

RELIABILITY: AN EFFECTIVE TOOL TO EXTEND THE OLEFIN PLANTS TURNAROUND

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RELIABILITY: AN EFFECTIVE TOOL TO EXTEND THE OLEFIN PLANTS TURNAROUND

ABSTRACT:

The purpose of turnaround is better utilization of resources and enhancement of safety, environment, reliability & continuous operation of the olefin plant at rated capacity. There is no clear distinction between two turnaround intervals of an olefin plant. There are olefin units with three & five year turnaround interval period. Mechanical integrity and unit efficiency determine majority of the schedule interval between two turnarounds. To sum up, a cultural shift is necessary to intellectually agree on total reliability program of an olefin plant. This will focus on proactive to prevent the surprises & deviation from operation & safety. Moreover, it will assist in extending the turnaround interval beyond the five year. These papers will emphasize, how total reliability program can affect plant performance and extend the turnaround period. The extended turnaround interval will provide two fold benefits. First, it will increase the on-stream factor, resulting in increase of production & profits. Secondly, it will reduce the turnaround cost over entire life of plant.

INTRODUCTION:

Jubail United Petrochemical Company (UNITED) an affiliate of SABIC has ethane cracker, was designed to produce 1350 KTA of ethylene along with C3+ & tail gas as by products. KBR is the process licensor which has designed to process up to 142 MMSCFD of ethane of 95% purity based on 8000 hrs to produce 4050 Ton/day of ethylene. Furnaces are designed to crack ethane in seven (7) SC-I furnaces, while eighth furnace will be in different mode of operation, i.e. hot steam standby, decoke or maintenance.

UNITED ethane cracker started in August 2004, has proven to be one of most reliable and safe operated ethylene plant in Middle East. The historical data on-stream factor of ethylene plant since start up i.e. 2004 is summarized below. It has revealed that plant has been operating on 100% on-stream factor since Year-2007. UNITED ethane cracker has achieved 789 days of continuous operation prior to planned shutdown in Year-2009. It has further achieved 598 days of continuous operation since start up in Year-2009. UNITED is targeting to continue its operation till 30-Nov'2011 for planned

Turnaround. It may achieve the contentious operation of 917 Days prior to plan turnaround in Y-2011.

Year	On stream	Down time
Year-2004	84.22%	Start up -Y
Year-2005	97%	3%(214 hrs)
Year-2006	97%	3%
Year-2007	100%	-
Year-2008	100%	-
Year-2009	99%	1%(79hrs)
Year-2010	100%	-
Year-2011	100%	As on date

Table-1: Historical data of on-stream factors

United ethane cracker has proven continuous operation since last 4-Years without compromising on safety & integrity of olefin plant. Then question must arise, **How** it has been achieved such long 100% on-stream factors. **What** are effective tools adopted to achieve such marvels on stream factors. Moreover, ethylene solemn study designated united ethane cracker, one of the best optimize. Even, it has been recognized as best safe operated plant by honoring "SOWARD OF HONOR" by SABIC-SHEMS committee.

OBJECTIVE:

It is now become essential to think intellectually & agrees to extend the globally accepted 5-Years of schedule turnaround interval to the extended period or any other alternatives options without compromising on safety & integrity of olefin plant. Which must be effective economically in term of Turnaround & profitable in production?

EFFECTIVE TOOLS TO ENCHANCE THE REALIABILITY:

UNITED struggle in the beginning of the startup, to ensure operational reliability & efficiency of the olefin plant. Several gaps were identified in various system i.e. leadership, Human skill, Equipments & other systems.

Later, a team was constituted to improve the plant performance based on the four pillars of highly reliability strategy. Therefore, a strategy was adopted to develop the "Total Reliability Program" of Olefin Plant to address comprehensive facet of reliability. The well defines structure & responsibility played an integral role in operational reliability and integrity of the olefin plant without compromising on any safety, environment and personnel health issues. The effective tools, has enable United ethane cracker to achieved its goal, are defined below.

1. **Leadership:** has derived the plant and cooperated the organization in total toward realizing the preset & proact on agreed business care objective.
2. **Human Skill:** Several gaps at various levels were identified during our study. Specific trainings were provided by licensors, vendors and equipments manufactures up to most satisfying requirements.
3. **Equipment:** Physical assets were identified which repeatedly contribute to down times and subjected to engineering solution.
4. **Systems:** Integrated methodologies adoption has provided signification benefits and is listed below.
 - 4.1. **Reliability Centered Maintenance (RCM):** Risk assessment rotates around two main axe:
 - a. Determine the optimum maintenance program
 - b. Optimize your maintenance efforts

RCM Benefits were identified as

- Provided the comprehensive equipment maintenance program
- Task and frequency
- Evaluation against technical and financial feasibility
- Identified physical and procedural redesigns
- Provided greater maintenance cost-effectiveness.
- Identified assets that will be allowed to run to failure.
- Identified key training opportunities
- Improved process knowledge across olefin plant.

4.2. **Risk based inspection (RBI):** Risk assessment rotates around two main axes:

1. Probability of failure, which is a function of deterioration rate.
2. Consequence of failure, which is a function of three factors.
3. Combination of above two axes yielded the **Criticality**.

RBI Benefits were identified as

- Provided to Develop an inspection strategy (plan, task, scope) that is Optimized & Cost effective
- Risk was control by Criticality Management
- Maximize availability
- Focused inspection

4.3. **Reliability Instrumented Systems (RIS):** Methodology provided specifically to automated responses to abnormal situations as detected by instrumentation. The process entails the execution of a risk assessment for each protective function. This was accomplished by consideration of the instrument failure probability and the associated consequences. Which has enhanced functional safety and overall safety that depends on a system or equipment operating correctly to its inputs?

RIS Benefits were capitalized as

- Spotted the light on unsafe areas
- Re-evaluating trip system in plant
- Minimized operation involvement during safe S/D & S/U.
- Any modification by providing well defined data
- Reliability, by eliminate unnecessary trips & convert them to robustness system

- Functional test frequency
- Considerable over engineering was removed/added.
- SIL was maintained or improved
- Compliance to RIS elements IEC 61508 / 61511 Achieved
- Spurious trips were reduced

5. Safety, Health Environmental Management System (SHEMS) of SABIC:

United olefin plant implemented the well adopted organization SHEM systems & fully compliance to all the fourteen (14) element of SHEMS as listed below.

- 5.1. Leadership & system Management
- 5.2. SHE documentation & control Record.
- 5.3. Risk Assessments
- 5.4. Operating & Maintenance Procedures.
- 5.5. Training & Competence
- 5.6. Contractor SHE Management
- 5.7. Pre-start up SHE review.
- 5.8. Mechanical integrity
- 5.9. Safe Work Practices.
- 5.10. Management of change
- 5.11. Incident Reporting, classification, Investigation & Analysis.
- 5.12. Emergency Planning & response.
- 5.13. Health & Industrial Hygiene
- 5.14. Environmental Management System.

6. Root cause Analysis (RCA)

7. Defect Eliminations Procedure.

8. Key Performance Indicator (KPI)

9. Integrity Monitoring Procedure (IMP)

All the above tools were being monitored under the one umbrella called Plant Reliability Team (PRT) of olefin Plant. Team consists of the following members.

1. Plant Operation
2. Plant Maintenance
3. SHE Department
4. Engineering support
5. Process Engineering.
6. Quality Control (LAB & ANALYSER)
7. Procurements & logistic.
8. Central Maintenance & Turnaround planning.

The PRT meet once in month to track all the tools and developed the action items to be completed in defined time line period. These tools were implemented in step wise manner to achieve the targeted goal of all aspect of reliability. Olefin plant started demonstrating safe & operational reliability and achieved 100% on-stream at rated capacity. These tools were being monitored continuously year to Year and shown sustainable operation with enhance production.

These tools demonstrated that United ethane cracker able to achieved contentious operation of 789 days & 598 days at rated capacity. If, these contentious operation days are achievable, then why not to think of extending the turnaround period or any other economically profitable options.

PROPOSED TURNAROUND OPTIONS:

The three (3) options for turnaround schedule & planning were proposed. It was ensured that operational and business requirements are met. The overriding objective for any option is to ensure that ethylene plant continues its high operational reliability, and that any turnaround schedule does not compromise safety & operational integrity of the Olefin Plant.

Option-I: Incremental increase in Turnaround period: The first turnaround is after 5-year, then subsequent turnaround is to be increase by one year after detail discussion of reliability report of olefin plant.

Option-II: Mini & Major Turnaround on every alternate of 5-year: In this option, a major turnaround is alternate with a mini turnaround. Turnaround will be on every 5-Year. Seven to 9-days turnaround will be called as mini turnaround and will meet the operational requirements. Next turnaround after the 5-Year will called as major turnaround and of the duration of 21-days as per reliability report of mini turnaround. It will allow for comprehensive inspection and major jobs as agreed by concerned authorities.

Option-III: Developed Spare Capacity: The spare capacity is to be developed to meet the operational & SHEMS guideline.

1. Provided adequate piping arrangement to operate the olefin plant on one catalyst bed OR provide spare vessel with piping arrangement for replacement of catalyst.
2. Provide the spare bed for dryer with piping arrangement to replace the dryer desiccants.

3. Provide spare heat exchangers (E-1141/42/43/44, if required) with piping arrangement in quench section. It will provide the spare capacity for cleaning of other heat exchangers.

4. Provide the spare PSV for critical service as identified.

5. Provide the spare Transmitter/XV/CV, if necessary.

The plant capacity is increased in order to compensate for downtime for turnaround. Moreover, the plant may be operational during the turnaround. Men & machinery may lead to unsafe operation.

COST BENEFITS ANALYSIS:

In order to calculate Cost benefit of each proposals. Followings guide lines were considered.

- i. Daily production = 3450 TPD
- ii. Standard Approx. turnaround days = 21
- iii. Standard Approx. Mini T/A days = 9
- iv. Net back of ethylene = 400 USD/ton.
- v. Total cost of production curtailment = $21 \times 3450 \times 400 = 29\text{MMUSD}$
- vi. Expected plant life is to be considered 30-Year.
- vii. Estimated expenditures per major T/A is 18 MMUSD.
- viii. Estimated expenditure per Mini T/A is 10 MMUSD

(Table-2: Proposal & Benefits of options)

PROPOSALS	BENEFITS
Option-I: Incremental increase in turnaround period. Extend 1-Year after every Turnaround. If applicable by reliability report.	Cost equivalent one T/A will be saved over the entire period of olefin plant. Even fund can be shifted for short term investment. Total saving will be 18MMUSD.
Option-II: : Mini & Major Turnaround on every alternate of 5-year:	<p>Total No. of days saved = $(21-9) = 12$ days</p> <p>Total Cost = $12 \times 3450 \times 400 = 16.6\text{MMUSD}$</p> <p>Difference in the cost of major & Minor T/A = 8MMUSD</p> <p>Total Cost saving = 25MMUSD on every Alternate 5-Year.</p> <p>Total cost saving over entire of plant life = 75MMUSD.</p>
Option-III: Developed Spare Capacity	Investment is needed to develop the spare capacity. Estimated investment is approx. 75MMUSD. Calculated from assets value report of Finance department. It will save 54MMUSD approx over the entire life (30-Y) of the plant.

CHALLENGES & MITIGATIONS

Turnaround activities are very crucial to ongoing reliability of any most reliable olefin plant. There are various challenges in olefin plants, which have to be mitigated prior to opt any options mentioned above.

A. Furnaces: Routine furnaces maintenance work should not be schedule during turnaround. Olefin Plant has spare furnace and all furnace work should be drawn outside of turnaround to avoid the use of valuable resources from other section of plant during the turnaround.

B. Instruments and Control System: There are numerous control valves & XV, which need to be inspected. The mini turnaround time span is quite adequate to inspect the entire Instrument & control system.

C. What Limits: Three general areas that need attention during the turnaround.

1. Maintenance /checking of relief (PSV) valve: Spare & tested PSVs will help to mitigate the maintenance & inspection of PSV. UNITED has enforced the same, which has saved time & restricted the resource utilization.

2. Crack gas compressor (CGC) due to fouling: On line wash oil injection & boiler feed water washing arrangement mitigate to avoid the opening of CGC due to fouled service.

3. Utilities & equipment in the interface with olefin plant: Mostly utilities & interface service have spare equipments which will mitigate plan. Moreover, operational & maintenance philosophy may help also to mitigate plan.

D. What not to be open in Mini Turnaround: Clean or cold service equipments like C2 or C3 splitter, ERC, PRC & de methanizer is not to be opened for inspection in every turnaround. Nox reaction with butadiene & resulting gum formation, mercury present in the feed, it could accumulate in some of cold service equipments. These may force to open the equipment for inspection. But proper mitigation plan & procedure are to be made available to avoid the opening. Moreover, derimming of cold box prior to start up of olefin plant will help to mitigate further.

E. Inspection & Operation: All the equipments suspected to fouling & corrosion should be opened for inspected during the mini turnaround. Moreover there are various operational requirements. Which need to be mitigated, is listed in table-3.

(Table-3: Inspection & operation Requirement for Olefin Plant Turnaround)

S.No	Items	Operational requirements	Interval
1.	Feed Saturator drum (V-1102)	Cleaning due to fouling	5 Y OR based on Equip. perform
2.	Quench water Col. (C-1145)	Cleaning	5 Y OR based on Equip. perform
3.	Coulmn Packing	Cleaning or replacment	5 Y OR based on Equip. perform
4.	Quench water separator (V-1141)	Cleaning	5 Y OR based on Equip. perform
5.	Quench Exchangers	Cleaning	5 Y OR based on Equip. perform
6.	Spent Caustic Tank (TK1217)	Cleaning	5 Y OR based on Equip. perform
7.	Quench water Tank (TK-1145)	Cleaning	5 Y OR based on Equip. perform
8.	Dox unit gravel & pebbel , garnite	Replacement	5 Y OR based on Equip. perform
9.	Stripper (C-1142)	Cleaning	5 Y OR based on Equip. perform
10.	Caustic Tower (C-1201)	Hot water cleaning	5 Y OR based on Equip. perform
11	Dryer (03) Desicant replacement	Replacement	5 Y OR based on Equip. perform
12	Acetylene Reactor catalyst	Replacement	5 Y OR based on Equip. perform
13	De-ethanizer column	Cleaning	5 Y OR based on Equip. perform
14	Cold Box Derimming	Derimming	5 Y OR based on Equip. perform

CONCLUSION:

UNITED ethane cracker has demonstrated the effective implementation of reliability tools, which has enhanced production by the increasing of on- stream factor. Moreover, has reduced the overall operational & maintenance cost. A study on all options were evaluated in reference to challenges & mitigation plans. Option-II is appear to be most adoptable and meet the all aspect of reliability requirements. There is olefin plant that go to seven year turnaround interval, some time even eight or nine years. The mitigation or mini turnaround between two major turnaround to meet the operational & inspection requirement at the interval at 3, 4 or 5-Year turnaround philosophy is in consistent with industry practices. The option-II provides financial saving and will meet the business commitments. Moreover, it shows full compliance to operational, safety,

personnel, and environment. Therefore, it was concluded that without any investment option-II is most favorable & reliable to meet the business & industrial needs.

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