



# CSIR-IIP : A Global Leader



Creating Future Fuels

Unilube , KSA &  
DeMenno Kerdoon, USA  
Paramount Grindly, KSA  
Gulf Petrochemicals, KSA

## Re-refining of Used Lube Oil

- Improving Colour and Colour Stability
- Basic Design Engineering Package (BDEP)

## SABIC, UK

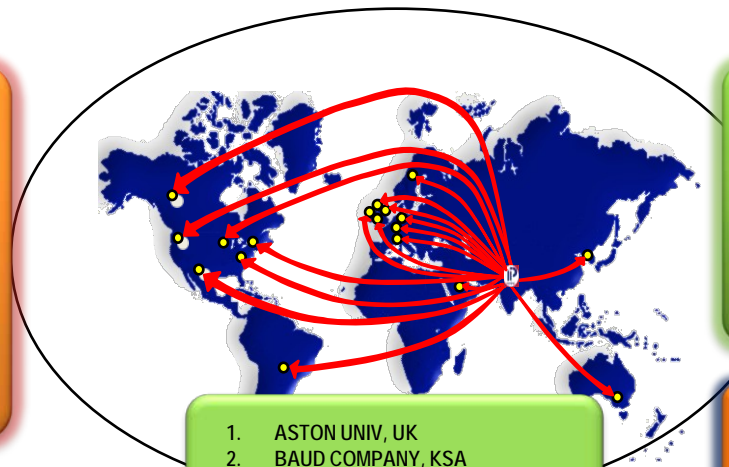
- Pure BTX from Straight Run Naphtha
- Revamp of Sulpholane Extraction Unit
- Transfer of CSIR- IIP BTX simulation model

## SABIC, KSA

- Signing of Master Research Alliance Agreement (MRAA)
- Benzene to Phenol

## ASTON UNIVERSITY, UK

- Pyrolysis Technology



- ASTON UNIV, UK
- BAUD COMPANY, KSA
- BP, UK
- DeMENNO / KERDOON, USA
- ENVERGENT TECHNOLOGY, USA
- EXXON MOBIL, USA
- FAU FRIEDRICH-ALEXANDER UNIVERSITAT ERLANGEN GERMANY
- FARABI, KSA
- GULF PETROCHEMICALS, KSA
- IMDEA ENERGIA, SPAIN
- MONASH UNIVERSITY, AUSTRALIA
- PATCHAM, UAE
- PRATT & WHITNEY, CANADA
- RTI, USA
- SABIC, UK
- SHELL TECHNOLOGIES
- SINTEF, NORWAY
- SOAT-LTT, GERMANY
- SwRI, USA
- TECH. UNIV. MUNCHEN, GERMANY
- UIUC, USA
- UKIERI, UK
- UNILUBE, KSA
- UNIV. OF ALBERTA, CANADA
- UNIV. OF ILLINOIS, USA
- UNIV. OF HUDDERSFIELD, UK
- UNIV. OF NEW CASTLE, UK
- UOP, USA
- RMIT UNIVERSITY, AUSTRALIA
- MELBORNE UNIVERSITY, AUSTRALIA

## Baud Company, KSA

- Processing of Group II Lubricating Base Oil

## FARABI, KSA

- Dearomatization of Kerosene

## SINTEF, NORWAY

- Sulphur reduction in the naphtha product
- Adsorption technology for ultra low sulphur diesel production
- Adsorption technology for recovery of CO<sub>2</sub>

## Clariant Corporation, USA

- Testing of FT Catalyst



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# Recent Achievements



# Simultaneous Production of US Grade Gasoline And High Purity Benzene from FCC Naphtha : CSIR IIP & RIL Technology



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## Need for this Technology

- ❖ MSAT – II regulations which became active on January 1<sup>st</sup>, 2011 (“EPA Regulatory Announcement” – EPA420-F-07-017, FEBRUARY 2007) , restricts the annual average benzene level in Gasoline sold in U.S, to 0.62 % vol.
- ❖ Surplus shale / ethane sources resulting in conversion of Naphtha crackers to Gas Crackers. Need to process alternative feedstocks to compensate for decreases in PyGas production.

## Salient Features of Technology

- Produces :
  - ❖ Gasoline having: (i) Sulphur < 10ppm (ii) Benzene < 0.3%
  - ❖ High purity benzene
- First time in the world and first indigenous technology Implemented in RIL, Jamnagar
- Capacity: ~0.7 MMTPA
- Capex: ~300 Crores INR
- Payback Period: Est. 2.5 Years

## Accolades

- ❖ CSIR Technology Award for Innovation, 2014
- ❖ US Patent 8722952, May 2014



**Plant successfully Commissioned at  
RIL Jamnagar in May 2016**





# Production of Paraffin & Microcrystalline Waxes at NRL



Numaligarh Refinery has installed a Wax D-eoiling Unit with an investment of Rs.676 crore using CSIR-IIP Technology.

## Production Capacity

- 45,000/50,000 TPA Paraffin Wax
- 5000 TPA Microcrystalline Wax
- Basic Design data generated at CSIR-IIP
- PEDP by EIL with IIP's Technical Support

Honourable Prime Minister Shri Narendra Modi dedicated the Wax Plant at Numaligarh Refinery Limited (NRL) to the nation on 5<sup>th</sup> February, 2016



Wax production unit , NRL, Assam

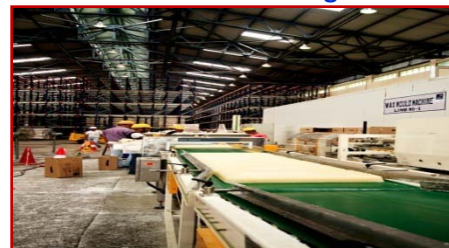


Dewaxing-Deoiling Pilot Plant at CSIR-IIP

Tanks of NRL Wax Plant



View of Wax Slabbing Unit





# Economic and Societal Benefits of Commercialization

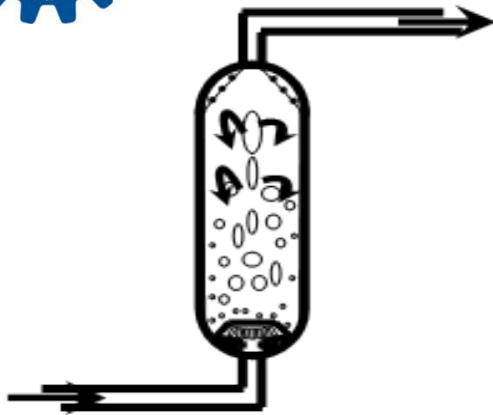


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- Increase in NRL profitability by Rs. 77.0 crores/annum equivalent to enhanced gross refinery margins by US \$ 0.53 per barrel.
- Significant savings on fixed capital investment and energy consumption compared to foreign technologies
- Wax production at NRL cut down wax import by 50% and saved foreign exchange of ~ US \$ 38 million.
- NRL has started export of paraffin wax to about 20 countries such as Nepal, Kenya, Bangladesh, Mexico, Nicaragua, Thailand and China
- **Societal Benefits** : Wax plant has generated direct jobs (125 persons) and created a new wave of wax entrepreneurs and cottage industries using wax in the **North-East**



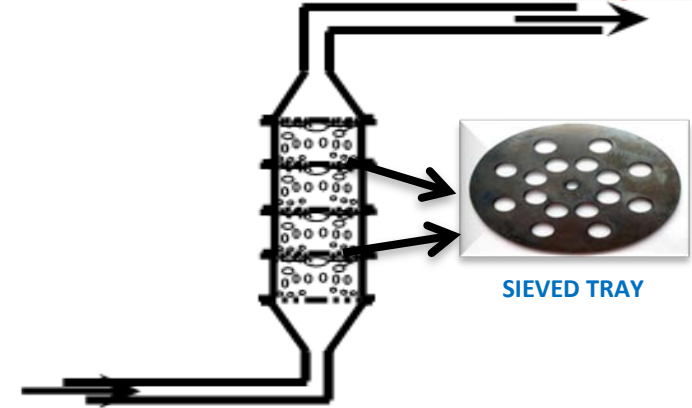
*Production of paraffin wax at NRL is a great success under 'Make in India'*



CONVENTIONAL SOAKER

## Benefits

- More distillates
- Improved fuel oil stability
- Better temperature profile
- Enhanced run length



SOAKER WITH INTERNALS

## Commercialisation and Economic Benefits

|                                 | HPCL, Vizag      | IOCL, Mathura    | IOCL, Haldia     |
|---------------------------------|------------------|------------------|------------------|
| Technology Transfer             | August, 2011     | January, 2013    | September, 2014  |
| Installation of internals       | September, 2012  | October, 2013    | February, 2016   |
| Commissioning                   | October, 2012    | November, 2013   | March, 2016      |
| Status                          | Running smoothly | Running smoothly | Running smoothly |
| Economic Benefit (Rs. Cr/annum) | 9.3              | 8.5              | 6.2              |
| Payback Period (months)         | <3               | <4               | <5               |

Thoxcat ES is useful for sweetening of LPG and other lighter petroleum fractions like LSRN/light cracked naphtha. Sweetening is a process for reduction/conversion of mercaptan sulfur.

Sweetening Unit

Commercialization



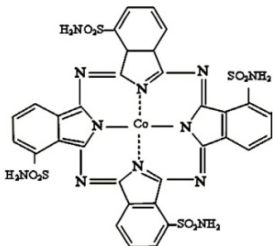
Catalyst Production Unit



Commercial Users of Thoxcat ES :

- ❖ BPCL, Mumbai (2008)
- ❖ HPCL, Mumbai (2009)
- ❖ HPCL, Vizag (2010)
- ❖ BORL, Bina (2011)
- ❖ HMEL, Bhatinda (2011)
- ❖ MRPL, Mangalore (2012)
- ❖ IOCL, Digboi (2012)
- ❖ RIL, Jamnagar (2012)

Catalyst Molecule  
Thoxcat ES



Licensed to  
M/s Lona Industries  
Ltd, Mumbai

- Globally competitive.
- Low cost
- Less consumption
- No additional investment
- Applicable in conventional & fiber-film sweetening processes

|                    |    |
|--------------------|----|
| • Patents: Foreign | 06 |
| Indian             | 03 |
| • Publications:    | 10 |

❖ License Fee & Royalty





# Modified Gur Bhatti



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## Development & Popularization of Improved Gur bhatti

- Improved 3- & 4- Pan *Gur Bhatti* developed & installed in rural areas (*over 35 installations*)
- Nearly 23% increase in daily *Gur* production observed.
- 12% savings in fuel consumption observed.
- Reduction in emissions (Smoke) clearly observed.

### Being popularized & installed under CSIR 800 mission



CSIR-IIP improved Gur bhatti installed near Meerut, U.P.



CSIR-IIP team with Gur Bhatti owner

**More profit, cleaner environment, better quality of jaggery**





# Prominent Technologies Developed & Ready for Commercialization

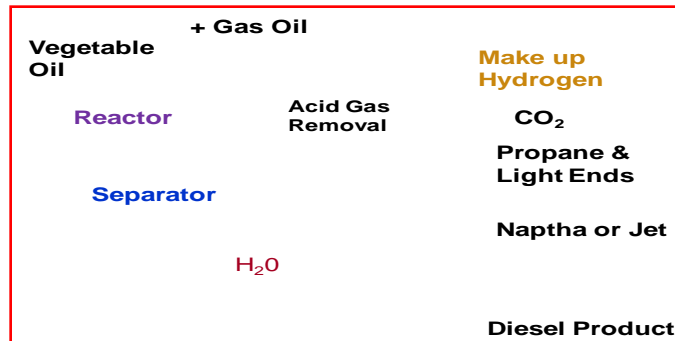
# Process for Bio-Jet Fuel



Biomass Derived oil



## Deoxygenation / Isomerization



Light Gases

Diesel

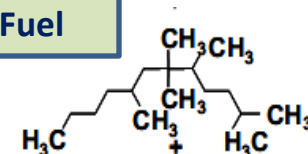
Light Gases

Naptha

## Deoxygenation / Selective Cracking / Isomerization

Bio-Jet Fuel

Diesel



CSIR-IIP Pilot Plant



- Capacity: 100 kg feed/day.
- 15 Liters of Bio-Jet Fuel supplied to Industrial Partners HPCL & IOCL
- The Bio-Jet Fuel Meets all the Major Specifications for Aviation Fuel as per ASTM D1655, and all parameters of IS:1571 except "petroleum origin" clause

## Scenario in India

### Waste Plastics

- ❖ As part of MSW in 60 major cities: **~ 15, 500 TPD (i.e ~ 56 Lakhs TPA)**
- ❖ Added everyday which lie littered (assuming 60 % recycling) : **~6137 TPD**

Source CPCB

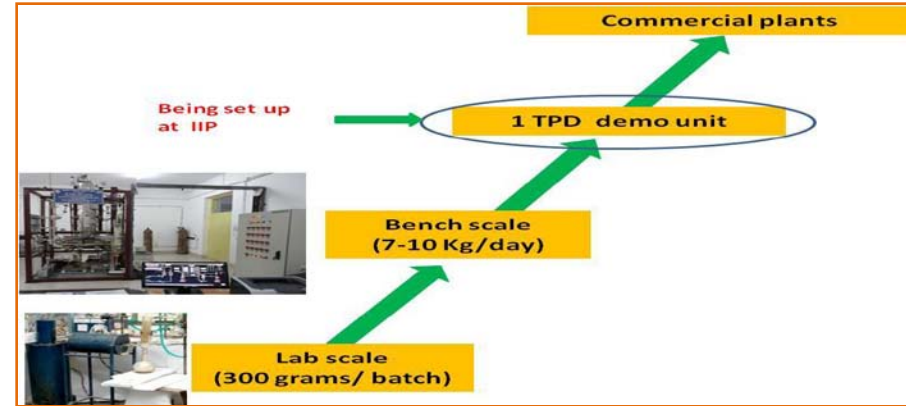


### Socio-economic impact

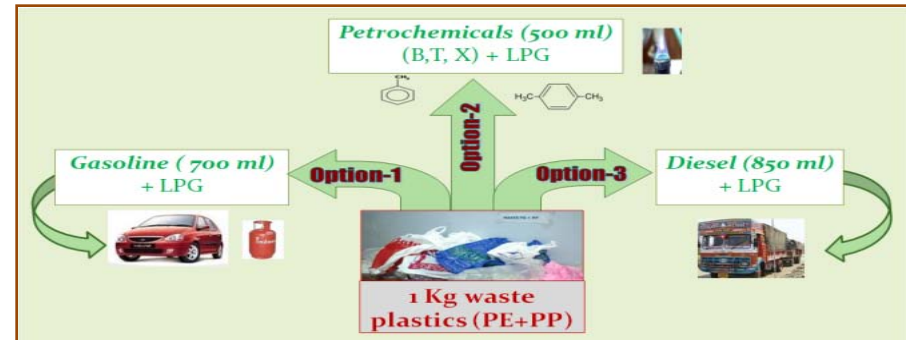


- Clean and economical automotive grade fuel from alternative source
- Impetus to waste plastics collection
- Economic benefits to rag pickers
- Green solution to waste plastics disposal

## Technology Development



## CSIR IIP & GAIL Technology



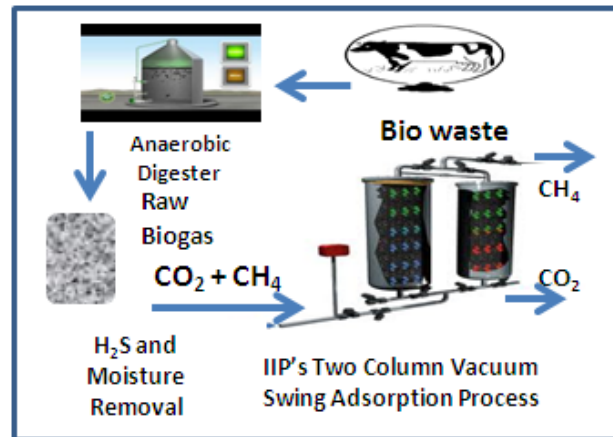
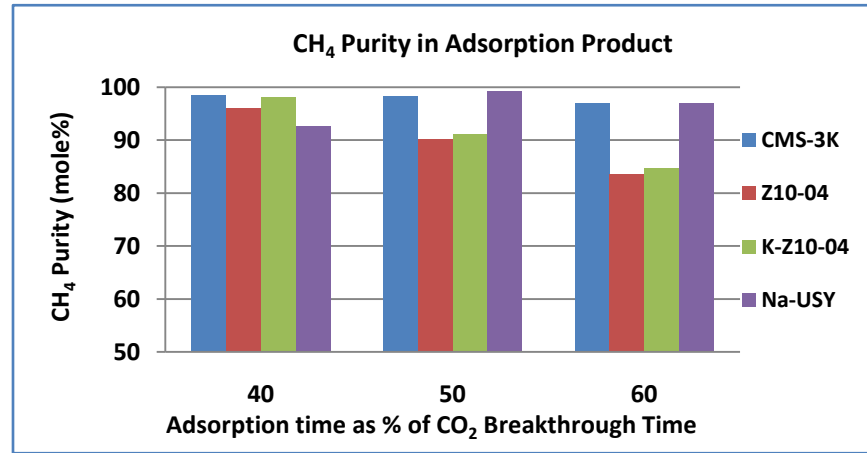
**National Award for Technology Innovation in 2012**

# Pressure/Vacuum Swing Adsorption (PVSA) Process for Biogas Up gradation

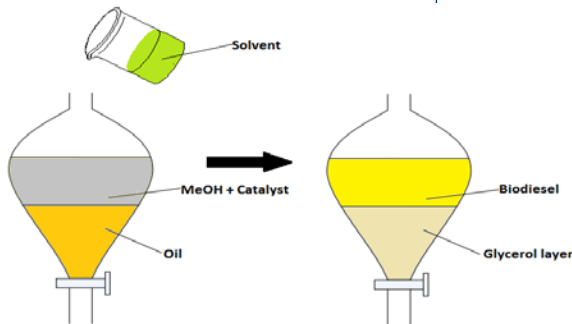
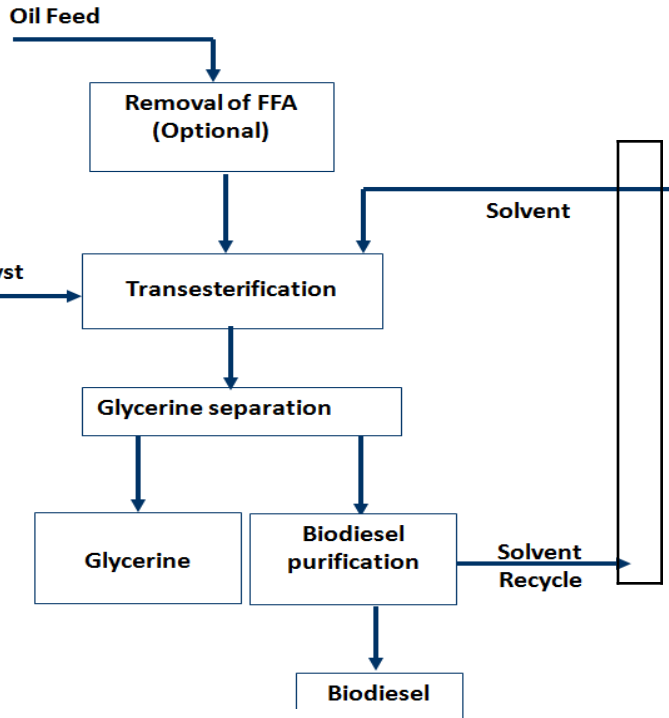
## Highlights

- ❖ Production of high purity  $\text{CH}_4$  with purity and recovery >90 mol%
- ❖ Simpler VSA cycle based on low cost commercial adsorbent
- ❖ Low energy required, high productivity
- ❖ Product biogas suitable for
  - ❖ Combined heat and power generation
  - ❖ Transportation fuel
  - ❖ Industrial and domestic usage
- ❖ Technology suitable for rural application
- ❖ Alignment to National Missions

A Demonstration Plant Based on this Process with a Raw Biogas Throughput of 10 m<sup>3</sup>/Day is being Set-up at CSIR-IIP







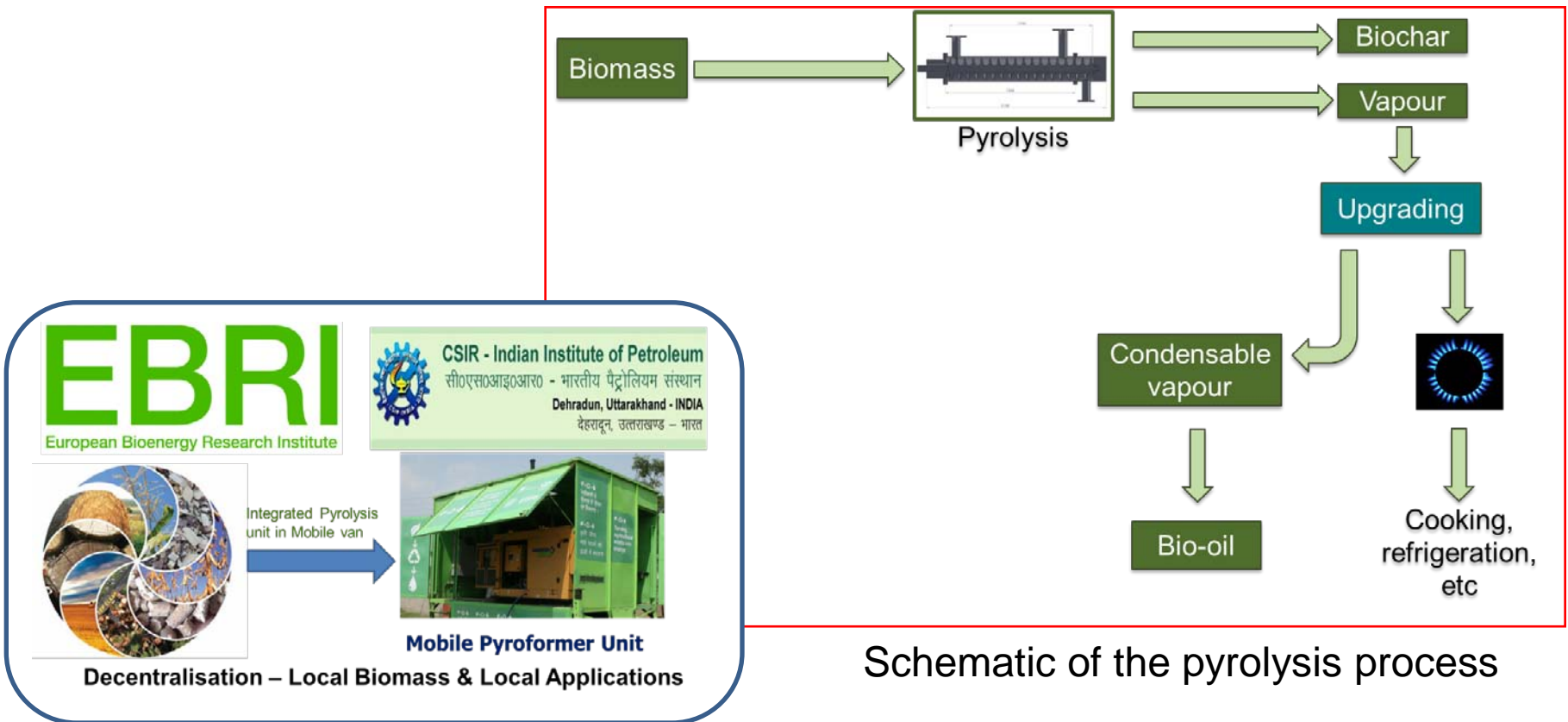
## *Salient Features*

- ✓ Suitable for feed stocks (non-edible oils) having FFA up to 10%.
- ✓ Reaction at ambient conditions without any heating or any mechanical stirring. After separation of glycerine, biodiesel is purified by water washing/distillation.
- ✓ Especially suitable for small scale operations in rural economies

**Patent Filed: 1 Indian Patent filed**

**Active collaboration with Chhattisgarh Biofuel Development Authority**

- Pyrolysis of agriculture waste for production of bio oil for stationary applications
- *Aston University, UK sponsored Joint project between EBRI & CSIR-IIP*



Schematic of the pyrolysis process

**Farmers need never burn crop residues again**



# Field Study to Determine Benzene Emission at Petrol Stations in India



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## Objectives

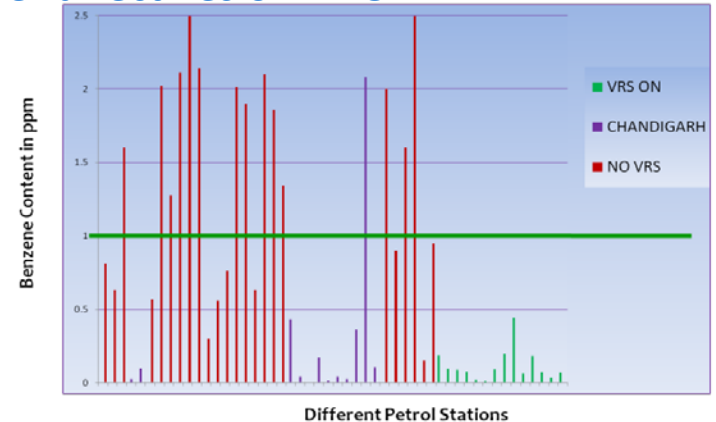
- To carry out a Field Study to determine Benzene Emission at Petrol Stations in India and different measures taken-up by OMCs on the same - **as per directives of PMO**

## Field Study

- IIP carried out a field study at **126 petrol stations in 13 cities w.r.t. installation of Vapor Recovery System (VRS) Stage-II, sale of petrol, type of ownership (ROs & COCOs) & OMCs (PSU and Private), petrol sell 50-300 KL/month, Benzene Emission.**

## Key Findings

- In general, **Benzene Content in forecourt of petrol stations having no VRS Stage - II** was in the range of **0.56 (min.) to 2.89 ppm (max).**
- Lower Benzene Content (0.01 to 0.44 ppm) was found, where VRS Stage - II has been installed -** which was **below the safe limit of 1.00 ppm of NIOSH's Short-Term Exposure Limit (STEL).** VRS Stage-II is useful to reduce Bz Emission.
- Current status of VRS Stage – II implementation** : In Delhi, out of 388 petrol stations, the Stage – II VRS has been installed at **130 petrol stations**; In the rest of the country, Stage – II VRS has been installed at **188 petrol stations.** **IIP recommended VRS Stage –II implementation at all petrol stations in the country.**



**Focus on health of petrol pump attendants and motorists**



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# Societal Impact



- Developed improved biomass stoves.
- Data on indoor air pollution by biomass *Chullhas* generated.
- Field trials & practical demonstration conducted at Champawat, Uttarakhand.
- For popularization of Chullhas, one day workshop attended at Champawat organized by UREDA.

| Conventional <i>Chullha</i> |   | Improved <i>Chullha</i> |   |
|-----------------------------|---|-------------------------|---|
| Thermal Efficiency (%)      | Total Suspended Particulates ( $\mu\text{g}/\text{m}^3$ ) | Thermal Efficiency (%)  | Total Suspended Particulates ( $\mu\text{g}/\text{m}^3$ ) |
| 15.12                       | 1000  | 26                      | 900   |



Improved Biomass *Chullha*



Improved *chullha* field trials



Popularization of *chullha*

Less fuel, reduced smoke, low cost



# Jigyasa Programme



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Council of Scientific and Industrial Research (CSIR) has joined hands with Kendriya Vidyalaya Sangathan (KVS) in form of Jigyasa, a student- scientist connect programme which was launched on 06 July 2017. The aim is to extend student's classroom education with that of a very well planned research laboratory based experimental learning.

## Jigyasa Activities

**Oil & Gas Conservation Awareness Week, "Saksham 2018"** The Oil & Gas Conservation Awareness Week, "Saksham 2018" was inaugurated on January 19, 2018. Main objective of awareness week is to bring awareness about Oil & Gas Conservation among students.

**Lecture by Scientist, IIP to Students of KV school:** A lecture on "Hydrocarbons: From Refinery to Day to Day Life" was delivered to students of KV school.

**Tarunotsav Program for XIth Students:** The "Tarunotsav" programme was organized on April 26, 2018 for students of XI<sup>th</sup> class

**Student Residential Program:** A three-day Summer Residential Programme in Science was organized at CSIR-I.I.P. for students of KV. during May 14-16, 2018

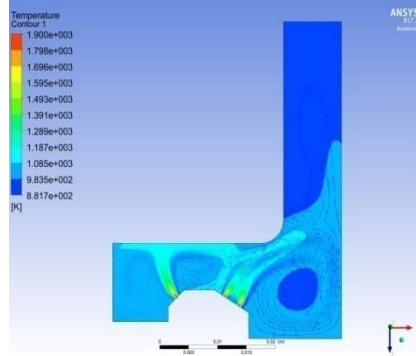
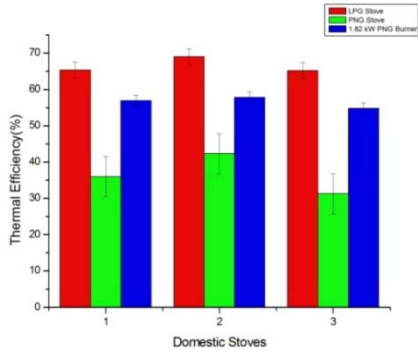




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# CSIR-IIP Road Map For New India Vision → Goals → For Future

(Sponsored by PCRA)



- Modifying LPG burner by increasing supply gas injector holes reduces the thermal efficiency of the burner
- Interchangeability between LPG and PNG is poor as “Flame Lift” phenomena is observed
- Changing supply pressure affects the flame characteristics in self aerated burners



PNG Burner

## Project Outcome:

- Improved PNG burners of four different output capacity designed
- Prototype PNG burners fabricated and experimentally evaluated
- Overall 15% improvement in thermal efficiency observed
- A standard facility for the evaluation of PNG burners established
- Evaluation procedure designed to help BIS to formulate Indian standard on PNG burners



PNG Burner Evaluation Facility





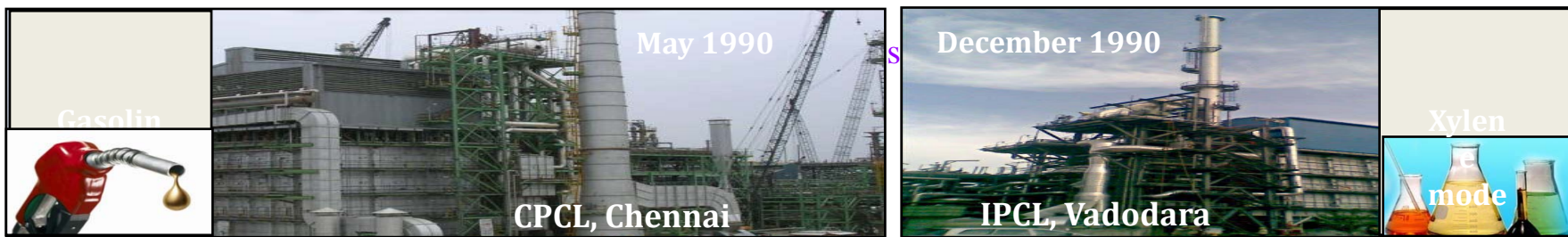
# INDIGENOUS REFORMING CATALYST



CSIR-Indian Institute of Petroleum has made efforts to make a remarkable break through in the development of indigenous Reforming catalysts. Extensive research carried out at IIP has resulted in successful design of a novel catalyst creating optimum acid sites and metal sites led to the development of a balanced Pt-Re/ $\text{Al}_2\text{O}_3$  catalyst called IPR-2001. The catalyst exhibits improved product quality in terms of  $\text{C}_5+$ , Octane, BTX and  $\text{H}_2$  yields along with improved catalyst life.



## Commercial Success : At CPCL and IPCL in 1990



## Feedback from User Industry (CPCL)

“  
*The performance of catalyst is quite satisfactory with good quality product especially with respect to reformate and  $\text{H}_2$  yields*  
*In fact the reformate RON was achievable at 5 °C temperature lower than what it was guaranteed*  
 ”

*The catalyst was in operation successfully for about 21 months of single*

**Recognition : CSIR-IIP Bagged CSIR Technology Award in 1992**