

## **COURSE CONTENTS**

### 1. BASICS OF CFR ENGINES

The CFR engines are used to measure anti-knock property of fuels in terms of OCTANE/CETANE Number by using standard and reference fuels. The combustion characteristics of SI and CI engines, Ignition delay etc. will be explained in details

### 2. REFERENCE AND STANDARD FUELS

Determination of Octane number is done using series of standard fuels. Standard fuels can be blends of Iso-octane and normal Heptanes (primary reference fuels) to ensure that the CFR engine is in perfect working.

### 3. DISMANTLING OF CFR ENGINES

Normally CFR engine can be used up to 300 hrs of continuous operation. After that minor overhauling is required. Complete engine will be dismantled and shown to the participants.

### 4. INSPECTION & MEASUREMENT OF ENGINE COMPONENTS

After this Inspection of components is carried out to estimate possible wear. It is vital for gauging the dimensional accuracy of a feature without reference to its actual size. Measurement is the act of deriving quantitative information about a physical object or by comparison with a reference.

### 5. ASSEMBLY OF CFR ENGINES

After measurement, assembling of the engine components will be done. Adjustments as per ASTM Test Procedure will be carried out

### 6. CALIBRATION & STANDARDIZATION OF CFR ENGINES

After assembly before conducting any test, calibration and standardization of CFR engines will be carried out using standard primary and secondary fuels.

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**[IV] Training Programme on “ANALYSIS OF PETROLEUM & PETROLEUM PRODUCTS”/  
“LABORATORY PRACTICALS” (2 weeks)**

1. Crude assay using Physico-Chemical and Analytical Methods  
Basic Chemistry of crude oil: Composition and classification , crude assay short assay, mid assay and detailed assay of crude oil, Types & Objectives of evaluation, Dehydration of crude oil, Atmospheric, Vacuum and short path distillation, ASTM D-86, D-1160, inter conversion of data from ASTM to TBP to EFV
2. Petroleum Product Characterization  
Crude oil products viz NGL, LNG, LPG, gasoline, Naptha, Kerosene, Middle distillates, long residue, VGP, short residue, lube oil and bitumen, their characterization by ASTM/ UOP/ IP/ IS test methods
3. Latest specifications on LPG, Naptha , MS, HSD, Kerosene, ATF (BIS, Defstan, ASTM), Furnace oil, bitumen, Pet Coke , sulfur Granules etc.
4. Analysis of MS  
Density, ASTM D-86 Distillation, Reid vapor pressure, vapour lock index, FIA, Total sulphur (ASTM D-4294 & 5453), Benzene content, Oxygenates, RON, MON, Copper Strip Corrosion, Existent gum, potential gum, Induction period , Lead Content
5. Kerosene/ ATF test  
Sp. Gravity, Aromatic contents, Olefinic content, kinematic viscosity, smoke point, Naphthalene %, freezing point, ASTM D-86, Water content, conductivity test, JFTOT (Jet fuel test), Total sulphur, Mercapton, H<sub>2</sub>S, Acidity, Colour Saybolt, Smoke Point, silver strip corrosion test, Burning Quality, Char value, Bloom on Chimney, FIA , Flash point ( Manual & Auto) , Water reaction , Existent Gum , Particle counter etc
6. Analysis of HSD  
Density, Kinematic viscosity, pour point, cloud point, CFPP, Cetane Number, Cetane index, Flash Pt./Abels, Aromatics contents, HFRR, Oxidation Stability , Particulate Contaminants , Moisture , ASTM Distillation , RCR , Ash Content , Acidity In organic & Total , Cupper Corr , etc
7. Furnace oil test  
Density, ash content, sulphur, water content, flash point, kinematic viscosity, calorific value, Micro carbon residue (MCR), Total Sediment (TSP), P-value , Pour point ,Metals ,etc.
8. Bitumen Analysis  
Penetration test, Softening Point, ductility, rheology, hardness, Rolling Thin Film Oven(RTFO) test, Frass Breaking point, Flash point (COC), TCE soluble matter , Wax Content , Specific Gravity , Water Content etc.
9. Other tests related to petroleum products  
ASTM D-1160 distillation, Foaming characteristics, TAN and TBN, Evaporation loss by Noacks Method, Emulsion characteristics and demulsification, Rust preventive characteristics, Air release value, Elemental analysis by chemical, carbon residue , cold cranking simulation, mini rotary viscometer, Total nitrogen (instrumental – Chemiluminiscence and Kjeldahls) , C & S on Catalyst , Calorific value by Bomb Calorimeter , etc..

10. Gasoline & Diesel Quality Parameters( RON, MON, CETANE No ) using CFR Engine Calibration & Standardization of RON, MON, CETANE No unit, as per ASTM test procedures Operation of RON, MON, CETANE Unit
11. Gas Chromatography Theory, Instrumental Setup, Qualitative and Quantitative Analysis, Application
12. Other Essential instrumental analysis technique :  
HPLC, SFC, NMR, IR, GS Mass FTIR, UV/ visible spectrometry, EDXRF (Sulfur and metals), ICP & AAS, etc: Theory, Instrumental Setup, Qualitative, Quantitative-Analysis, Application

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## **[V] Training Programme on “REFINING PROCESSES CATALYSTS AND TECHNOLOGY” ( 3 days)**

1. Introduction to oil refinery catalytic processes
  - Naphtha Hydro-treating
  - Kerosene Merox
  - Diesel hydro-treating
  - Sulfur Recovery
  - Fluid Catalytic Cracking
  - Hydrocracking & Delayed Cocker
  
2. Introduction to oil refinery processes & Classification of Catalysts; types and usage for different types of industrial applications / processes, chemical reactions.
  - Platforming/Reforming process
  - Isomerization process
  - Difference between heterogeneous and homogeneous catalyst.
  - Catalyst types versus industrial processes /applications.
  - Catalytic reaction; chemical reactions at surfaces, reactivity of metal complexes, or macromolecular structure to catalytic function and processes
  - Catalyst performance improvement
  
3. Catalyst operating parameters; catalyst contaminants/poisons; catalyst special procedures; catalytic reaction/promoters, new catalyst in the market
  - Catalytic Reforming: difference between fixed bed and moving bed; advantages/disadvantages.
  - Catalyst operating temperature & pressure
  - Effect of chloride on Reformer/Platformer/ Isomerization catalysts
  - Effect of water/moisture on Penex catalyst
  - Catalyst regeneration, reduction
  - Catalyst special procedures (Handling, On-the fly-replacement; decoking, loading/unloading, circulation, drying)
  - Catalyst contaminants/poisons (temporary as well as permanent)
  - New catalysts in the market, for example for waste reduction, reduced energy use or efficient use of feedstocks.

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**[VI] Training Programme on “VEHICULAR POLLUTION” (1 week)**

1. Gasoline Vehicles: Engine Technology - Fuel Quality and Emission
2. Diesel Vehicles: Engine Technology, Fuel Quality and Emission
3. Alternative Fuel Vehicles
4. Role of Lubricants for Pollution Control
5. Central Motor Vehicles Rules for CNG and LPG Vehicles
6. Road safety for rural and urban areas
7. Maintenance and Calibration of Portable Gas Analyzers & Smoke meter
8. Effects of Vehicular Pollution on Human Health including the Road Safety and Supporting Aid, Aspects

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**[VII] Training Programme on “ELECTRIC VEHICLES FOR FUTURE URBAN MOBILITY - CHALLENGES AND OPPORTUNITIES” (1 week)**

1. Basics of the Electric Vehicle (EV) and Hybrid Electric Vehicle
2. Charging Infrastructure: present and future scenario
3. Battery technologies
4. In-vehicle energy management
5. New driving cycles for EVs and test methods
6. Effect of different drive modes on energy consumption of EVs
7. Electric Drives and Power electronics
8. Hybrid and Electrical Vehicles : Current and future Scenario
9. Diagnostic system management in EVs
10. Technology comparison of IC Engine vehicle and EV
11. Effect of ICE vehicular pollution on human health and environment
12. On-road mobility options

***Practical / Lab Demonstrations***

- Max. speed and energy consumption measurements of EVs
- Solar Charging Station
- Retro-fitment of old & polluting petrol-diesel vehicles in EVs
- Electric Powertrain System

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## **[VIII] Training Programme on “HEAT EXCHANGER DESIGN AND TROUBLESHOOTING” (3 days)**

1. Single-phase shell-and tube heat exchangers
  - Overall aims of thermal design
  - Types of heat exchangers
  - Design data required
  - Fundamental correlations for thermal design
  - Optimising tubeside design
  - Optimising shellside design
  - Shell style and baffling
  - Stream analysis
  - Temperature profile distortion
  - Minimisation of pressure drop
  - Minimising shellside pressure drop
  - Minimisation of shellside pressure drop
  - Use of multiple shells in series/parallel
  - Allocation of shellside and tubeside
2. MTD
  - LMTD
  - Co-current flow
  - Counter-current flow
  - Temperature cross
  - ‘F’, ‘G’ and ‘H’ shells for temperature cross
  - Temperature profile distortion (TPD)
3. Thermal design of Condensers
  - The mechanisms of condensing
  - Condensate film
  - Gravity- and shear-controlled condensation
  - Condensation of mixtures
  - Classification of condensers
  - Practical guidelines for thermal design
  - Shell type and baffling
  - Multiple shells in series/parallel
  - Desuperheating
  - Subcooling
  - Special applications: low-fin tubes and reflux condensers
4. TEMA basics
  - Nomenclature
  - Fabrication tolerances
  - General fabrication and performance information
  - Installation, Operation and Maintenance
  - Mech. Standards TEMA Class RCB
  - Flow-induced vibration
  - Thermal relations

- Physical properties of fluids
  - General information
  - Recommended good practice
5. Thermal design of Reboilers
    - Pool boiling and parameters affecting it
    - Flow boiling
    - Design of distillation column reboilers: kettle, vertical thermosyphon, horizontal thermosyphon and forced flow. Special design considerations: film boiling and very low  $\Delta T$ . Selection of reboilers, start-up and control of reboilers
  6. Fouling - Causes, consequences and mitigation
    - Adverse effects of fouling
    - Categories of fouling
    - Parameters that affect fouling
    - The stages of fouling
    - How to provide a fouling allowance
    - Selection of fouling resistance
    - Design guidelines for reducing fouling
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  7. Flow-induced vibration analysis
    - Introduction
    - Mechanics of flow-induced tube vibration
    - Modes of tube failure
    - Producing a safe design
    - The vital link between flow-induced tube vibration and pressure drop
    - Acoustic vibration
  8. Enhanced heat transfer
    - What is enhanced heat transfer?
    - The imperative for EHT
    - Benefits of EHT
    - Techniques for heat transfer enhancement
  9. Twisted-tube heat exchangers (TTHE's)
    - Shortcomings of the STHE
    - Features, advantages and applications of the TTHE
    - The retrofit situation
    - Comparison with conventional STHE's
  10. Helixchangers
    - Limitations of conventional baffle design
    - Advantages of Helixchangers
    - Best applications
    - Comparison with conventional STHE's
  11. Air-cooled heat exchangers (ACHE's)
    - Pros and cons of ACHE's
    - Optimising air and water cooling: selection of break temperature



- Construction features

**12. Heat exchanger troubleshooting, debottlenecking and revamp**

- Excessive cooling water scaling
- Supplementing existing shell
- Missing longitudinal baffle
- Changing from series to parallel operation
- Replacement/modification of tube bundle – tubeside
- Replacement/modification of tube bundle – shellside
- Interchange of fluid sides (two case studies)
- Addition of tube inserts
- Air-cooled heat exchangers
- Increase air flow rate
- Reduce no. of tube passes to handle higher tubeside flow rate Add, supplement or replace trim cooler

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**[IX] Training Programme on “CORROSION CONTROL AND MATERIAL SELECTION IN REFINERIES” (1 week)**

1. Principle of Low Temperature (wet) Corrosion
2. Various forms of wet Corrosion and remedial measures
3. High temperature corrosion principles
4. (High Temperature Corrosion) : Oxidation, Sulphidation, Liquid Metal corrosion
5. Fuel ash Corrosion and HTHA (Nelson Curve) & Case study.
6. Corrosion Monitoring methods: direct and indirect, intrusive and non-intrusive methods, coupon method,
7. ER & LRP monitoring, NDT and analytical methods of monitoring
8. Mitigations: Materials Selection, Design for corrosion control, coatings, cathodic & anodic protections and modification of environment.
9. Classification of Engineering Material (metals, composites and non- metals)
10. Properties and Application of (Ferrous, Ni-Cr-Fe Alloys, Non-ferrous Alloys.
11. Properties and Application of Duplex and NACE-Material).
12. Material Selection Methodology, Specification, code & standards
13. Material Degradation & Mechanical Failures Material Degradation  
Carburization/Graphitization, Temper Embrittlement Sensitization / Sigma phase)
14. Mechanical Failures (Overloading, Creep, Fatigue, wrong material selection / Metallurgy mix-up, Material abuse and Thermal shock)
15. Crude oil characteristics, API gravity and corrosivity. Impact of crude oil impurities on process unit corrosion. Overhead Corrosion control
16. High TAN(Naphthenic Acid) and sour crude corrosion and mitigation and material selection.
17. Erosion – Corrosion, Stress Corrosion Cracking (Polythionic and Chloride
18. Stress Corrosion Cracking), material selection and MOC
19. Hydroprocess ( Hydro Cracker, Hydrotreater and Desulfurizer)
20. Ammonium Bisulfide Corrosion and mitigation.
21. High temperature H<sub>2</sub>/H<sub>2</sub>S Corrosion, corrosion rate curves for alloys and copper-Gorman curve , corrosion mitigation, material selection and MOC, SS321 Vs SS347 application. Stress relaxation cracking (SRC) and stabilization heat treatment.
22. Lighter End and Auxiliary Units ( LPG & Amine treating and SRU Units
23. Sour environment corrosion (Wet-H<sub>2</sub>S Corrosion). Amine Cracking, PWHT, Material Selection and MOC, NACE Material & NACE-RP 103
24. Caustic embrittlement , caustic gauging and cracking, material and PWHT requirement.

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**[X] Training Programme on “ADVANCED AUTOMOTIVE TECHNOLOGY AND INDIAN ROAD TRAFFIC PATTERN- CHALLENGES & OPPORTUNITIES.”  
(1 week)**

1. Fundamentals of Internal combustion engine and perspective of Automotive Fuel Quality and Emissions
2. Advanced Alternative engine concepts for improvement in efficiencies
3. Advance Exhaust treatment systems in vehicles ( BS IV and BS VI) for reduction of emissions
4. Current and new generation CNG and LPG engine/vehicle design and developments
5. Fundamentals of Electric and Hybrid power train and their role in reduction of on-road emissions and fuel consumption
6. Real world driving emissions: A review of the worldwide activity and its applicability in Indian context
7. New Generation engine oils for advance I C Engines
8. Engine performance and emission measurements on transient, steady state engine dynamometer
9. Indian vehicle population/roads infrastructure and its correlation with ambient air quality

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