UNICAT
CATALYST TECHNOLOGIES, LLC

Magcat Reforming catalysts Technology

Do You want to reduce CO2 ?

Himanshu Chauhan
Regional Sales Mgr. APAC
UNICAT CATALYST TECHNOLOGIES
Himanshu.Chauhan@unicatcatalyst.com
+919540856574

Company Info

- **UNICAT was formed in 2000**
- **White Deer Energy (Multi-billion-dollar US company) purchased UNICAT in 2020**
- **UNICAT bought Magma Group in 2021 (Our Dewsbury UNICAT Catalyst UK site)**
- **UNICAT opened new catalyst plant in Vietnam in 2023**
- **UNICAT is currently constructing a catalyst plant in the US in 2024**

General Information

Owned by White Deer Energy

A multi Billion Dollar Private Equity Firm

Sales

UNICAT has grown tremendously since being formed in 2000.

R & D Facilities

UNICAT Facilities in Baytown TX, Merryville TN, Dewsbury UK and Dalian PRC

Customer Base

> 700 Industrial references throughout the USA, Europe, South America and Middle and East Asia

Sales & Service

Offices located in Houston, Chicago, Amsterdam, Brussels, Barcelona, Aruba, Dubai, London Ontario, and Dalian

Service

Knowledgeable Engineers able to provide on site service to customers

Specialty catalysts

New JV Vanguard Catalyst LLC with a Manufacturing plant in the USA

ISO Certified

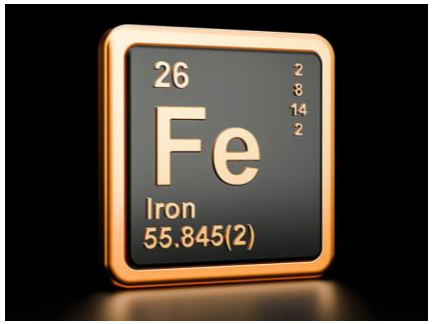
ISO-14001 & 9001 production sites in Asia, UK and the USA

Industries

We span a range of industries

- **Refineries**
- **Petrochemical Plants**
- **Ammonia Production**
- **Iron-DRI**
- **Oil & Gas Processing**
- **Hydrogen**
- **Methanol Production**

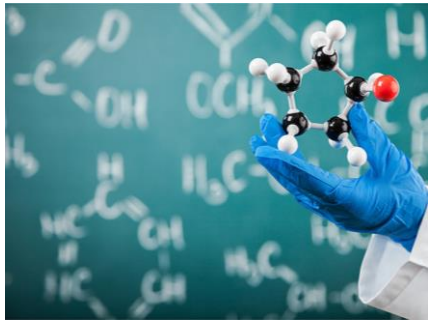
AMMONIA



IRON-DRI

OIL & GAS

HYDROGEN



METHANOL PRODUCTION

PETROCHEMICALS

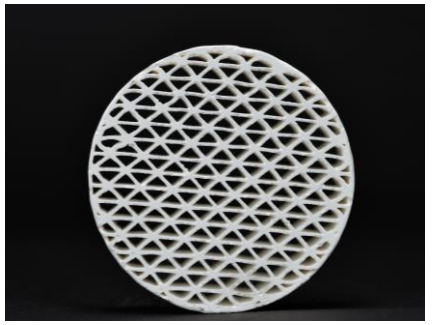
Product Range

Our Major Product Ranges:

- Purification
- Synthesis gas Production, including Magcat®
- AFS – Advanced Filtration System Disks
- Polycat
- PSA
- Control Systems

Purification

Magcat®



AFS

Polycat

PSA

Controls

Company Overview

UNICAT TECHNOLOGIES

Products

Control panels
PLC systems
SCADA systems
Motor control centres
Distribution switchboards
Safety systems
Hazardous area/ATEX rated panels
Gas Skids
Furnaces
Kilns
PSA systems
Instrumentation
Combustion Equipment
Burners

Location

Based in Huddersfield in the UK, Magma provides products and services to a worldwide customer base.

Aim

To provide high quality systems to our customers with the very best levels of service.

200+ CLIENTS

46 EMPLOYEES

Recognized System Integrator
A ROCKWELL AUTOMATION PARTNER

Solution Partner
Automation Drives
SIEMENS

bsi. ISO 9001 Quality Management | ISO 14001 Environmental Management | ISO 45001 Occupational Health and Safety Management

TÜV Rheinland
Functional Safety Type Approved
FS

UL 508A / 698A

ETL Intertek

cULus UL PANEL SHOP

Select Unicat Customers

Phillips 66
Valero
Marathon
Chevron
HollyFrontier Sinclair
Shell
Exxon Mobil
Motiva
Flint Hills
Suncor
BP
Air Products
Citgo
Calumet
Statoil
Repsol
Total
Nutrien
Koch Industries
LSB Industries
CF Industries

BOC Linde
Slovnaft (MOL Group)
HollyFrontier
Pertamina Oil
Petrorin
Sabic
Farmland
Yara
Unipetrol
Irving Oil
Giant Refining
SunOil Refining
Cross Oil
ENI Group
PCS
Saudi Aramco
Qafac
Nippon Group
Cargill
Nippon Oil
PKN Orlen

ADM
AGP Refining
PIC Kuwait
Qafac MEOH
AGP Refining
Krakatau Steel
Arcelor Mittal
Slavnaft
Gazprom
Lukoil
Kuwait Oil
Hanwha Total/Chemical
SK Energy
Mozyr
S-Oil
Gazprom
PTT Thailand
Bangchack Refinery
Equinor
Satorp
Cepsa

Organisation – management / product development

UNICAT CATALYST TECHNOLOGIES, LLC

Mark Stuckey – CEO

Oversaw buyout from Dyson Precision Ceramics and since we have enjoyed continual and significant growth. We have three divisions, notably Ceramics, Catalysts and Combustion and operate worldwide from our facilities in the UK & Vietnam.

Gary Bennington – Regional Sales Director APAC

30 years of experience within the syngas catalyst (ICI/Johnson Matthey), chemical & steel industries, has included sales, technical, marketing and business development.

Chris Pesek – Global Sales Director

30 years+ global sales experience with leading companies – Albermarle , Johnson Matthey e.t.c

Himanshu Chauhan Regional Bus. Dev. Mgr. APAC.

A Chemical Engineer with over 16 years of experience with leading catalyst technology companies(JM, Topsoe) in technical and commercial roles in the syn-gas industry. Experience in catalyst operation, troubleshooting, and chemistry for Hydrogen, Ammonia, and Syn. Gas plants.

K. R Rama Kumar– Technical Sales Manager

Over 18 years of experience in Technical Services and sales of Refinery/Ammonia/Hydrogen/petrochemical catalysts. Involved in multiple plant commissioning and troubleshooting for various catalyst worldwide.

James Esteban Sr. Tech. Mgr.

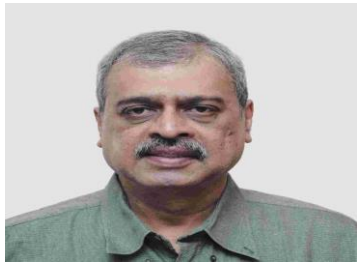
A Chemical Engineer with more than 9 years of direct refinery experience with Suncor. He also gained a strong background in catalyst technologies during his time with Criterion Catalysts and Technologies and later built on that experience through offering technical support with Refined Technologies (RTI).

Team – Asia Pacific

Gary Bennington – Regional Sales Director APAC

30 years of experience within the syngas catalyst (ICI/Johnson Matthey), chemical & steel industries, has included sales, technical, marketing and business development. Based out of Australia

Syn. Gas Expert



Paresh Amin– Technical Sales Manager APAC

Over 39 years of operations, Technical Sales and services Experience across petroleum refineries and catalyst companies. Based out of India

FCC/Refineries Expert

Andreas Mak– Technical Sales Manager APAC

Over 30 years of operations, Technical Sales and services Experience. Based out of Indonesia

Ceramics Expert

Himanshu Chauhan Regional Bus. Dev. Mgr. APAC.

A Chemical Engineer with over 16 years of experience with leading catalyst technology companies(JM, Topsoe) in technical and commercial roles in the syn-gas industry. Experience in catalyst operation, troubleshooting, and chemistry for Hydrogen, Ammonia, and Syn. Gas plants. Based out of India

Syn. Gas Expert

Bong Ngugen– Technical Sales Manager APAC

15 years of process plant experience in Oil refinery in operations and technical services. Based out of Vietnam

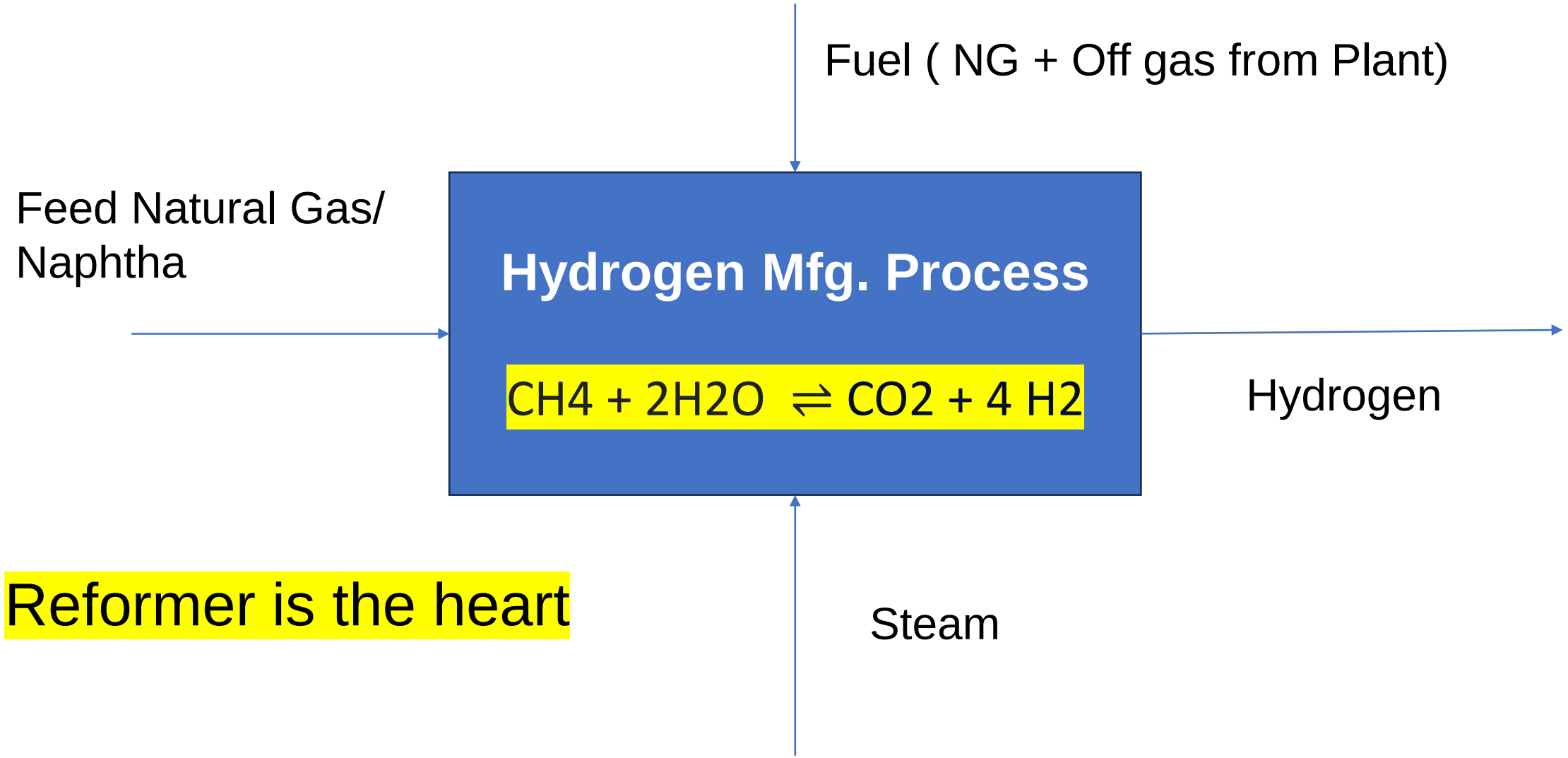
PSA, Refineries Expert

Ashutosh Patil– Supply Chain officer /Chemical Engineer APAC

Over 10 years of operations, production and technical services Experience. Based out of India

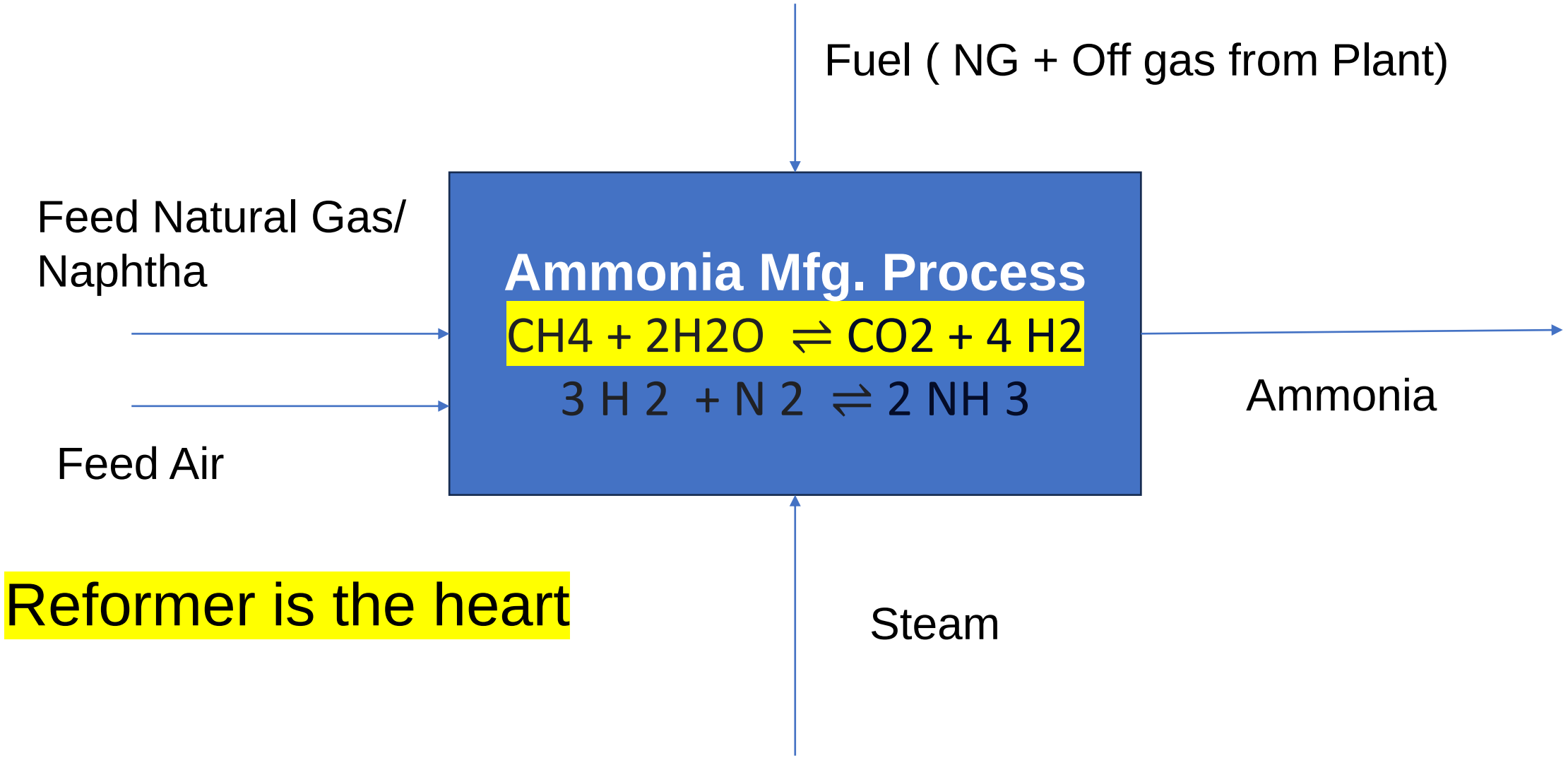
Local Business Partner Plus Exploration in Thailand

Syn. Gas Hydrogen



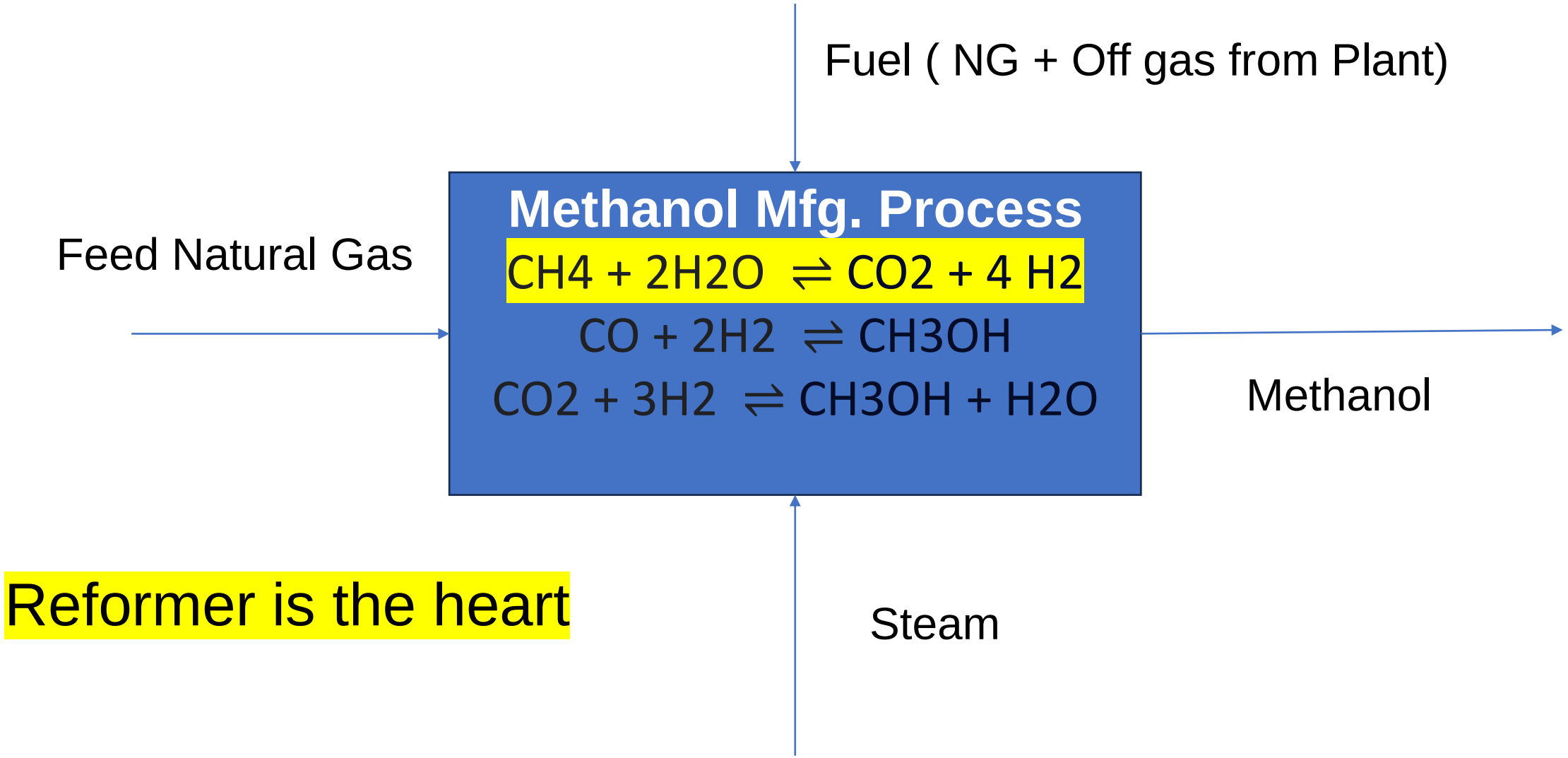
Reformer is the heart

Syn. Gas Ammonia



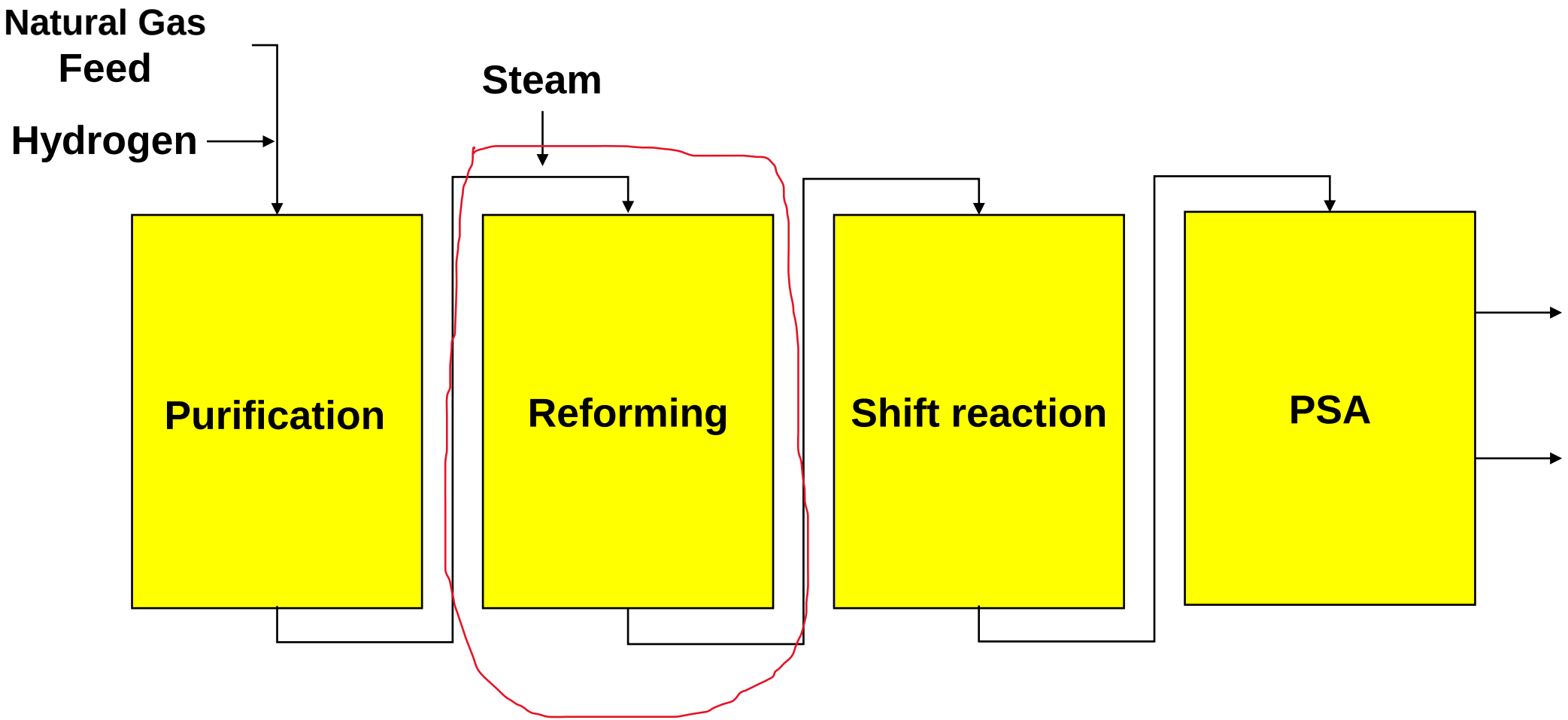
Reformer is the heart

Syn. Gas Methanol

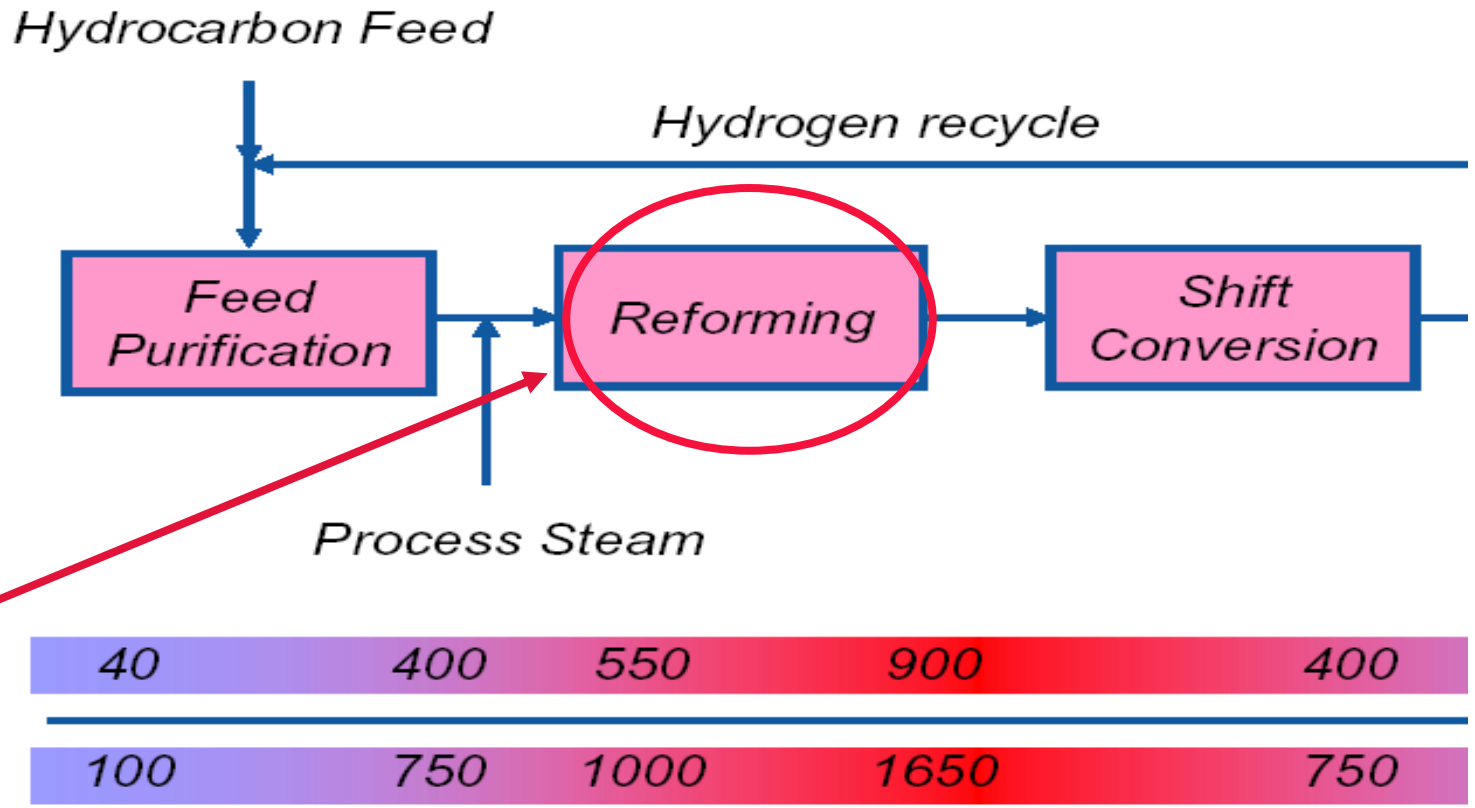


Reformer is the heart

Simplified Block Diagram of a Hydrogen Plant



Magcat Technology



New Innovative SMR Catalyst technology

Magcat production Site- England

- Site manufacturers Catalysts, Ceramics & Combustion equipment
- 25,000 m^2 of manufacturing space.
- Plant expansion to 10 Tonnes/day since 1st May 2022
- 2010 (24 employees) 2023 (>300 employees)
- Merged with UNICAT in February 2021

Catalysts in >40 commercial tubular reformers (>1600 tubes). Performing well, repeat orders received.

Conventional Shape

UNICAT
CATALYST TECHNOLOGIES, LLC

Conventional cylindrical shaped Reforming catalyst is being used in the industry for last 50 years…

What next?

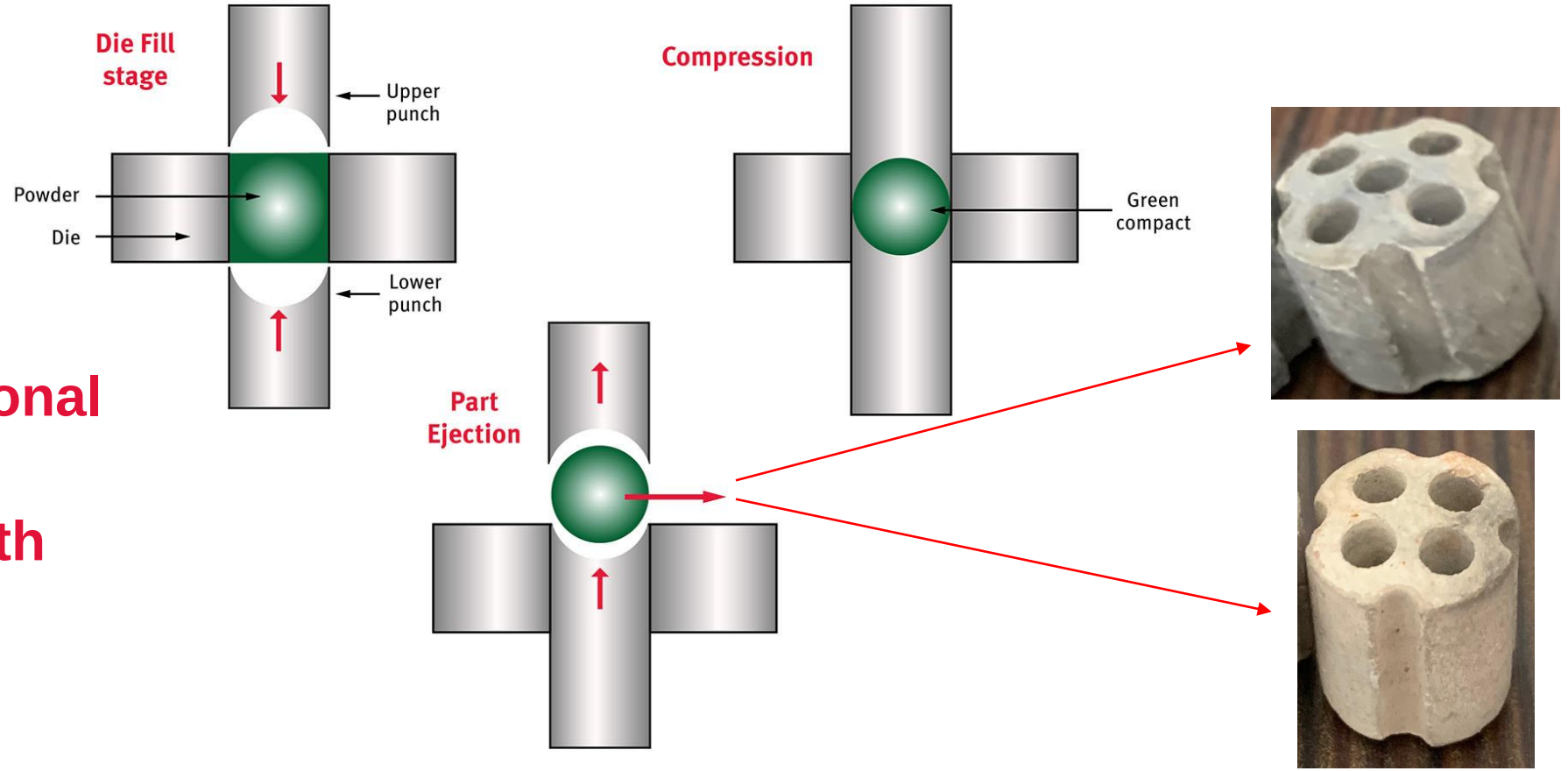
New Shape

Unicat Magma have come up with the latest innovation in reforming catalyst

New Textured Spheres

Conventional casting process

UNICAT
CATALYST TECHNOLOGIES, LLC



Compression Casting- Conventional Method

Limitation – Smooth Surface , Inherent porosity is lost

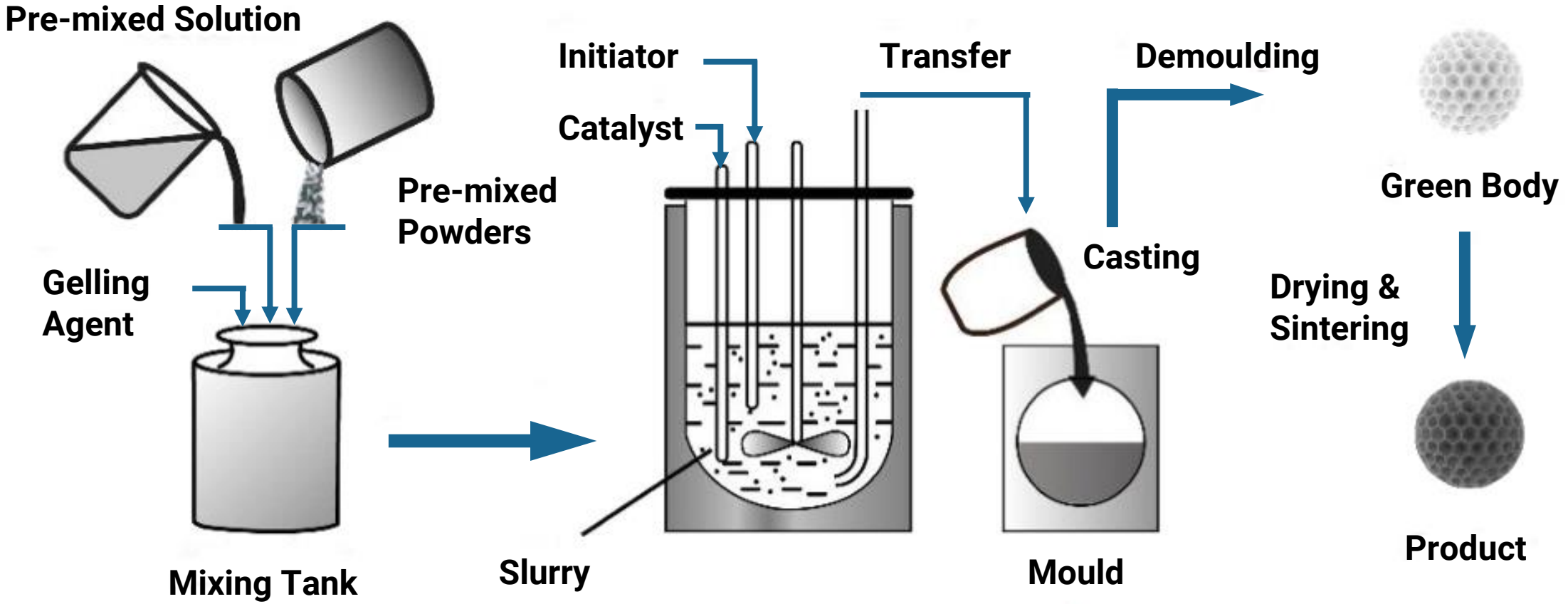
Magcat® Production Process

UNICAT CATALYST TECHNOLOGIES, LLC

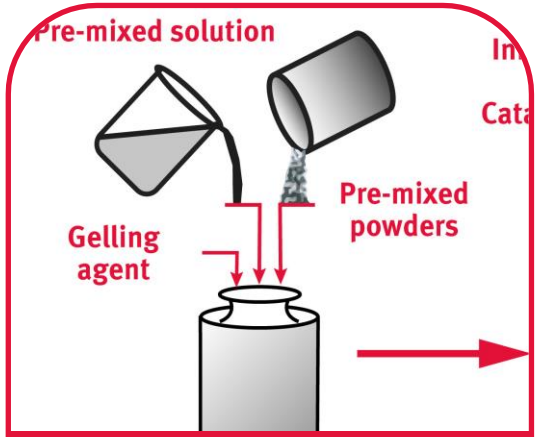
Gel Casting

Magcat Textured®

TEXTURED CATALYST TECHNOLOGY®

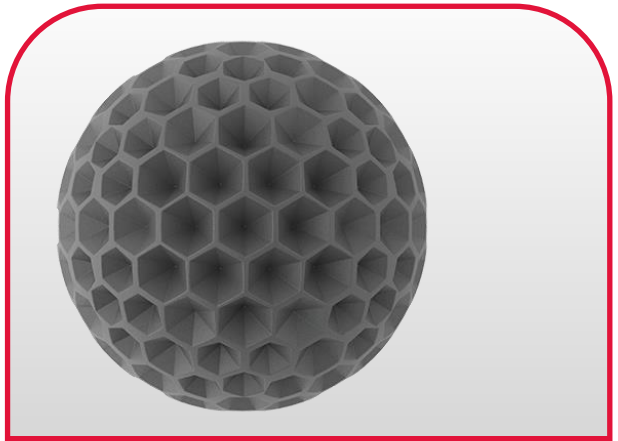


How Magcat is different



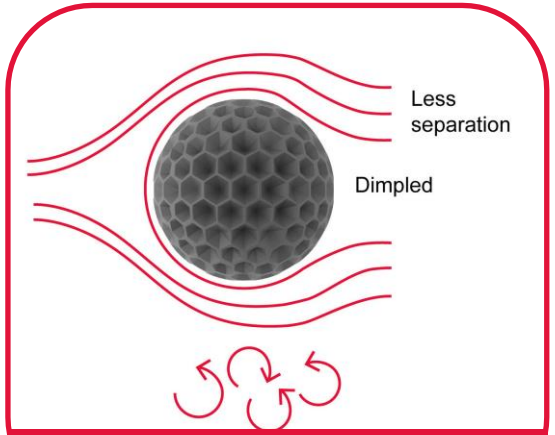
Gel Casting

- Porosity
- Inherent Strength



Shape

- Uniform Distribution
- Uniform Loading

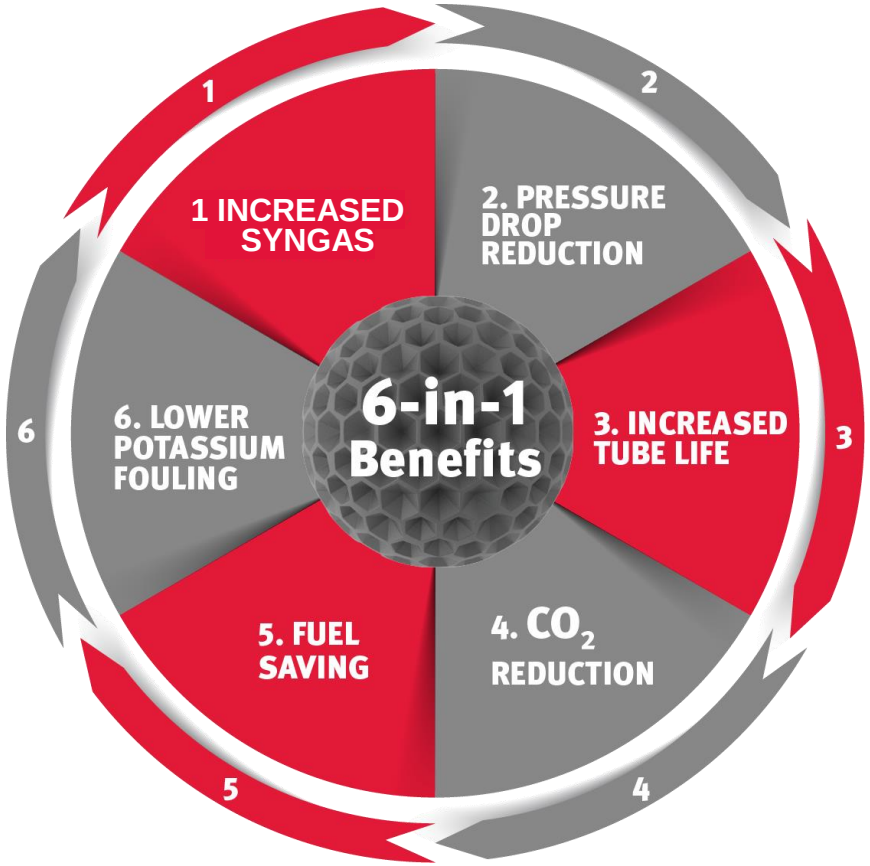


Texturing

- Heat Transfer
- High Activity
- Low Delta P

6-in-1 Benefits of Textured Spheres

UNICAT
CATALYST TECHNOLOGIES, LLC



1. Increased Syngas/H2
2. Pressure Drop Reduction - Lower for Longer
3. Increased Tube Life - +40%
4. CO_2 Reduction
5. Fuel Saving
6. Lower Potassium Fouling

Huge $ Savings for the Reformer operator!

CO2 Reduction- Higher Heat Transfer

Higher Heat Transfer

↓

Less firing of fuel / Natural Gas per MT of H2 Product

↓

Less firing lead to less CO2 production in flue gas

↓

CO2 Reduction

CO2 Reduction- Higher reforming activity

Higher Reforming Activity

↓

Lower Feed consumption SOR to EOR per MT of H2

↓

Less CO2 exit reformer per MT of H2 product

↓

CO2 Reduction

CO2 Reduction

MAGCAT Technology CO2 Reduction

Higher Efficiency

Lower Feed+ fuel consumption per unit H2 make

Lower CO2 Emissions per Unit H2 Production

SOR Performance Magcat

UNICAT CATALYST TECHNOLOGIES, LLC

*** PRIMARY REFORMER ***		
*** PERFORMANCE MODE ***		
1-FUEL FLOW RATE	NM3/SEC	3.3803
2-FIRING RATE(FUEL*LHV)	MW	91.298
3-TOTAL HEAT INPUT(FIRING+SENSIBLE)	MW	91.464
4-HEAT LOSSES THROUGH WALLS AND OPENING	MW	2.2329
5-FIREBOX EFFICIENCY(FIRING RATE BASIS)	PERCENT	66.062
6-TOTAL FLUE GASES FLOW	KG/S	34.6
7-FLUE GAS TEMP AT FIREBOX EXIT	DEG C	734.19
8-TOTAL HEAT ABSORBED	MW	60.313
9-PROCESS TEMPERATURE(INLET/OUTLET)	DEG C	573.5/ 812.5
10-PROCESS PRESSURE (INLET/OUTLET)	KPA	2340.7/2207.0
11-MAX OUTSIDE TUBE WALL TEMPERATURE	DEG C	855.99
12-STEAM TO CARBON MOLE RATIO (AT INLET)		4.8271
13-CALCULATED METHANE LEAKAGE - DRY MOL	PERCENT	3.7292

COMPONENT	**** MOLE FRACTIONS **** (WET BASIS) INLET	(WET BASIS) OUTLET	(DRY BASIS) INLET	(DRY BASIS) OUTLET	MASS FLOW RATE KG/S INLET	MASS FLOW RATE KG/S OUTLET	MOLAR FLOW RATE KGMOL/S INLET	MOLAR FLOW RATE KGMOL/S OUTLET
CO	0.0011	0.0592	0.0045	0.1069	0.051	3.295	0.0018	0.1176
CO2	0.0265	0.0650	0.1040	0.1175	1.846	5.690	0.0420	0.1293
H2	0.0730	0.4085	0.2862	0.7383	0.233	1.638	0.1155	0.8123
CH4	0.1543	0.0206	0.6053	0.0373	3.917	0.658	0.2442	0.0410
C2H6	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C3H8	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C4	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C5	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C6	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C7	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C8	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C9	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C10	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
Cx	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
N2	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
O2	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
ARGN	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
H2O	0.7450	0.4467			21.236	16.003	1.1787	0.8882
				TOTAL	27.284	27.284	1.5822	1.9885

EOR Performance Magcat

UNICAT CATALYST TECHNOLOGIES, LLC

*** PRIMARY REFORMER ***		
*** PERFORMANCE MODE ***		
1-FUEL FLOW RATE	NM3/SEC	3.3344
2-FIRING RATE(FUEL*LHV)	MW	90.056
3-TOTAL HEAT INPUT(FIRING+SENSIBLE)	MW	90.105
4-HEAT LOSSES THROUGH WALLS AND OPENING	MW	2.2400
5-FIREBOX EFFICIENCY(FIRING RATE BASIS)	PERCENT	65.773
6-TOTAL FLUE GASES FLOW	KG/S	34.1
7-FLUE GAS TEMP AT FIREBOX EXIT	DEG C	736.92
8-TOTAL HEAT ABSORBED	MW	59.232
9-PROCESS TEMPERATURE(INLET/OUTLET)	DEG C	573.5/ 812.5
10-PROCESS PRESSURE (INLET/OUTLET)	KPA	2363.8/2206.9
11-MAX OUTSIDE TUBE WALL TEMPERATURE	DEG C	856.24
12-STEAM TO CARBON MOLE RATIO (AT INLET)		4.8271
13-CALCULATED METHANE LEAKAGE - DRY MOL	PERCENT	4.2371

COMPONENT	**** MOLE FRACTIONS **** (WET BASIS) INLET	(WET BASIS) OUTLET	(DRY BASIS) INLET	(DRY BASIS) OUTLET	MASS FLOW RATE KG/S INLET	MASS FLOW RATE KG/S OUTLET	MOLAR FLOW RATE KGMOL/S INLET	MOLAR FLOW RATE KGMOL/S OUTLET
CO	0.0011	0.0575	0.0045	0.1049	0.051	3.185	0.0018	0.1137
CO2	0.0265	0.0648	0.1040	0.1183	1.846	5.646	0.0420	0.1283
H2	0.0730	0.4026	0.2862	0.7345	0.233	1.606	0.1155	0.7965
CH4	0.1543	0.0232	0.6053	0.0424	3.917	0.737	0.2442	0.0460
C2H6	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C3H8	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C4	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C5	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C6	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C7	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C8	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C9	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C10	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
Cx	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
N2	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
O2	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
ARGN	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
H2O	0.7450	0.4519			21.236	16.109	1.1787	0.8942
				TOTAL	27.284	27.284	1.5822	1.9786

SOR Performance Competition catalyst

UNICAT CATALYST TECHNOLOGIES, LLC

*** PRIMARY REFORMER ***		
*** PERFORMANCE MODE ***		
1-FUEL FLOW RATE	NM3/SEC	3.4049
2-FIRING RATE(FUEL*LHV)	MW	91.962
3-TOTAL HEAT INPUT(FIRING+SENSIBLE)	MW	92.130
4-HEAT LOSSES THROUGH WALLS AND OPENING	MW	2.2589
5-FIREBOX EFFICIENCY(FIRING RATE BASIS)	PERCENT	65.576
6-TOTAL FLUE GASES FLOW	KG/S	34.9
7-FLUE GAS TEMP AT FIREBOX EXIT	DEG C	743.58
8-TOTAL HEAT ABSORBED	MW	60.305
9-PROCESS TEMPERATURE(INLET/OUTLET)	DEG C	573.5/ 812.5
10-PROCESS PRESSURE (INLET/OUTLET)	KPA	2370.0/2207.1
11-MAX OUTSIDE TUBE WALL TEMPERATURE	DEG C	869.14
12-STEAM TO CARBON MOLE RATIO (AT INLET)		4.8271
13-CALCULATED METHANE LEAKAGE - DRY MOL	PERCENT	3.7340

COMPONENT	**** MOLE FRACTIONS **** (WET BASIS) INLET	(WET BASIS) OUTLET	(DRY BASIS) INLET	(DRY BASIS) OUTLET	MASS FLOW RATE KG/S INLET	MASS FLOW RATE KG/S OUTLET	MOLAR FLOW RATE KGMOL/S INLET	MOLAR FLOW RATE KGMOL/S OUTLET
CO	0.0011	0.0591	0.0045	0.1069	0.051	3.294	0.0018	0.1176
CO2	0.0265	0.0650	0.1040	0.1175	1.846	5.690	0.0420	0.1293
H2	0.0730	0.4084	0.2862	0.7382	0.233	1.637	0.1155	0.8121
CH4	0.1543	0.0207	0.6053	0.0373	3.917	0.659	0.2442	0.0411
C2H6	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C3H8	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C4	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C5	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C6	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C7	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C8	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C9	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C10	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
Cx	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
N2	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
O2	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
ARGN	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
H2O	0.7450	0.4467			21.236	16.004	1.1787	0.8883
				TOTAL	27.284	27.284	1.5822	1.9884

EOR Performance Competition catalyst

UNICAT CATALYST TECHNOLOGIES, LLC

*** PRIMARY REFORMER ***		
*** PERFORMANCE MODE ***		
1-FUEL FLOW RATE	NM3/SEC	3.3093
2-FIRING RATE(FUEL*LHV)	MW	89.378
3-TOTAL HEAT INPUT(FIRING+SENSIBLE)	MW	89.426
4-HEAT LOSSES THROUGH WALLS AND OPENING	MW	2.2704
5-FIREBOX EFFICIENCY(FIRING RATE BASIS)	PERCENT	65.175
6-TOTAL FLUE GASES FLOW	KG/S	33.9
7-FLUE GAS TEMP AT FIREBOX EXIT	DEG C	748.18
8-TOTAL HEAT ABSORBED	MW	58.252
9-PROCESS TEMPERATURE(INLET/OUTLET)	DEG C	573.5/ 812.5
10-PROCESS PRESSURE (INLET/OUTLET)	KPA	2449.4/2207.1
11-MAX OUTSIDE TUBE WALL TEMPERATURE	DEG C	869.76
12-STEAM TO CARBON MOLE RATIO (AT INLET)		4.8271
13-CALCULATED METHANE LEAKAGE - DRY MOL	PERCENT	4.7186

COMPONENT	**** MOLE FRACTIONS **** (WET BASIS) INLET	(WET BASIS) OUTLET	(DRY BASIS) INLET	(DRY BASIS) OUTLET	MASS FLOW RATE KG/S INLET	MASS FLOW RATE KG/S OUTLET	MOLAR FLOW RATE KGMOL/S INLET	MOLAR FLOW RATE KGMOL/S OUTLET
CO	0.0011	0.0559	0.0045	0.1029	0.051	3.085	0.0018	0.1101
CO2	0.0265	0.0647	0.1040	0.1190	1.846	5.604	0.0420	0.1273
H2	0.0730	0.3970	0.2862	0.7309	0.233	1.576	0.1155	0.7820
CH4	0.1543	0.0256	0.6053	0.0472	3.917	0.810	0.2442	0.0505
C2H6	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C3H8	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C4	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C5	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C6	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C7	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C8	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C9	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
C10	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
Cx	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
N2	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
O2	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
ARGN	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000
H2O	0.7450	0.4568			21.236	16.208	1.1787	0.8997
				TOTAL	27.284	27.284	1.5822	1.9696

Magcat Technology Higher Efficiency

UNICAT CATALYST TECHNOLOGIES, LLC

MAGCAT					
	Feed Nm3 /sec	Fuel Nm3/sec	H2 prod. Ref. exit Nm3/sec	**Feed/ Nm3 of H2**	**Fuel / Nm3 of H2**
SOR	9.044049	3.3803	18.2069	**0.4967**	**0.1857**
EOR	9.044049	3.3344	17.8528	**0.5066**	**0.1868**
Conventional catalyst					
	Feed Nm3 /sec	Fuel Nm3/sec	H2 prod. Ref. exit Nm3/sec	**Feed / Nm3 of H2**	**Fuel / Nm3 of H2**
SOR	9.044049	3.4049	18.2024	**0.4969**	**0.1871**
EOR	9.044049	3.3093	17.5278	**0.5160**	**0.1888**

Feed means - Inlet gas to reformer without Steam

Table was prepared Basis Data from slides 3-6

Magcat Technology Higher Efficiency

UNICAT
CATALYST TECHNOLOGIES, LLC

Benefit of Magcat Technology	
SOR (fuel reduction per Nm3 of H2)	0.00140
EOR (Fuel reduction per Nm3 of H2)	0.00203
SOR (Feed Reduction per Nm3 H2)	0.00012
EOR (Feed reduction per Nm3 H2)	0.00939

CO2 Reduction Higher Heat Transfer- lower Fuel

UNICAT CATALYST TECHNOLOGIES, LLC

CO2 Emissions Reduction- basis lower fuel rate SOR to EOR	Average Fuel reduction per Nm3 of H2 (SOR to EOR)	0.0017		H2 exit reformer	65000	NM3/hr
	Fuel saved per hr	111	NM3			
	Fuel saved per year	924780	NM3	C no. of Make up fuel gas is 0.69; it means 1 NM3 per hour of fuel has 0.69 NM3 of Carbon .		
	CO2 Emmissions saved per year	**638099**	**NM3**	1 NM3 per hour of fuel gas combustion produces 0.69 NM3/hr of CO2.		
	CO2 Emissions saved full life cycle of catalyst	**5104788**	**NM3**	Catalyst life	8	year
	CO2 Emissions saved per year	**1253**	**Ton**	C credit pr ton	65	USD
	CO2 Emissions saved full life cycle of catalyst	**10021**	**Ton**			
	CO2 Emissions Benefit per year	**81421**	**USD**			
	CO2 Emissions benefit full life cycle of catalyst	**651365**	**USD**			

CO2 Reduction Basis Higher Activity Lower Feed

UNICAT CATALYST TECHNOLOGIES, LLC

CO2 Production Process Side across Reformer			
Reformer Inlet feed	**Unit**	**Reformer Exit CO2**	**Unit**
0.4035	kgmole per sec feed	0.1293	kgmole per sec CO2
1	kgmole per sec feed	0.3204	kgmole per sec CO2
1	**NM3/sec feed**	**0.3204**	**NM3/sec CO2**

CO2 Production Process Side basis CO conversion across Shift (70 % conversion assumed)			
Reformer Inlet feed	**Unit**	**Reformer Exit CO/CO2**	**Unit**
0.4035	kgmole per sec feed	0.1176	kgmole per sec CO
1	kgmole per sec feed	0.2914	kgmole per sec CO
1	NM3/sec feed	0.2914	NM3/sec CO
1	**NM3/sec feed**	**0.2040**	**NM3/sec CO2 Shift Exit**

Total CO2 Production Process Side (Reformer + Shift catalyst)			
Reformer Inlet feed	**Unit**	**Reformer + Shift Exit CO2**	**Unit**
1	**NM3/sec feed**	**0.5245**	**NM3/sec CO2**

Basis Data from Slide 3

CO2 Reduction Higher Activity – Lower Feed

UNICAT CATALYST TECHNOLOGIES, LLC

CO2 Emissions Reduction- basis lower Feed rate SOR to EOR	Average Feed reduction per Nm3 of H2 (SOR to EOR)	0.0048		H2 Plant Exit reformer	65000	NM3/hr
	Feed saved per hr	309	NM3	Feed means - Inlet gas to reformer without Steam		
	Feed saved per year	2566803	NM3	1 NM3 of feed gas produce 0.5245 NM3 of CO2 in process side.		
	CO2 Emmissions saved per year from process gas	**1346188**	**NM3**			
	CO2 Emissions saved full life cycle of catalyst	**10769503**	**NM3**	Catalyst life	8	year
	CO2 Emissions saved per year	**2643**	**Ton**	C credit pr ton	65	USD
	CO2 Emissions saved full life cycle of catalyst	**21141**	**Ton**			
	CO2 Emissions Benefit per year	**171772**	**USD**			
	CO2 Emissions benefit full life cycle of catalyst	**1374176**	**USD**			

CO2 Reduction Basis Lower feed + Fuel

UNICAT CATALYST TECHNOLOGIES, LLC

Magcat - Total CO2 Reduction					
CO2 Emission reduction per year basis lower feed	2643	Tons	8 years catalyst life		
CO2 Emission reduction per year basis Lower fuel	1253	Tons			
Total CO2 Emmission reduction per year	3895	Tons	C Credit value	65	USD per ton
CO2 Emission reduction full catalyst cycle life basis lower feed	21141	Tons			
CO2 Emmission reduction full catalyst cycle life basis lower feed	10021	Tons			
Total CO2 Emission reduction full catalyst cycle life	31162	Tons			
Total CO2 Emission Benefit per year	253193	USD			
Total CO2 Emission reduction Benefit Full catalyst cycle life	2025541	USD			

References

UNICAT
CATALYST TECHNOLOGIES, LLC

Customer	Plant	Country	# of tubes	Start up
Phillips 66	Ponca City (2 units)	USA	88	Jun-19
Marathon	St Paul Park (2 units)	USA	80	Sep-19
DRI Site	Confidential	USA	5	Sep-19
Confidential	Busan	South Korea	24	Feb-20
Marathon	Dickinson	USA	36	Dec-20
MIDREX	VoestAlpine	USA	5	Dec-20
Confidential	Daejon	South Korea	20	Feb-21
Confidential	Busan (10 Fuel Cell Units)	South Korea	10	Feb-21
Phillips 66	Wood River	USA	192	Apr-21
US Top 5 Refiner	US Mid-West	USA	216	Jul-21
Calumet	Montana	USA	92	Nov-21
Phillips 66	Billings (2 units)	USA	144	Jan-22

References

Customer	Plant	Country	# of tubes	Start up
Pan American	Existing H2	Columbia	8	Nov-22
Neste	Jurong Island	Singapore	114	Mar-23
Calumet	Montana (New Build)	USA	48	Jan-23
Calumet	Louisiana	USA	40	Mar-23
UPM	Kymmene	Finland	31	Apr-23
Jaxon Energy	Jackson MS	USA	30	May-23
Flint Hills Refinery	Pine Bend, MN	USA	216	May-23
CHS (#2 Plant)	Laurel Refinery, MT	USA	48	Jul-23
CHS (#3 Plant)	Laurel Refinery, MT	USA	144	Sep-23
Air Products Inc	Confidential	USA	36	Sep-23
Air Liquide	Antwerp	Belgium	144	March-24
Evonik	H2 Plant	Indonesia	10	Oct-23
Pupuk Kalimantan	NH3 Plant, Timor	Indonesia	240	Nov-23
Solvay Chemicals	Longivew, WA	USA	44	Dec-23
NIS Pancevo	H2 Plant	Serbia	232	Mar-24
ADNOC	Refinery	UAE	208	Apr-24
ArcelorMittal	Midrex DRI	Canada	180	Jun-24
BP Gelsenkirchen	Refinery	Germany	102	Sep-24

Overall Benefits to Clients

UNICAT
CATALYST TECHNOLOGIES, LLC

- Higher Efficiency – Lower Feed + Fuel SOR to EOR
- CO2 Reduction
- Higher Guaranteed Life
- Possibility of higher H2 production if needed
- No need of DENSE loading thus saving in cost and time

THANKS

Himanshu Chauhan
Regional Sales Mgr. APAC
UNICAT CATALYST TECHNOLOGIES
Himanshu.Chauhan@unicatcatalyst.com
+919540856574