Acta Scientific Chemical Engineering

Volume 1 Issue 3 March 2023

Review Article

Crucial Olefins Conversion Units Start-Up Considerations

Ravi Kiran Dasari*

Process Engineering Manager, Audubon Engineering Companies, USA

***Corresponding Author:** Ravi Kiran Dasari, Process Engineering Manager, Audubon Engineering Companies, USA.

Received: January 23, 2023

Published: February 15, 2023

Abstract

The olefins conversion process, like any other process, involves a certain amount of risk. There are some consequences faced during start-up due to the various causes that need to be considered in the relevant topic. These can be limited to one unit or simultaneously multiple other units issues elaborated in the relevant topic section

Keywords: Start-Up; OCT/OCU; Feed Treatment; Selective Hydrogenation Unit; DP Reactor Section, Desisobutanizer Unit; Deethylenizer Section; Depropylynizer Section; Hot Bypass

Introduction

Olefins Conversion Technology (OCT) employs metathesis and isomerization chemistry to produce propylene from reacting ethylene with C4 and/or C5 olefins. This is the only commercially demonstrated route to propylene using metathesis chemistry. The source of the C4 and C5 olefins can be from steam cracking, refinery processes, MTO or ethylene dimerization. Polymer grade propylene is readily produced in a simple catalytic fixed bed reactor without the use of super fractionators since no paraffins are formed in the metathesis or isomerization reactions. In addition, the metathesis reactions are mildly exothermic. There is no energy input into the reaction step, making OCT the only route to propylene that does not require energy input to the reaction step. This reduces operating costs and greenhouse gas emissions. Further, since OCT has a selectivity to propylene of over 95%, very few by-products are produced, which offers superior operating economics and low capital investment. OCT is the most selective route to propylene of all demonstrated routes. Worldwide, there are 49 OCT units either in operation or under design, producing over nine million metric tons of propylene—more than 10% of worldwide capacity. Unit capacity ranges from 60 kta of polymer grade propylene to 800 kta of propylene.

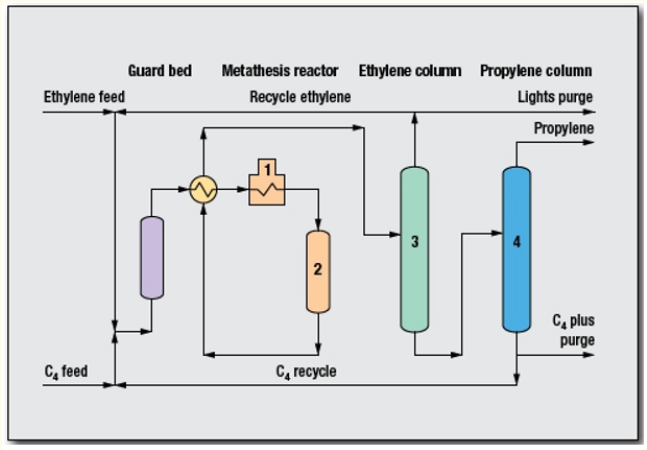

Figure 1

Relevant topic

The start-up issues are defined in detail per the individual units or streams of the olefin conversion unit as below.

Feed treatment

- Padding C4 surge drum with N_2 at very high pressure - large amount of N_2 dissolving in C4's

- Poor level indication in Treaters:
- Wrong installation of LT's
- Wrong calibration of LT's
- Wrong filling fluid
- Excessive plugging of filter elements
- Installation of filter with smaller-than-design mesh
- Water and TBA breakthrough from Treaters due to upsets in upstream units, lack of communication between units
- HH E/B ratio interlock based on volumetric flows, actual measurement based on mass flows
- Wrong setpoints of Treater interlocks
- Low megohm condition in electric heater not solved properly
- Problems drying out heater in-situ
- No protection of N_2 lines due to overpressure (although provision was added in design)
- Excessive leaking of Treaters' XZV's
- Performing water-run of pumps without checking design pressure of pipes
- Liquid-filling Treaters too slowly → high exotherm
- Putting jumpers in Treaters interlocks

Selective hydrogenation unit

- Temperature maldistribution in bed due to distributor problems:
- Cold center → liquid channeling, no H_2
- Hot perimeter → most of the reaction takes place on the perimeter, increase tendency to foul catalyst
- Low selectivity: higher-than-design saturation, BD breakthrough
- Lost of activity due to catalyst poisoning:
- Free water carryover, sulfur, NMP, TBA
- Runaway during initial catalyst wetting→high BD concentration
- (> 0.8 mol-%) in "safe fluid"
- Problems controlling temperature during catalyst activation
- Should not exceed 130°C

Desisobutanizer unit

- High isobutene concentration in bttms to OCU:
- Operator tries to maintain steady flow to OCU, even when the feed flow to the column decreases → need to keep mass balance!
- Reboiler control problems:
- Control tray analyzer (isobutene) resets every 15 – 20 min → this is too long, tower conditions may change rapidly
- For reboilers using QW, lack of tuning of QW system in ethylene plant
- Too much H_2 will increase saturation
- Higher BD in the feed will lower butene recovery

DP reactor section

- High delta P in DP Reactor caused by crushed inert balls
- Properly activating DP Reactor catalyst
- Difficulty in controlling regen air flow:
- Size of air valves
- Range of FE
- Distance between regen heater and reactors
- Temperature maldistributions in DP Reactor Feed Heater coils during heating (2-phase regime)
- Time delay for LL flow interlock in DP Reactor Feed Heater too short
- High concentration of contaminants in OCU feed → sampling required!
- LL pressure trip of heater burners did not match liberation curves
- Range of duty controllers in heaters too small
- Water analyzer in regen line installed in wrong location
- Ramping up temperatures in heaters too fast during refractory dryout
- Poor insulation of lines
- Waiting to torque bolts after unit is in operation (hot torquing)
- Welding of sliding supports of pipes operating at high temperature – pipe cannot grow! Also, not removing min stops of supporting springs
- Poor adjustment of valves' stroke speed (selenoid vent valve diaphragm)
- Fabricating additional spool-pieces to speed up maintenance group response
- Operating heaters with too low/high excess O_2
- Not properly purging HC with N_2 from DP Reactor after shutdown
- Leaking valves
- Operating with too low E/B ratio

Deethylenizer section

- Poor adjustment of valves' stroke speed (selenoid vent valve diaphragm)
- Fabricating additional spool-pieces to speed up maintenance group response
- Operating heaters with too low/high excess O_2
- Not properly purging HC with N_2 from DP Reactor after shutdown
- Leaking valves
- Operating with too low E/B ratio
- Poor adjustment of valves' stroke speed (selenoid vent valve diaphragm)
- Fabricating additional spool-pieces to speed up maintenance group response
- Operating heaters with too low/high excess O_2
- Not properly purging HC with N_2 from DP Reactor after shutdown
- Leaking valves
- Operating with too low E/B ratio

Depropylynizer section

- High concentrations of propylene in C4 recycle, not keeping the right heat balance in the tower
- Damaging the reflux pumps after running with too low level in the reflux drum
- Operating conditions in Depropylenizer condenser when broken tube was identified:
- Condenser design temp. = 150°C
- Condenser operating temp. = 210°C
- High concentration of C4's in tower ovhd
- Leaking tubes in condenser:
- Caused by operation at higher-than-design temperature, high concentration of C4's in tower overhead
- Corrosion of tubes due to lower-than-design CW flow, low velocities

Hot bypass

Difficulty in controlling Depropylenizer pressure due to low CW temperature:

- Design CW temp = 33°C, actual = 24°C
- Design tower pres = 17.8 MPaG, actual = 14 - 15 MPaG

Because of the low pressure, it was very difficult to send the bttms to OSBL (no pump was provided). In addition, at lower pressure concentration of C4's in ovhd is higher → propylene off-spec.

Using the hot bypass valve would introduce instability into the system: pressure would rise slowly and then it would drop very rapidly, due to vapor collapse.

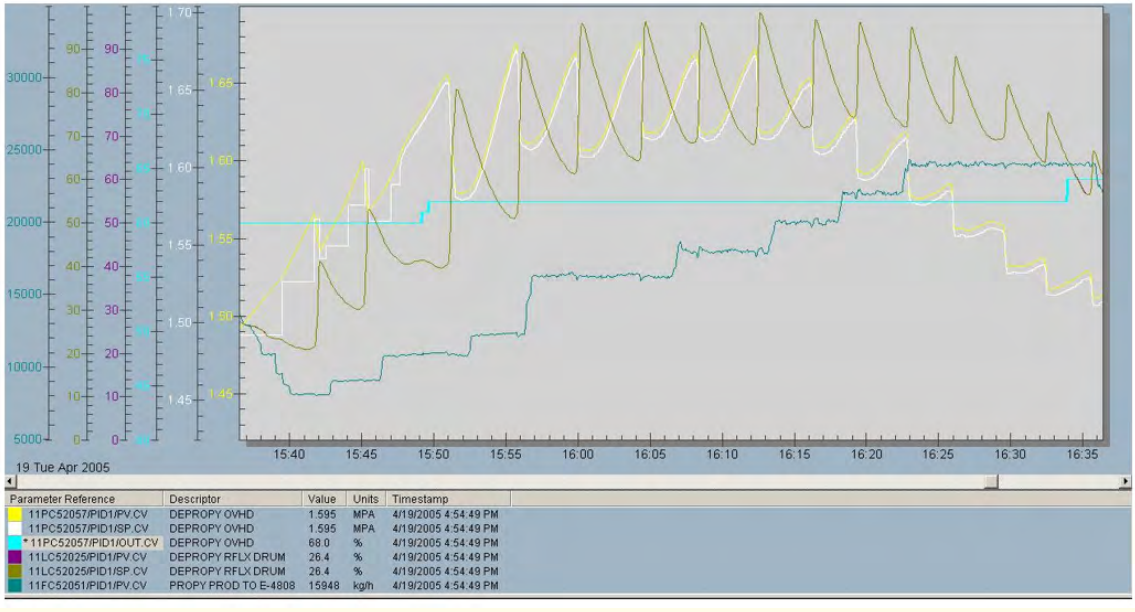

Figure 2

Depropylenizer ovhd lines, hot bypass line and reflux drum not insulated → made system very sensitive to weather changes (day – night, rain, etc.).

Figure 3

Analysis

- Testing of feed streams was not always conducted before initial feed-in → catalyst poisoning
- Improper installation of DP Reactor feed analyzer
- Installation of wrong sampling station for DP Reactor feed and effluent streams
- Online analyzer does not analyze for n-butenes in Depropylenizer purge
- Using the same sampling system for taking samples with very different composition (sample contamination)
- Problems with Wobbe analyzers
- Sometimes lab analysis methods are not clear even for the lab facility
- Operator issues
- Operating procedures were not available to the operators in the control room
- Reading the SOM and detailed operating instructions is important – however, having a team discussion about a given activity just before the activity is carried out is more important
- It is essential to inform and coordinate with other units (ethylene plant, BEU, etc.) when an activity is about to be carried out
- Poor understanding of DCS and Triconex systems
- Bypassing interlocks without doing the proper MOC (Management of Change) paperwork, and not keeping records of what has been bypassed/changed
- Lack of supervision – there should be an experienced shift supervisor in the control room at all times
- Operations and process engineers play an important role in any startup. However, the actual operation of the plant should be executed by qualified operators – it is not the job of the process engineer to manipulate the panel.

Conclusion/Recommendations

Its very important to consider all the factors mentioned under relevant topic of various units but not limited to this article. Post construction mechanical completion installation of equipment and instrumentation along with piping is one of the important step prior too commissioning. Then Pre commissioning/Comissioning is the critical step following the procedures prior to start-up. Then follows the start-up with the relevant procedures for successful operation or production [1].

Bibliography

1. Olefins Conversion (OCT) | Lummus Technology.