safe operation



Coal to Methanol Pilot Plant Testing & Performance

Coal Grade	G10	G12	G14	G10	G15	G16	G12
Coal	Ranchi	WCL-01	WCL t	WCL-02	WCL-03	MCL-01	WCL-04
	DG20	DG24	DG26	DG32	DG34	DG35	DG-36
FC (wt%)	39.00	25.79	22.51	34.05	22.55	15.40	28.85
VM	28.10	22.82	22.35	19.90	20.89	20.76	27.03
Moist	6.70	7.45	5.32	6.02	4.94	6.97	9.08
Ash	26.20	43.94	49.82	40.03	51.62	56.87	35.04
Total	100.00	100.00	100.00	100.00	100.00	100.00	100
Coal GCV [kcal/kg]	4387	3835	3312	4326	2891	2298	4054

1100 Litres/Day
Methanol
production capacity

4 TPD CO₂
capture capacity
achieved

7
Types of Coal
tested

6
TPD Coal firing

Salient Observations:

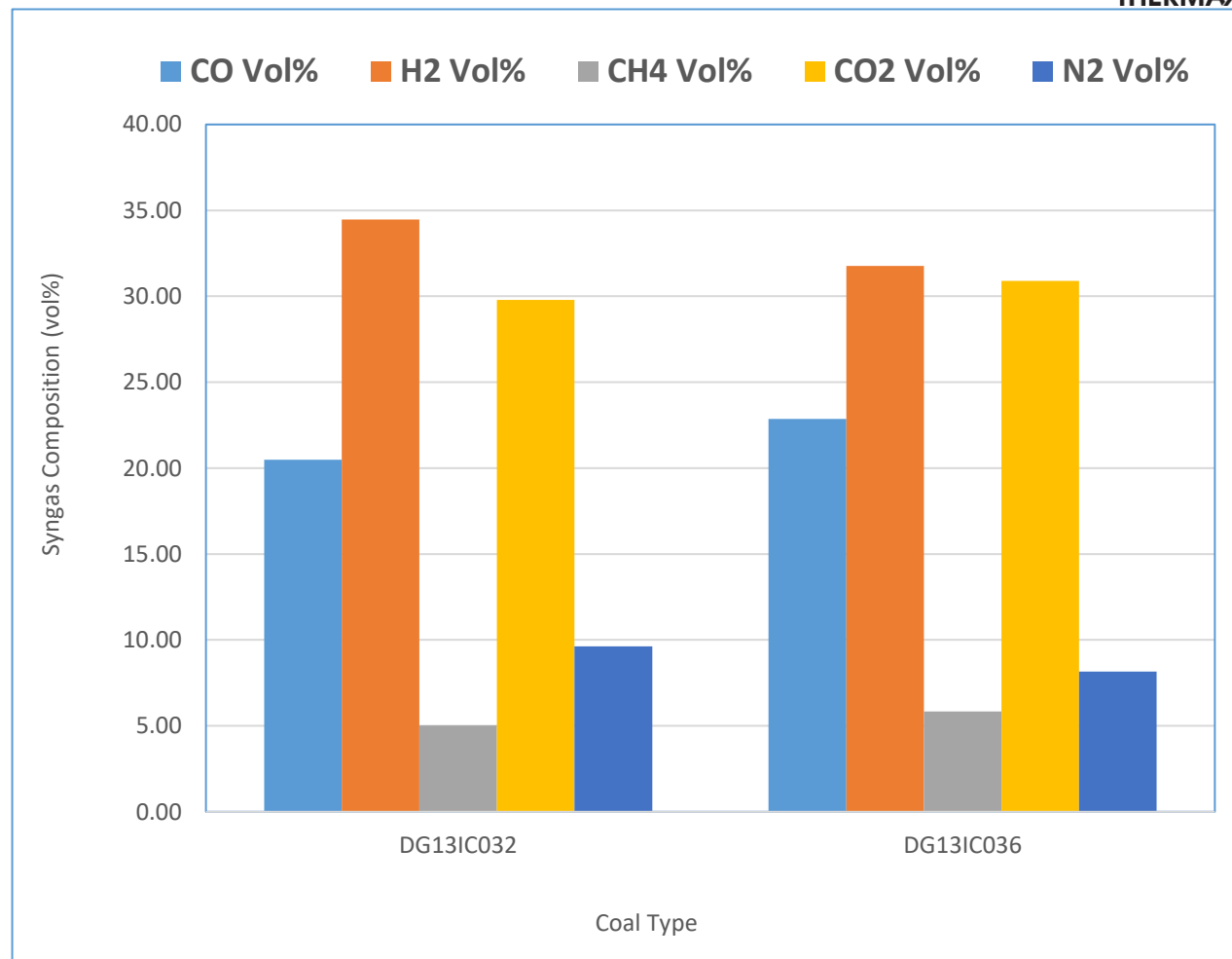
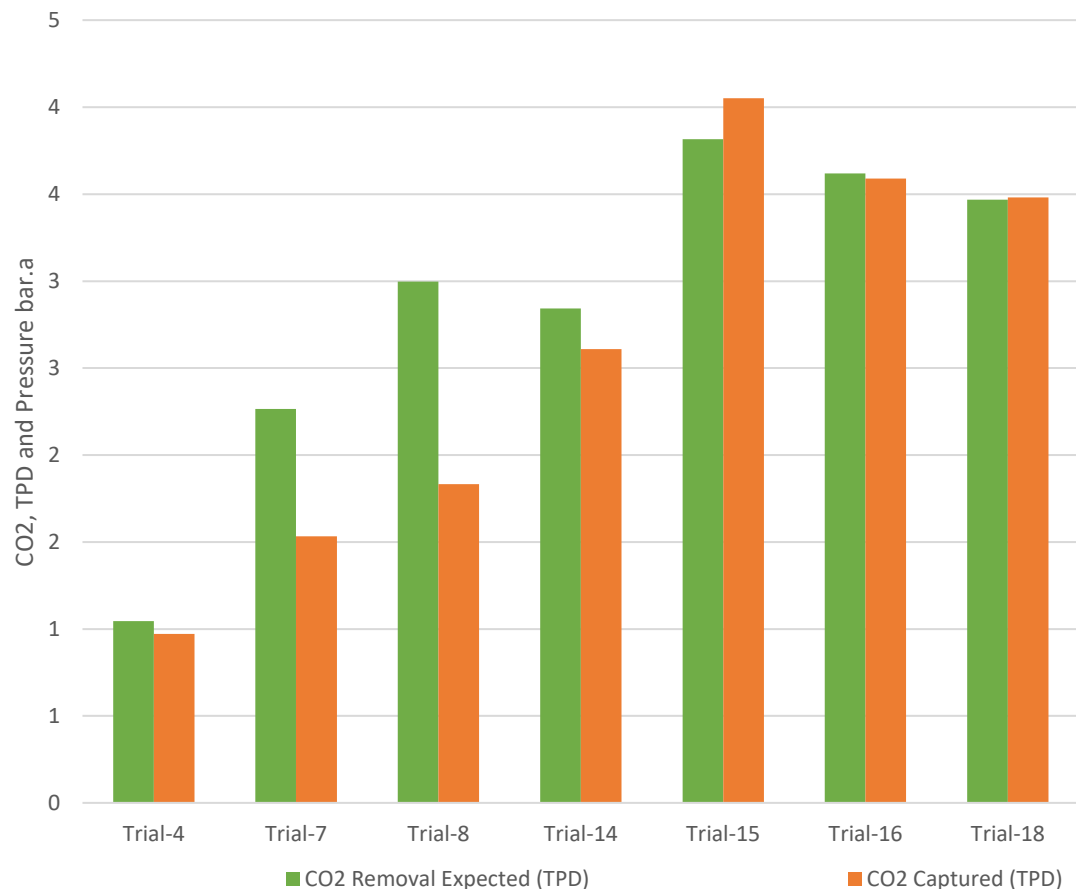
- Medium pressure operation
- Tested for Ash% in coal : 26-57%
- Crude Methanol quality (as certified by GNFC) : 85%-93% by wt

Methanol-85.8 wt.%
Water-7.6 wt.%
Ethanol-5.7 wt.%



Acid Gas Removal Unit

CO2 Capture Efficiency - AGRU



Raw Syngas Composition (vol%)

- CO2 removal efficiency : upto 91%
- CO2 capture : 4 TPD (amine based)

Coal To Chemical/Methanol Facility at Thermax



Gasification Plant Inauguration by on. Dr. V.K. Saraswat, NITI Aayog

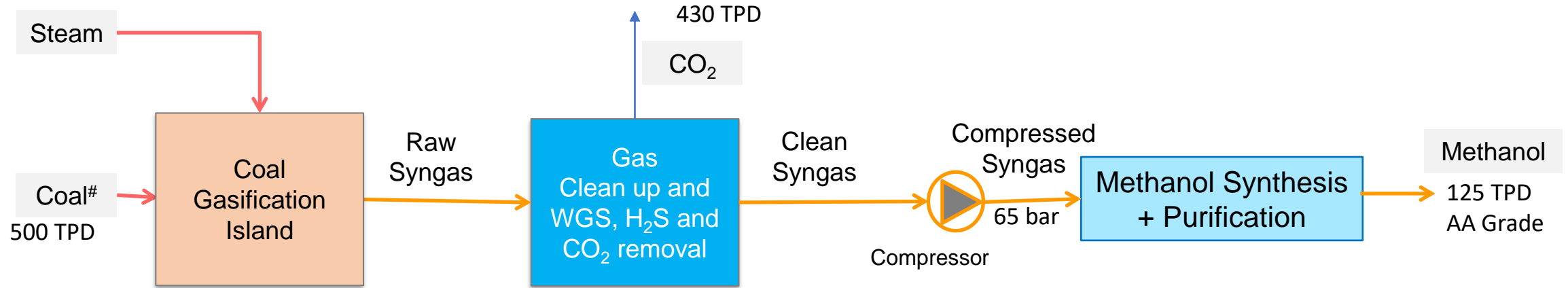


Shri Amrit Lal Meena, Hon. Coal Secretary

Scale up : 500 TPD (0.15 MTPA) Plant



Schematic diagram for Indian Coal to Methanol Process (Coal GCV 4437 kcal/kg)



	Clean Gas
Gas flow, Nm ³ /hr	18000
CO (v/v%)	20-22
H ₂ (v/v%)	61-64
CO ₂ (v/v%)	<6%
CH ₄ (v/v%)	<6%
N ₂ (v/v%)	<4%

#Coal GCV: 4437 kcal/kg
 Ash: 36 wt%
 Moist : 8 wt%
 Feed size : +2mm-6mm

Gasifier Performance: Variation in Coal GCV and Ash % (Tentative)



		Coal GCV-4400	Coal GCV-4000	Coal GCV-3400
Coal	TPD	500		
Steam	TPD	300-430#		
Oxygen	TPD	200-280		
CO ₂	TPD	360-430		
Pure Gas flow	Nm ³ /hr	18000	15000	12000
		Pure gas		
CO	v/v%	19-22		
H ₂	v/v%	60-64		
CO ₂	v/v%	<6%		
CH ₄	v/v%	<7%		
N ₂	v/v%	<3%		
Methanol	TPD	125	100	80
Coal/Methanol	MT/MT	4	5	6.25

1. Coal GCV: 4437 kcal/kg
Ash: 36 wt%
Moist : 8 wt%
Feed size : +2mm-6mm

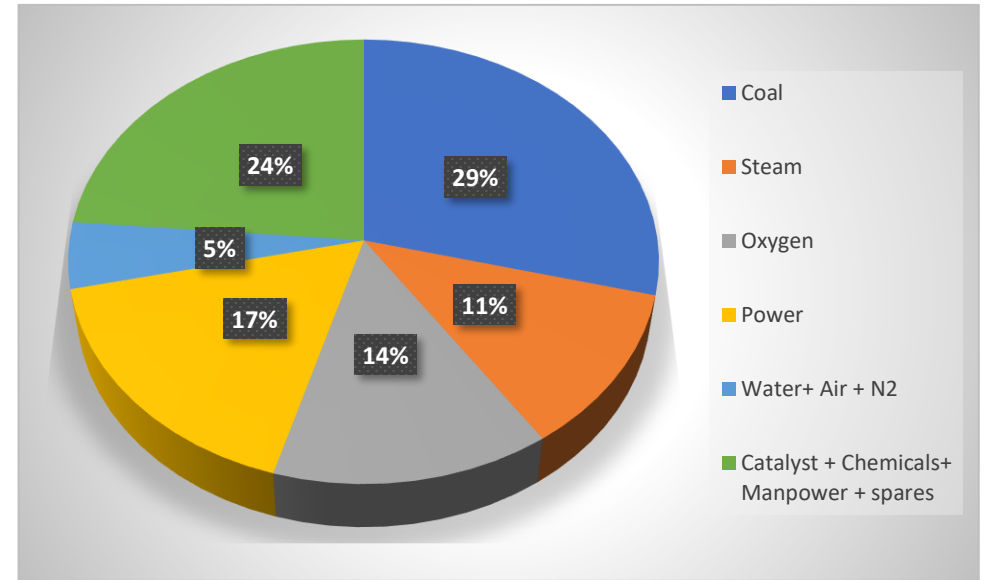
2. Coal GCV: 4055 kcal/kg
Ash: 35 wt%
Moist : 9 wt%
Feed size : +2mm-6mm

3. Coal GCV: 3400 kcal/kg
Ash: 45 wt%
Moist : 6 wt%
Feed size : +2mm-6mm

optimization possible

Opex Cost (Tentative)

Itemized	Specific consumption	Per kg of methanol	INR/ Kg Methanol
Coal	4.4	kg	6.60
Steam	5.3	kg	2.65
Oxygen	2.3	kg	3.19
Power	1.0	kW	3.88
Water+ Air + N2	--		1.1
Catalyst + Chemicals+ Manpower + spares	--		5.4
			22.82



#Coal GCV: 4055 kcal/kg
 Ash: 35 wt%
 Moist : 9 wt%
 Feed size : +2mm-6mm

	Unit Rate	Unit
Coal	1.5	Rs/kg
Steam	0.5	Rs/kg
O2	1.4	Rs/kg
Power	4	Rs/kW

+Finance, cost extra

Above Unit rate are in Indicative

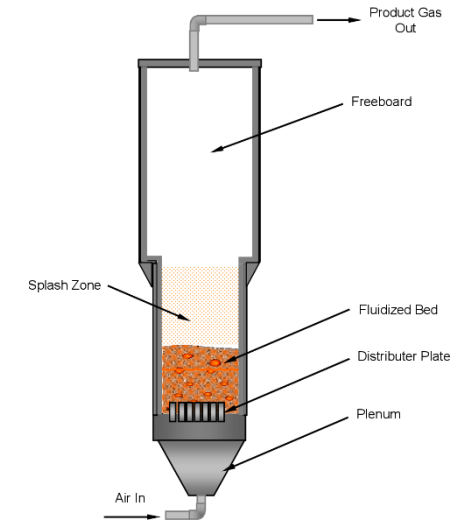


Boundlessly bridging the gap
between energy availability
and sustainability

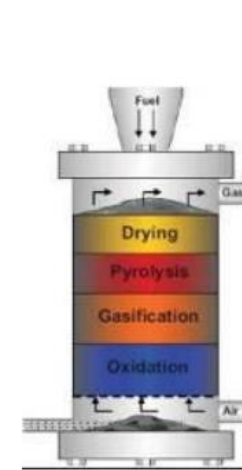
THANK YOU

Types of Coal Gasifier

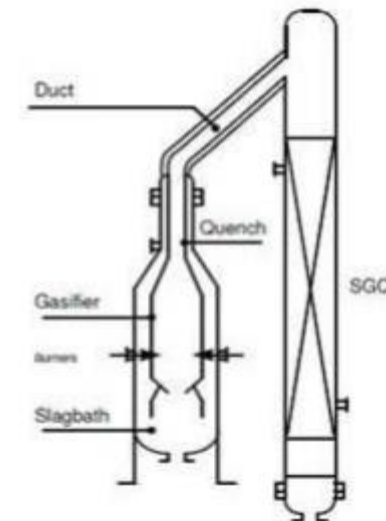
Category	Moving-bed		Fluid-bed		Entrained-flow
Ash Conditions	Dry bottom	Slagging	Dry ash	Agglomerating	Slagging
Typical Processes	Lurgi	BGL	Winkler, HTW, KBR, CFB, HRL	KRW, U-Gas	KT, Shell, GEE, E-Gas, Siemens, MHI, PWR
Feed Characteristics					
Size	6-50 mm	6-50 mm	6-10 mm	6-10 mm	<100 μm
Acceptability of Fines	Limited	Injection thr' tuyeres	Good	Better	Unlimited
Adaptability of Caking Coal	Yes (with stirrer)	Yes (with stirrer)	Possibly	Yes	Yes
Preferred Coal Rank	Any	High	Low	Any	Any
Operating Characteristics					
Outlet Gas Temperature	Low 425-650 °C	Low 425-650 °C	Low 900-1050 °C	Low 900-1050 °C	High 1250-1600 °C
Oxidant Demand	Low	Low	Moderate	Moderate	High
Steam Demand	High	High	Moderate	Moderate	Low
Other Characteristics	Hydrocarbons in gas	Hydrocarbons in gas	Low carbon conversion	Low carbon conversion	Pure gas, high carbon conversion



Fluid bed

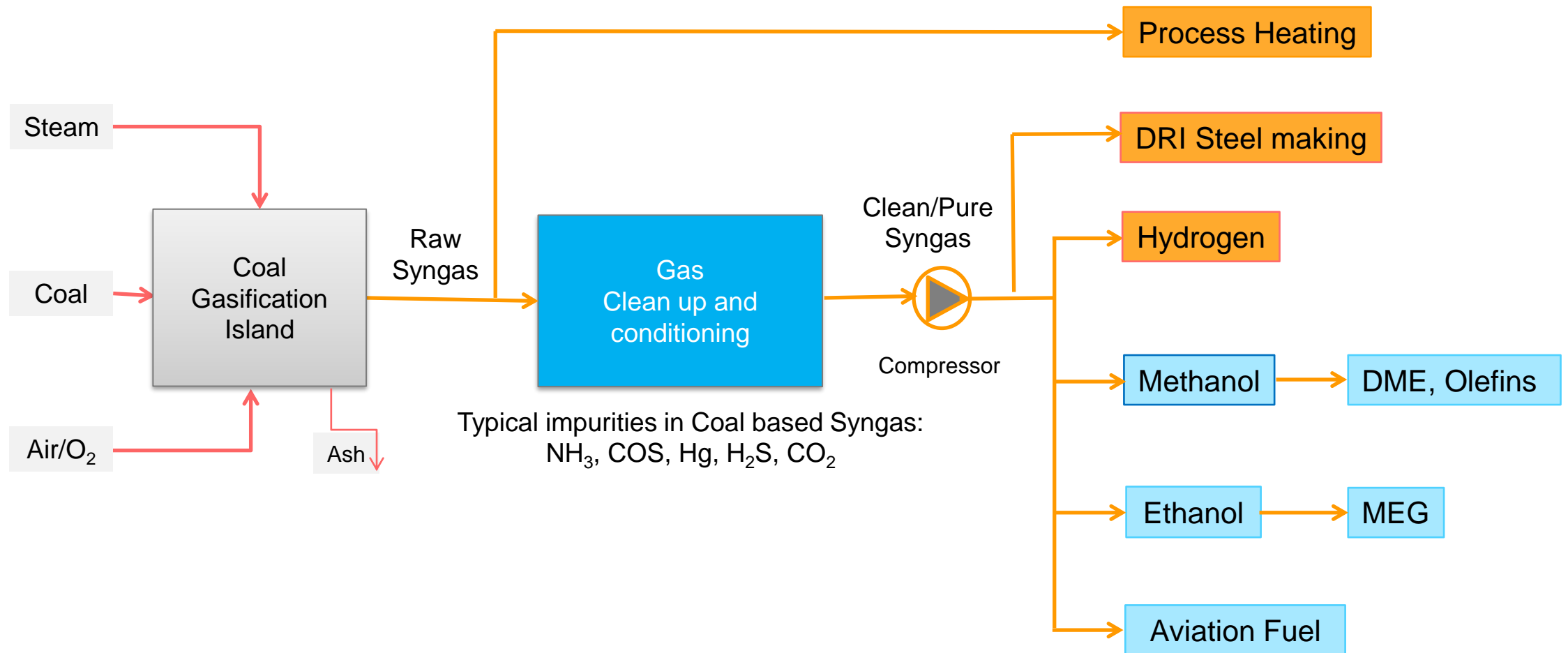


Updraft Moving bed



Entrained flow

Coal Gasification Plant (CGP) Applications



Gas Cleaning System can be customised to suit different coal compositions