Enhance Refinery Margins by Producing Premium Refinery Products from FCC Slurry Oil

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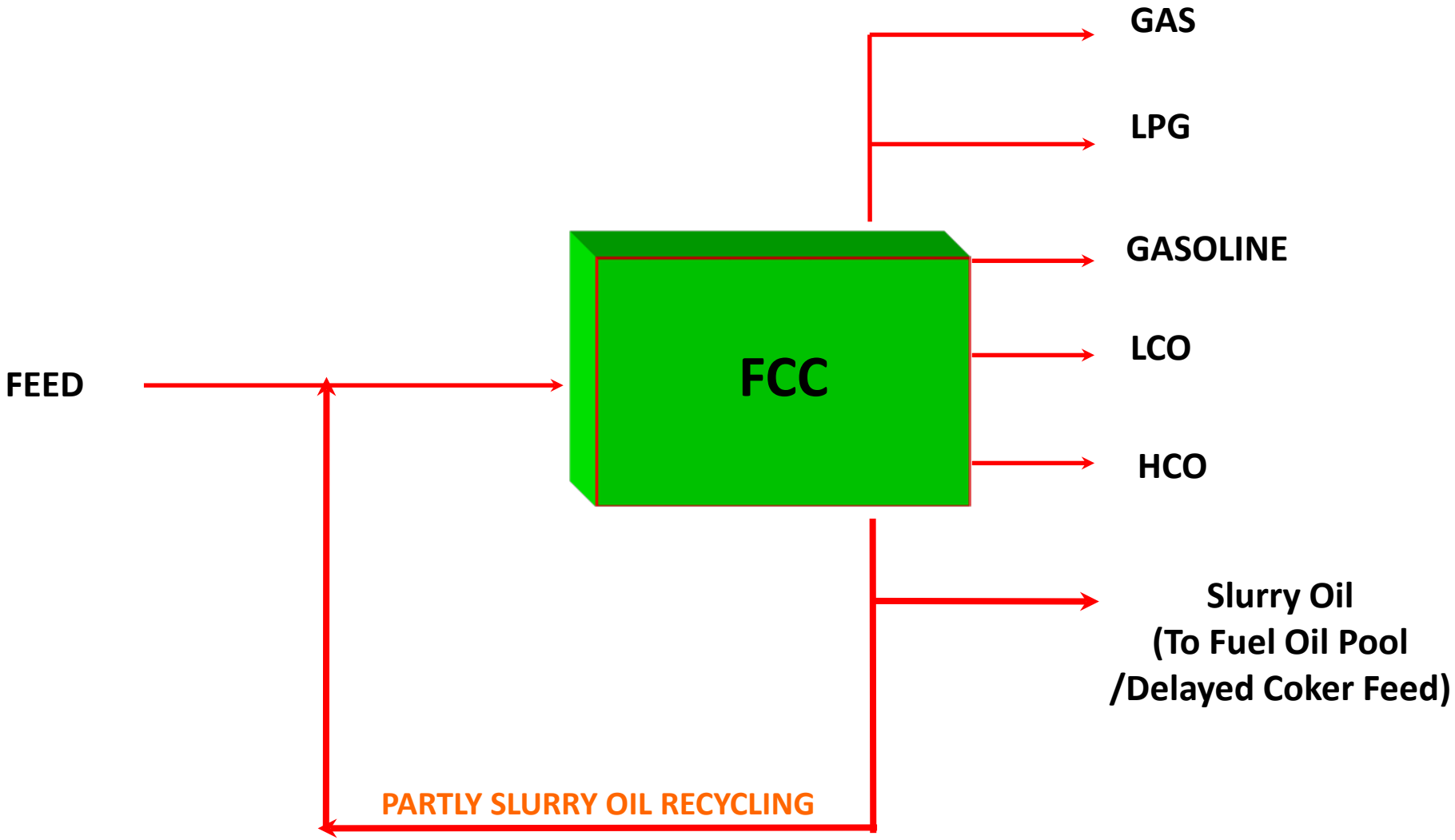
Challenges

- **FCC unit in refinery produces Slurry Oil, an aromatics laden residue stream, which is refractory in nature.**
- **Upgradation of slurry oil into transportation fuels through catalytic route is very difficult**
- **slurry oil recycling in FCC unit is limited**
- **Therefore, refiners blend major portion of slurry oil into fuel oil - demand of which is continuously declining or as 'Delayed Coker' feed - if such a unit exists in the refinery**

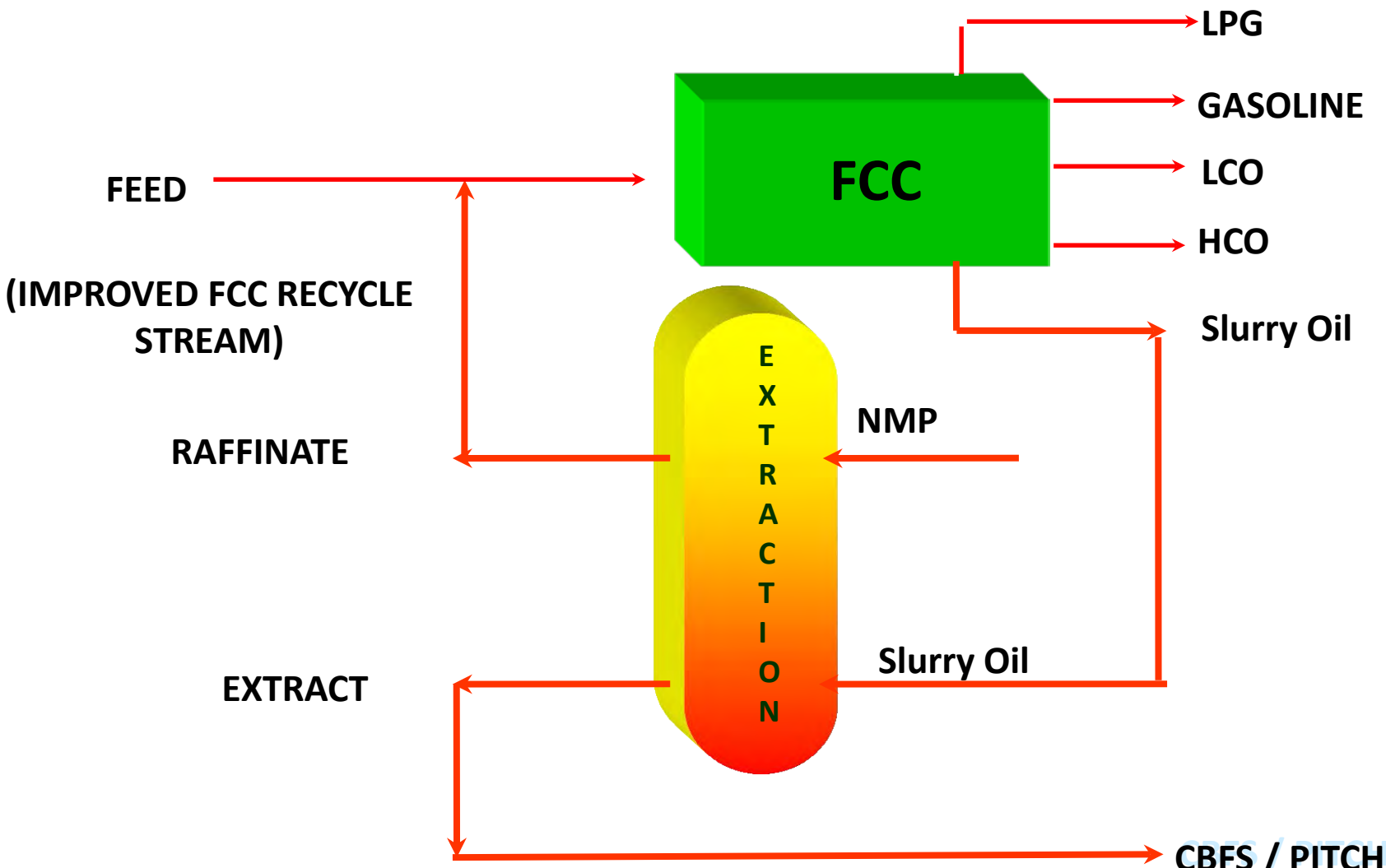
General Refining Scheme



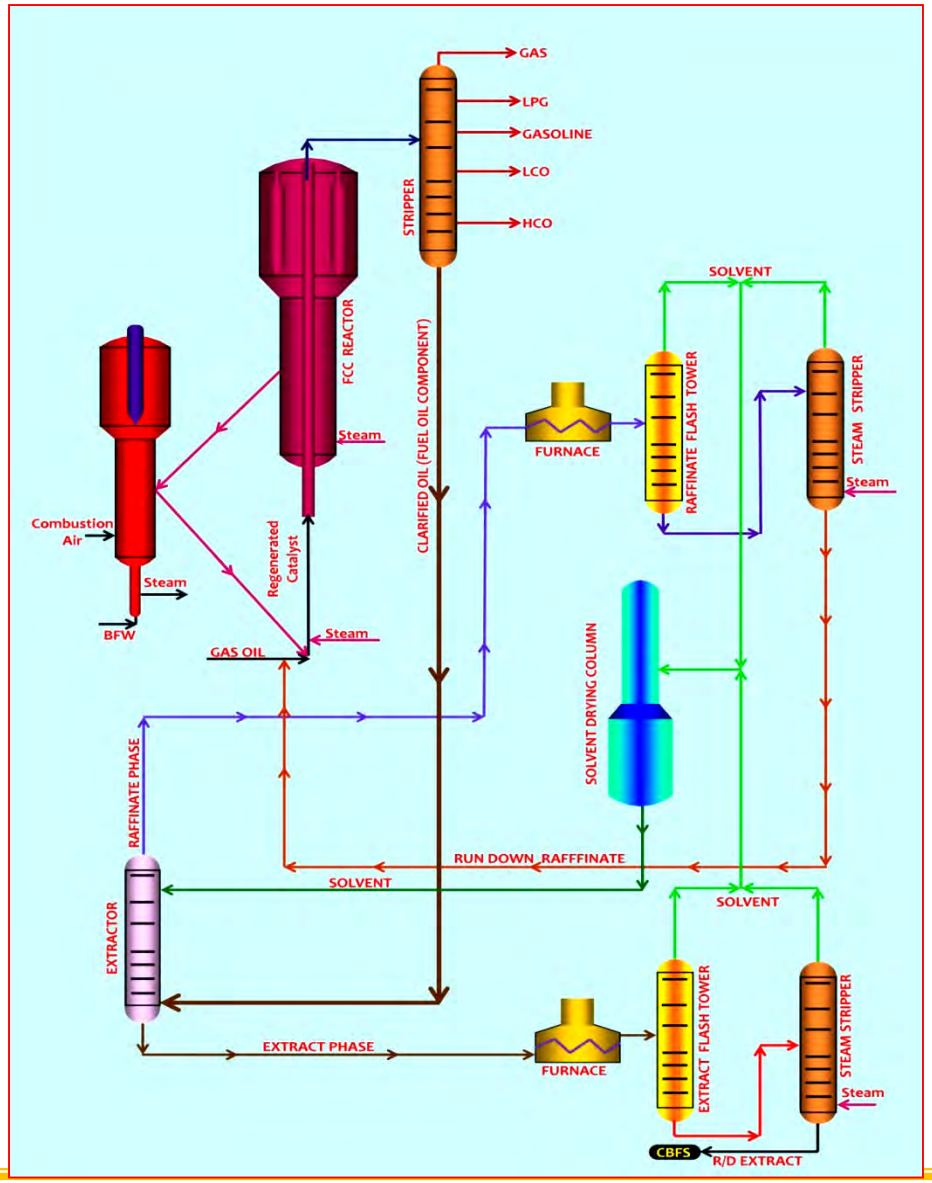
Technology for Production of Premium Products from FCC Slurry Oil

- A novel application for upgrading slurry oil into value added premium refinery products
- Innovative concept of integration of two different processes :
  - Solvent Extraction
  - Catalytic Cracking

Innovative Processing Option



Process Flow Diagram



Technology Objectives

This technology is aimed to achieve the following :

- **Generation of additional quantity of clean FCC feed and thereby enhanced distillate yields**
- **Reduction in fuel oil components**
- **Production of premium quality carbon black feed stock (CBFS)**
- **Conversion of aromatics present in slurry oil into high value mesophase pitch - precursor for advanced carbon materials**

Key Features/Advantages of Technology

- Provides improved quality FCC feed stock, which is as clean as fresh feed (VGO)
- Higher yields of FCC products (gas/distillate) of better quality (reduced sulfur)
- Co-production of high BMCI aromatic extract (premium quality CBFS)
- Reduction in coke lay down on cracking catalyst leading to enhanced catalyst efficacy and cycle life, reduced catalyst consumption and regenerator load
- Reduced CO_2 emissions (meeting future carbon emission legislations of the refinery)
- No major investment, high profitability

Technology Development

- **Phase I : Basic data generation (single stage and multistage extraction, Cracking Studies in ACE unit) at lab scale**

- **Phase II : Fine tuning with process parameters of current operation of HPCL refinery**

- **Phase III : Successful commercial run at HPCL to prove technology concept**

The technology is currently operating successfully

Typical Feed Properties

- **Technology was developed/fine tuned based on HPCL feed stock (slurry oil) with properties as given below :**

Properties	
Density gm/ml d_4^{15}	0.8927
Kin Viscosity cSt at 100^oC	4.18
Pour Point, ^oC	+45
Flash Point, ^oC	122
BMCI	36
IBP, ^oC	282.9
FBP, ^oC	516.9

Slurry Oil Extraction Data

- Typical bench scale lab data & commercial scale test run data obtained and compared
- Bench scale data (yields, BMCI etc.) are well comparable with refinery test run data

Parameter	Bench Scale Data		Test Run Data
	Single Stage	Multi Stage	
Extraction Temperature, °C (T/B)	65	65/55	75/65
Solvent to Feed Ratio	0.9	0.9	0.9 -1.0
Raffinate Yield, wt%	82.7	76.9	74.0
Raffinate Density@ 15°C, gm/ml	0.8637	0.8485	0.8613
Extract Yield, wt%	17.3	23.1	26.0
Extract Density @ 15°C, gm/ml	1.0857	1.1208	1.1200
Extract BMCI	127	144	135 -144

Comparison of FCC Yields with Recycling of Slurry Oil & its Raffinate

- This technology increases the yields (wt%) of gas, LPG and gasoline, while reduces coke lay down on catalyst and formation of slurry oil

Product	Base Case (FCC Feed : VGO + slurry oil)	Modified Case (FCC Feed : VGO + Raffinate)
Dry Gas	1.7	2.15
LPG	11.1	15.86
Gasoline	25.3	42.40
Distillate	44.1	26.44
Coke	2.2	2.02
Bottoms (CLO)	15.6	11.13

Evaluation of Extract as CBFS

- **Aromatic rich by-product extract exceeds key specifications for premium quality CBFS**

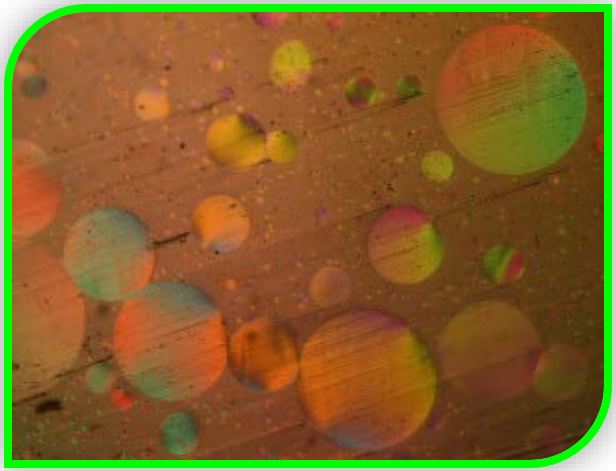
Characteristics	CBFS Specifications	Extract Values
Specific Gravity @ 15° C	1.07 - 1.12	1.117
BMCI by viscosity method, min	125	146
Sulphur, wt%, max	3.7	2.1
Asphaltene, wt%, max	6.00	1.71

Potential for Further Value Addition of Aromatic Extract Stream

- **The extract stream produced is very rich in aromatics and can be converted into high value mesophase pitch – a precursor for a variety of advanced and engineering carbon materials.**

- **This is a very major value addition to aromatic extract with potential to make huge money.**

- **Advanced carbon materials produced from mesophase pitch are needed for various strategically important materials**



Mesophase Pitch

Commercial Run at HPCL Mumbai Refinery

- M/s HPCL carried out 'commercial run' for processing of slurry oil in one of their existing solvent extraction units of lube block at Mumbai refinery.
- The commercial run was a great success.
- Technology is tailor made to HPCL but not limiting to it.

Investment/Economic Impact of Technology

- **HPCL invested ~ Rs 50 Lakhs only for implementing this technology**
- **Gross refinery margin (GRM) of HPCL has increased by ~ US $ 0.14/bbl**
- **Increase in profit of refinery to the tune of ~US$ 15 million/annum)**
- **Reduction in generation of fuel oil components by ~65 TMT (0.9 wt%) annually/5.45 TMT per month**
- **Monthly production of 3.85 TMT of premium cat feed (raffinate) and 1.60 TMT of premium CBFS (Extract)**

Other Potential Applications of Technology

Other potential applications of Technology include :

- **Production of paraffinic feed for isodewaxing /isocracking to make new generation high quality group-II and Group-III lube base oils**

- **Production of low aromatic raffinate from LCO which can be blended for quality upgradation with diesel**

- **Production of needle coke from premium CBFS (the major demand of needle coke is met through import)**

Recognition

This innovative technology begged prestigious

‘CSIR Technology Award’

Conclusions

- A novel technology for production of valuable refinery products from low – value slurry oil such as good quality FCC feed, premium quality CBFS, precursor for advanced carbon materials
- Concept of integration of solvent extraction and FCC is new
- This is a proven technology as it is successfully running at HPCL Mumbai refinery
- Investments are low, enhancement in annual refinery profit is high
- Best suited for refineries having FCC and Solvent extraction units but can be implemented to other refineries also with only small investment

Acknowledgements

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- We compliment M/s HPCL for implementing the technology in its Mahul Refinery for which they are deservedly reaping rich dividends.

C O N T A C T S

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