

## Catalysis in Petrochemical Processes: Principles, Functions, Methods, and Maintenance for Industrial Applications

### Course general description:

Catalysis is the cornerstone of petrochemical processes, enabling efficient and cost-effective production of fuels, chemicals, and polymers. Catalysts play a critical role in enhancing reaction rates, improving selectivity, and reducing energy consumption while meeting stringent environmental regulations. This course provides a comprehensive exploration of the principles, functions, methods, and techniques of catalysis in petrochemical processes. Participants will also learn to identify operational malfunctions, troubleshoot issues, and implement effective maintenance strategies to ensure optimal performance and catalyst longevity.

### Audience:

This course is designed for:

1. Process engineers and operators working in refineries and petrochemical plants.
2. Plant managers and supervisors overseeing catalytic processes.
3. Maintenance and reliability engineers responsible for catalyst and reactor systems.
4. Graduates in chemical, petroleum, or process engineering disciplines

### Course objectives:

1. Understand the fundamental principles of catalysis and its role in petrochemical processes.
2. Learn the key functions and applications of catalysts in refining and chemical production.
3. Master the methods and techniques used in catalyst selection, design, and optimization.
4. Develop skills in diagnosing operational malfunctions and implementing troubleshooting strategies.
5. Gain knowledge of maintenance practices to enhance catalyst performance and equipment reliability.
6. Explore advancements in catalyst technologies and sustainability practices

### Course duration:

5 days

### Course location:

Cairo-Dubai-Istanbul

### Course contents:

#### **Day 1: Fundamentals of Catalysis**

- Introduction to Catalysis – Importance in petrochemical processes, types (homogeneous, heterogeneous, biocatalysts), key concepts (activation energy, selectivity, turnover frequency).
- Chemistry & Reaction Mechanisms – Catalytic cycles (adsorption, surface reaction, desorption), active sites, promoters, key reactions (cracking, reforming, hydrogenation, dehydrogenation).
- Discussion & Case Study – Challenges in catalyst selection, analysis of catalysts in FCC units.
- Pretest & Knowledge Assessment – Baseline knowledge evaluation.

#### **Day 2: Catalyst Design and Optimization**

- Catalyst Design Principles – Composition (supports, active phases, binders), surface area, porosity, particle size, and characterization techniques (BET, XRD, SEM, TPD).
- Optimization Techniques – Yield maximization, balancing activity/stability/cost, simulation tools for performance prediction.
- Practical Exercises & Assessment – Calculating catalyst activity/selectivity, simulation of catalytic reactions, quiz on design and optimization.

### **Day 3: Operation Malfunctions and Troubleshooting**

- Common Issues – Catalyst deactivation (fouling, poisoning, sintering, coking), pressure drops, temperature excursions, product contamination.
- Troubleshooting Strategies – Root cause analysis, predictive maintenance, real-time monitoring, digital diagnostic tools.
- Case Study & Discussion – Troubleshooting catalyst poisoning in a hydrotreating unit, best practices for reducing unplanned shutdowns, troubleshooting quiz.

### **Day 4: Maintenance and Reliability**

- Catalyst Maintenance – Preventive and predictive maintenance, catalyst regeneration, materials and coatings for longevity.
- Reliability Engineering – FMEA, risk-based inspection, condition monitoring, lifecycle management.
- Hands-On & Group Activity – Simulation of catalyst deactivation prediction, developing a maintenance plan for a fixed-bed reactor.

### **Day 5: Advancements and Final Assessment**

- Innovations in Catalysis – High-selectivity catalysts, advanced reactor designs (membrane, modular systems), sustainability (green catalysts, carbon capture, renewable feedstocks).
- Industry Outlook & Career Pathways – R&D opportunities, professional development, global refining and energy transition trends.
- Final Assessment & Wrap-Up – Written exam, post-test comparison with pretest, feedback session, certification distribution.

### **Methodology:**

- 50% lectures & concepts
- 10% Videos
- 15% Case studies
- 15% Exercises & Quizzes.
- 10% Discussions

**Course code: (TPR0027)**