Madhukar Onkarnath Garg

Research and Development Leader | Deep expertise in Petroleum Refining and Petrochemicals, Biofuels, Waste Plastic to Pyrolysis Oil, Solvent Extraction, Advanced Control, Pinch Analysis and Modelling and Simulation / 49 + years Driving New and Innovative Technology development and Commercialization

Profile Summary

Visionary R&D leader with over 49+ years of driving New and Innovative Technology development and commercialization in Refining, Petrochemicals, Biofuels, and Circular economy.

Deep expertise in various Processes in Refining and Petrochemicals such as CDU,VDU, Distillation, Extractive and Azeotropic Distillation, FCC, Merox units, CCR reformer, BTX, Group I and II lube oils, Solvent deasphalting, Dewaxing / Deoiling, Visbreaking, Bitumen, Delayed coking, Steam Cracking, Butadiene Extraction, BTX Extraction.

Core Competencies:

1 Solvent Extraction / Extractive Distillation

Development, Commercialization, Trouble shooting and Optimization of all solvent extraction and Extractive Distillation based processes : BTX extraction, Food grade hexane, Recovery of benzene from FCC gasoline, Extraction of pyridine / picoline , Lube extraction, solvent de-asphalting.

2 Process Integration / Pinch Analysis

Applied pinch analysis to various process units such as standalone CDU, Integrated CDU/VDU, FCC, Delayed coking, Wax deoiling, various chemical plants.

Applied Column Targeting for optimizing the performance of distillation columns.

3 Modelling, Simulation, Data Reconciliation and Advanced Control

Expert in modelling and simulation on PRO II, HYSYS, HYSIM and ASPEN Plus. Modelled both ideal and non-ideal systems. Used sequential modular and Open equation Approach.

Applied DMC Plus Model Based Predictive controller on three CDU/VDU and FCC including online optimization.

Developed in-house Data Reconciliation and Gross Error Detection software called RAGE. Used it successfully to analyze more than 500 commercial and lab scale data.

4 Lectures / Training Courses

Delivered large number of Keynote / plenary / invited lectures in several prestigious national and international conferences covering all aspects of the hydrocarbon industry.
Made several techno-commercial presentations for marketing technologies.
Delivered basic as well as advanced lectures on several technical subjects. A few of them are listed below:

- Refinery Process technologies
- Advances in hydrocarbon industry
- Catalytic reforming
- Lubes and Bitumen
- Advanced Control and On-Line Optimization
- Solvent Extraction and its Applications to Refinery Industry
- Data Reconciliation and Gross Error Detection
- Advances in Process Modeling and Simulation
- Pinch Analysis for Process Integration

Delivered 10 editions of Course on "Petroleum Refining Technology" with indepth technical coverage of all refinery process units (Course consists of 20 lectures)

Key Skills

- Vast and in-depth knowledge of the hydrocarbon industry.
- Possess unique and rare capability of conceptualising, development, scale up and commercialisation of innovative new research ideas
- Special skills in marketing and commercialising technologies.
- Exemplary leader and an able administrator who believes in leading by example.

Professional Experience

Reliance Industries Limited, Mumbai, India
President R&D (Refining and Pet Chem) December 2017 to November 2024

- Conceptualization, development and implementation of new research ideas of short term and long-term interest of Reliance
- Provide leadership, motivation and skill building amongst the scientist and engineers in Reliance R&D.
- Commercialized four technologies: Design of New Column Internals in Merox Units, Recovery of BTX from FCC gasoline, Sulfolane clean up in Benzene recovery units, Energy reduction in Rubber plant.

- Effective coordination with manufacturing, business, technical services and management for accelerated commercialization of in house developed technologies
- Expand the scientific base of the company to provide cutting edge, first to the world technologies.
- To Mentor and guide the young scientists and engineers for development and scale up of technologies from bench scale and steps required for commercialization.
- Close coordination with various national research laboratories, and academic institutes both in India and abroad.

Indian Institute of Technology Bombay

Professor, Department of Chemical Engineering Jan to Nov 2017

- Offered and Taught a Master's course on Petroleum Refining Technology
- Taught a Summer Course on Equipment selection and design
- Supervised final year unit operations laboratory exercises
- Supervised three Master students for their research Thesis

CSIR Indian Institute of Petroleum, Dehradun, India
Director: August 2003 to September 2016
Head Refining Technology Division: July 1998 to July 2003

- Opened new areas in line with the requirements of the oil industry. Initiated projects on pet coke gasification, biomass conversion, new generation biodiesel and SAF technology, gas to liquid technologies, waste to wealth, CO_2 capture, heavy oil upgradation, carbon materials, and hydrogen.
- Initiated collaborative development activities with international companies such as Saudi Aramco, Pratt and Whitney, SINTEF, RTI, UOP, CD-Tech, IFP, SABIC, BP/Castrol, UNILUBE, PETROBRAS, Demenno Kerdoon, FARABI etc.
- Commercialized IIP's Sweetening Catalyst, production of paraffin wax, NTGG Technology, refining of used lube oil, advanced Visbreaker Technology with Internals, Food Grade Hexane, biodiesel technology, SO_2/CO_2 recovery from flue gas in Indian refineries.
- Developed and commercialized benzene recovery from FCC gasoline. A world scale plant is successfully commissioned and in operation at Reliance Jamnagar. This is the first to the world and first indigenous technology ever commercialized by Reliance.
- Executed a large multi Institutional project under Indo Canadian cooperation program along with Pratt and Whitney to develop SAF technology from non-edible vegetable oils. This Sustainable fuel meets international standards and has been used successfully by Spice-jet and Indian Air Force.
- Developed Technology for Converting waste plastic to Euro VI diesel. Put up a 1 TPD demo unit at IIP campus.
- Conceived and executed a large multi-Institutional project named Mini-DME under the grand Challenge call of Australia India Strategic Research Fund. Developed a mini reactor-based technology and process to valorize stranded natural gas to DME.

- Negotiated an agreement to license IIP solvent extraction technology to a petrochemical complex in the UK for production of pure aromatics from straight run naphtha. Revamped their unit to operate on pyrolysis gasoline as well as licensed our BTX model.
- Providing leadership for successful development of NMP based extraction technology for re-refining of used lube oil for Unilube Saudi Arabia and Confidential Client in USA and Australia.
- Initiated and executed large multi-agency research projects in the following areas:
    - Adsorptive desulfurization of gasoline and diesel fuels (SINTEF, Norway)
    - Biomass to jet fuel under IUSSTF
    - Resid cracking with HPCL, BPCL, EIL and CHT
    - Hydrogen from sulphur iodine cycle with ONGC, CSIR laboratories and IIT Delhi
    - CO2 adsorption from flue gas with NTPC, CSIR labs and IIT Bombay
    - Biomass to gasoline and diesel with HPCL, Bangalore
- Provided leadership to bag two UKIERI projects, one with University of Newcastle on Biodiesel and the other on Nano Particles for Lubrication with University of Huddersfield. Also bagged two AISRF grants with CSIRO and Monash University, Australia.
- Initiated collaboration with SINTEF which resulted in successful development of adsorption based technology for desulphurization of gasoline and diesel. Also, developed MOF based adsorbent for CO_2 removal from flue gases.
- Conceptualized and executed an innovative project on converting waste plastic to valuable hydrocarbon products such as LPG, gasoline, diesel, light aromatics and waxes.

Council of Scientific and Industrial Research (CSIR), New Delhi India
Ministry of Science and technology, Government of India
Director General: February 2015 to August 2015

- Provided high level leadership to initiate new activities.
- Provide prompt support and guidance to the entire administrative, finance, vigilance, and planning departments for smooth operation of the headquarters as well as the laboratories.
- Liaison and networking with various ministries, government institutions and Prime minister's office.
- Appointed Directors of ten CSIR labs as well as obtained extension in tenure of nine Directors
- Initiated the assessments and promotion of scientists at various levels, cadre review of staff, and harmonization of grade pay with CSS.
- Provided awareness and exposure to the Honorable Minister by visiting several Laboratories of CSIR
- Held the historic Directors conference at Dehradun ending with the famous Dehradun Declaration
- Conducted the Governing council meeting of CSIR
- Provided high level administrative support and leadership to headquarters as well as the laboratories.

Kinetics Technology (TECHNIP) India Limited , New Delhi India
General Manager, Process Systems and Services : May 1994 to June 1998

- Led a team of 10 engineers to execute the Program for Accelerated Commercialisation of Energy Research (PACER) along with Linhoff March, UK. This project involved developing the next

generation of SUPERTARGET software, preparing tutorials, delivering Linhoff March four Day course on Pinch Analysis, and carrying out six industrial Pinch Analysis projects.

- Revamped the pyridine / picoline plant by developing technology based on liquid liquid extraction. Installed an extractor which helped to increase the capacity 4X.
- Carried out dynamic simulation of Steam reformers in China and Russia to design the advanced control system
- Installed offline and online version of SPYRO on Steam Crackers at Hazira complex of Reliance Industries.
- Participated in sales and marketing of high technology based products and sevices to various clients including KTI HQ in Netherlands.
- Provided high level technical support for implementation of UOP training simulators on CDU, Hydrogen CCR, and Visbreaker

Engineers India Limited, New Delhi, India: May 1976 to March 1994
Junior Engineer to Manager R&D

- Developed a software in FORTRAN for simulating multicomponent multi stage separation columns by solving MESH equations using Broyden Method coupled with Continuation method of Davidenko.
- Developed several technologies based on liquid-liquid extraction covering applications ranging from BTX extraction, food grade hexane, lube extraction, solvent deasphalting, solvent dewaxing, solvent de-oiling. The technologies were developed and scale up from lab level.
- Implemented SETPOINT advanced control and on-line optimization technology in three refineries on CDU/VDU and FCC.
- Developed a Data Reconciliation and Gross Error detection software (RAGE)
- Developed software for modelling and simulation of SR and CCR reformers
- Customized an inhouse software to simulate the Naphtha cracker downstream separation.
- Modified an Edeleanau Process (Liquid SO2) to run on Heavy Naphtha.

Educational Background

1982: Ph.D. from the University of Melbourne Australia. Specialised in liquid – liquid extraction Worked with Professor H.R.C. Pratt, Former, Chief CSIRO, Australia

1976: MTech in Chemical Engineering from the Indian Institute of Technology, Kanpur. Obtained "A" grades in all the courses. CGPA: 10.00 out of 10.00

1974: BTech in Chemical Engineering from Laxminarayan Inst. of Technology, Nagpur University, Nagpur. Secured 82.7% marks in aggregate. Stood FIRST in the University in this discipline.

1969: H.S.S.C. from Maharashtra Board of Secondary Education, Nagpur. Scored 83% marks in Science group with distinction in Maths, Physics and Chemistry.

Notable Achievements

- **28** Solvent Extraction based technologies developed / commercialized
- **19** breakthrough technologies developed / commercialized in Refining and Petrochemicals,
- **16** successful implementations of Pinch Analysis
- **8** Path Breaking developments in Simulation and Modelling.
- **43** Indian and **25** International patents granted
- Author of 100 peer reviewed papers and **200** papers in proceedings of prestigious conferences.
- Thesis Supervised: **1** Ph D; **3** M Tech
- Chapters in Books: **4**
- Elected Fellow of the Indian National Academy of Engineers
- **Awards** : MOPNG Innovation Award (2016), TDB Technology Day Award (2017 and 2019), ICC Life time Achievement Award (2013), Vasvik Award (2017), besides several CSIR Technology as well as Innovation awards from 1998 to 2016.

Major Technologies Developed / Commercialized

Sl No.	Technology	Year	Client
Refining/Petrochemical Technologies based on Solvent Extraction			
1	Aromatics extraction using Sulfolane	1981	BPCL, Mumbai
2	Aromatics Extraction Using Sulfolane	1984	KRL, Kochi
3**	Propane Deasphalting of Short Residue	1986	HPCL, Mumbai
4**	Propane Deasphalting of Short Residue	1986	CPCL, Chennai
5*	Revamp of Shell Sulfolane Unit	1986	NOCL, Mumbai
6**	NMP Extraction of Lube distillates	1988	IOCL, Haldia
7**	Revamp of Phenol Unit to NMP for processing Wide Cut Distillate	1988	IOCL, Barauni
8	Food Grade Hexane using Sulfolane	1990	CPCL, Chennai
9	Revamp of Udex Unit to Tetraethylene glycol	1990	IOCL, Gujarat
10**	Dearomatization of ATF/Kerosene by sulfolane	1991	HPCL, Mumbai

11***	Conversion of KTU from Kerosene to Heavy Naphtha using Liquid SO_2	1994	IOCL, Barauni
12	Food Grade Hexane using NMP	1994	HPCL, Mumbai
13***	Counter Current Extraction of Ammoniacal Liquor for Producing Pyridine/Picoline using Benzene	1997	VAM Organics, Gajraula
14***	Revamp of Kerosene Treating Unit to Process Heavy Naphtha, Kerosene and Diesel Using Re-Extraction with NMP as Solvent	2001	IOCL, Guwahati
15***	Food Grade Hexane from Aromatic Rich Naphtha	2002	ONGC, Hazira
16***	Pure BTX from Straight Run Naphtha using NMP	2006	SABIC, UK
17***	Recovery of NMP From NMP-Brine Mixture	2006	HPCL, Mumbai
18***	Changeover from Reformate to Pyrolysis Gasoline in Shell Sulfolane Unit (SSU)	2008	SABIC, UK
19***	Re-refining of Group I Used Lube Oil by Solvent Extraction Using NMP	2008	UNILUBE, Saudi Arabia
20***	CLO Upgradation in Lube NMP Extraction Unit to Produce High BMCI Extract	2009	HPCL, Mumbai
21***	Revamp of Food Grade Hexane Unit to NMP	2011	CPCL, Chennai
22***	Processing of Light Neutral in Lube NMP Extraction Unit	2012	CPCL, Chennai
23***	Re-refining of Group II/III Used Lube Oil by Solvent Extraction Using NMP	2012	Demenno Kerdoon
24***	Production of US Grade Gasoline and Pure Benzene from FCC Gasoline	2013	Reliance, Jamnagar
25***	De-oiling of Waxy Distillate Using MIBK to Produce Paraffin and Micro Crystalline Wax	2015	Numaligarh Refinery
26***	Innovation in Re-refining of mixed Used Lube Oil by Solvent Extraction Using NMP	2017-18	Confidential Australian client
27	Production of Pure BTX from full range FCC gasoline	2023	Confidential
28	A single step process to remove heavy hydrocarbons from solvent while reducing aromatics in ED raffinate	2023	confidential
B) Other Refining / Petrochemical Technologies			
29**	Implementation of Naphtha to Gas and Gasoline Technology (NTGG)	2000	GAIL, Vagodia
30***	Development of Technology for Adsorptive Desulfurization of Gasoline	2007	-
31***	Development of Technology for Adsorptive Desulfurization of Diesel	2007	-

32***	Development of Technology for Oxidative Desulfurization of Diesel	2007	-
33***	Revamp of Soaker Visbreaker with Advanced Internals	2008	HPCL, Vizag
34***	Commercialization of LPG Sweetening Catalyst (Thoxcat) in Various Refineries	2008 onwards	BPCL/RIL/HPCL/IOCL etc.
35**	Development of Technology for Supercritical Solvent Deasphalting	2008	-
36***	Revamp of Soaker Visbreaker with Advanced Internals	2011	IOCL, Mathura
37***	Production of BTX, Gasoline and Diesel from Waste Plastic	2012	IIP, Dehradun
38**	Hydro-processing of Non-edible Vegetables Oils to Bio-Jet Fuels	2014	KRL, Cochin
39**	Biodiesel Based on Solid Catalyst and Novel Reactor Design	2015	-
40***	Revamp of Soaker Visbreaker with Advanced Internals	2016	IOCL, Haldia
41***	Commercialization of LPG Sweetening Catalyst (Thoxcat)	2016	Sohar Refinery, Oman
42***	Ionic Liquid based technology for revamp of a HF based alkylation unit in the LAB plant	2020	Reliance Industries Limited
43	Technology for 1 Hexene by trimerization of ethylene	2019	Reliance Industries Limited
44	Technology for Disentangled Polyethylene (UHMWPE)	2020	Reliance Industries Limited
45	A low energy process to replace light solvent from IIR polymerizate with Hexane cut	2023	confidential
46	An advanced method to remove sulfur bearing compounds from straight run and cracked LPG	2023	Reliance Jamnagar
47	A method for Producing Linear Alkyl Benzenes from Renewable Sources	2023	confidential
C) Process Integration/Pinch Analysis			
48***	Pinch Analysis of CDU for Increased Throughput	1996	IOCL, Haldia
49***	Pinch Analysis for Energy Optimization of Acetic Anhydride Plant	1997	VAM Organics, Gajraula
50***	Energy Optimization of Acetic Acid Plant	1997	VAM Organics, Gajraula
51***	Pinch Analysis for Increasing Throughput of Solvent De-waxing Unit	1997	IOCL, Haldia
52**	Pinch Analysis on CDU for Increased Throughput	1998 & 2009	IOCL, Guwahati
53***	Pinch Analysis for Increasing Throughput of Integrated Crude/Vacuum Unit	2006	Reliance, Jamnagar
54***	Pinch Analysis on CDU for Increased Throughput	2009	IOCL, Digboi
55***	Pinch Analysis for Energy Optimization of Delayed Coking Unit	2009	IOCL, Digboi
56***	Pinch Analysis for Energy Optimization of Delayed Coking Unit	2009	IOCL, Guwahati
58***	Column Targeting on Propylene Recovery Unit to Double its Capacity	2009	HPCL , Vizag

59***	Pinch Analysis on Lube NMP Extraction Unit to Improve Yield and Throughput	2010	HPCL, Mumbai
60**	Pinch Analysis of Two Crude Units for Increased Throughput	2012	HPCL, Vizag
61***	Pinch Analysis on CDU for Increased Throughput	2013	KRL, Kochi
62***	Pinch Analysis for Energy Optimization of Propane/ Deasphalting Unit	2014	CPCL, Chennai
63	Pinch Analysis of Crystallization based p-xylene unit	2018	RIL, Jamnagar
D) Simulation/Modelling/Advanced Control			
64***	Development of Software for Multi Stage Computation Using Continuation Method of Davidenko	1978	EIL (Process Dep.)
65**	Simulation Model for Naphtha Cracker Downstream on SIMSYS	1988	IPCL, Baroda
66**	Online Optimization of UOP FCC Unit	1989	CPCL, Chennai
67**	Online Optimization of UOP FCC Unit	1992	BPCL, Mumbai
68***	Data Reconciliation and Gross Error Detection Package (RAGE)	1992	BPCL, Mumbai/ CPCL, Chennai
69***	Dynamic Simulation of Steam Reformer in a Hydrogen Plant	1996	Anquing, China
70***	Dynamic Simulation of Steam Reformer in a Hydrogen Plant	1996	Confidential, Russia
71**	Training Simulators for CDU Hydrogen, Reformer and Visbreaker Based on UOP Technology	1996	MRPL, Mangalore

Notes :

***** Technologies yet to be commercialized

****** Provided strong technical leadership for success

******* Provided technical and administrative leadership from initiation to commercialization/ Development