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Top Ten Ways to Improve Catalyst Performance

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In-service catalyst deactivation is unavoidable, and poisoning incidents compound the problem. The goal in catalytic processing is to minimize catalyst cost in ¢/bbl of feed while achieving process targets (conversion, selectivity, etc.) over the useful life of the catalyst. Thus catalyst "management" is key to maximizing unit profitability.

Following are generalized action steps to more effectively manage catalysts for fixed bed, moving bed, and fluidized bed commercial operations:

1. Selection
   Choosing the best catalyst formulation for a specific application assures that factors such as expected feed characteristics and process conditions are properly considered. Is the catalyst "fit for purpose?" Soliciting proposals from catalyst vendors is a good way to start the selection process. In some situations a pilot plant study comparing candidate catalysts may be warranted and is a valuable investment.
2. Certification
   Does the delivered catalyst meet all physical and chemical properties specified? Laboratory analysis of the fresh catalyst can reveal potential problems, e.g., higher abrasion which could lead to excessive fines formation during loading and operation. Subtle deviations from specifications like pore size distribution can dramatically affect in-service deactivation.
3. Charging/Loading
   Are dense loading vs. sock loading taken into consideration to assure fixed bed homogeneity and minimize pressure drop? Does FCC fresh catalyst loader/e-cat withdrawal operate with precision?
4. Pretreatment/Activation
   Critical steps such as reduction and pre-sulfiding should be carefully monitored to avoid such pitfalls as noble metal sintering. Systematic development and implementation of detailed procedures for catalyst activation pay big dividends in capturing their full potential.

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Work Highlights

Process, Operations & Safety

- *Ongoing PIMS linear program simulation modeling and refinery optimization on various ongoing projects.*
- *Providing process designer support on numerous HAZOP, project safety review, and Transient Operations HAZOP (TOH) efforts for multiple refinery locations and clients.*
- *Completed process consulting to review a refiner's FCC and HF Alkylation processing capabilities, and high level gap analysis assessment including improvement action recommendations.*
- *Providing on-going long-term lubes technology licensing support to a major refiner/ licensor.*

5. Startup
   Oil-in for fixed bed operations can be challenging, especially when deviations from normal procedures are required to address unanticipated events. Team review of start-up procedures prior to oil-in is a good practice. Formulating back-up plans addressing "what ifs" are useful to minimize catalyst damage, e.g., from localized exotherms.

6. Feed Contaminant Monitoring
   Regular feedstock analysis is critically important to identify higher than normal concentrations of basic nitrogen compounds or heavy metals introduced from imported feeds or possibly addition of refinery "slop streams." These and other poisons can quickly impair catalyst activity. An aggressive feed sampling and analysis program, ideally before planned feed changes to the process are made, is a good investment of time and money.

7. Process Monitoring/Upset Mitigation
   Continuously tracking indicators such as bed temperature profiles can reveal a decline in catalyst selectivity. Likewise, when process upsets occur swift corrective actions to protect the catalyst can prolong its life.

8. Regular Catalyst Sampling/Analysis
   Frequent monitoring of catalyst properties provides information useful for taking remedial steps where possible and for planning changeouts. This information is routine in fluidized bed operations such as FCC, where e-cat analysis and MAT testing is normal. Sampling fixed bed units is typically non-routine, but equally useful to characterize catalyst condition and suggest changes such as bed skimming to enhance unit performance. Online fixed bed catalyst sampler designs have been successfully implemented in a number of applications.

9. Regeneration
   Whether in fixed or fluid bed operations, regeneration plays a crucial role in both the life and performance of the catalyst. Fixed bed or moving bed catalyst regen procedures can be adjusted to compensate for some prevalent shortfalls, for example by redispersing partially agglomerated noble metals. Furthermore, ex-situ regeneration of fixed bed catalysts is another option which can facilitate better control of conditions and enhanced recovery of activity. Judicious monitoring when torch oil is added to FCC regenerators is important to minimize loss of catalyst surface area due to localized high temperatures at the nozzles. Also adjusting other variables in FCC regenerators such as bed level can reduce catalyst losses.

10. Replacement/Change-out Strategy
    Ultimately catalysts deactivate to a point where replacement is the only feasible option. Quite often these decisions are deferred to the point that overall process capability is significantly reduced and economics are negatively impacted. Developing a longer range plan for replacing catalysts offers an opportunity to reevaluate their formulation (selection process), as well as recapturing the initial performance realized if a replacement in kind is chosen. Learnings captured during a particular catalyst's life cycle are extremely valuable in guiding future decisions.

About the Author

George Swan is a Chemical Engineer specializing in innovative engineering solutions and profit opportunity identification, novel process conceptualization, technology development and deployment strategies, and intellectual property formulation and management.

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