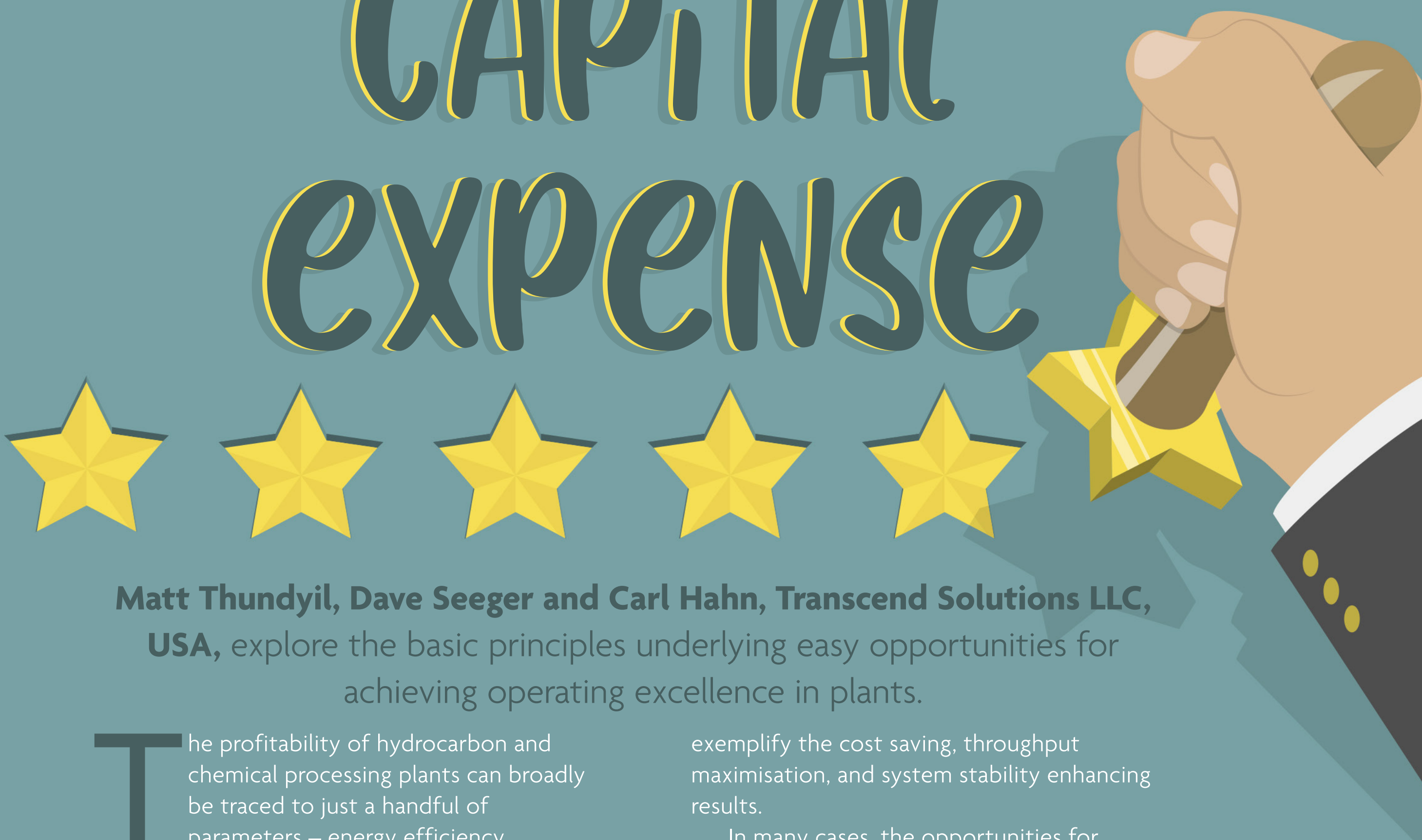
Operating excellence without capital expense



Matt Thundyil, Dave Seeger and Carl Hahn, Transcend Solutions LLC, USA, explore the basic principles underlying easy opportunities for achieving operating excellence in plants.

The profitability of hydrocarbon and chemical processing plants can broadly be traced to just a handful of parameters – energy efficiency, maximising asset utilisation, as well as flexibility in feedstock and product quality. When operating a complex, highly integrated processing plant, it is easy to assume that identifying opportunities for operating excellence will be complicated and difficult. However, there are many opportunities that are easy to identify, have low barriers to implementation and can often be monetised without significant CAPEX. This article focuses on the basic principles underlying the identification of these opportunities, including case studies that exemplify the cost saving, throughput maximisation, and system stability enhancing results.

In many cases, the opportunities for operating excellence can be revealed by asking three simple questions:

- What is the frequency and duration of routine downtime?
- What is the frequency, duration and throughput impact of the process upset?
- What is the frequency and duration of off-spec product?

This leads to a single follow up question: is contamination the proximate root cause of downtime, process-upset, or off-spec product?

Downtime

Downtime has a direct impact on plant throughput and therefore on profitability. Common examples of events that trigger routine downtime include:

- Fouling of catalyst beds.
- Rotating equipment maintenance.
- Fouling of heat exchange or mass transfer surfaces.
- Power outage.

Figure 1. Inlet separator to an amine treater.

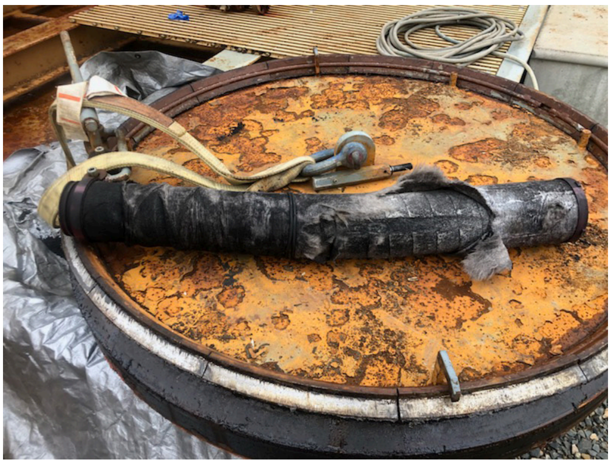


Figure 2. Conventional coalescer element used in the inlet separator. The damage suffered to the element is apparent.

Informal industry surveys indicate that 33% of fixed bed catalyst beds go down on pressure drop before reaching their activity limits. Whenever there is a pressure-drop issue in a process unit, it suggests that some species is obstructing the flow path. This foulant is generally a solid and if it is removed, the fouling tendency of the reactor will be mitigated. When a catalyst bed is down for catalyst skimming or replacement, the lost opportunity cost generally overshadows the cost of the catalyst itself.

Rotating equipment downtime is typically not as long when it occurs but has a similar impact on the operating economics of a unit. Corrosion in the pipeline can cause wear and fouling within pumps and compressors. Compressor valves are notoriously susceptible to particulate and liquid contaminants in process streams. Ethylene compressors are generally operated without back-up, so contamination can affect operating efficiencies as well as uptime. In fact, 62% of the world's ethylene producers named compressor fouling as the second most frequent cause of failure.

Fouling of heat exchange and mass transfer surfaces is very common (notable bad actors include condensate stabilisers, amine units, sour water stripper units and fractionation trains). When fouling occurs on a heat exchanger, the plant can often compensate, for some time, by adding more energy (increase feed temperature, live steam injection, etc.) or chemical addition, but the heat exchanger must ultimately be cleaned out.

This cleaning process requires exchanger downtime. This downtime can be several days, unless the plant has invested in a standby heat exchanger or has a rental heat exchanger. Similarly, distillation, absorption or extraction towers are subject to fouling of trays or packing. Fouling on these units is typically addressed with chemical addition until a shutdown can occur. Depending on where it has occurred, the cost of downtime is related to the production rate of the unit. In some cases, the cost of downtime is related to the production rate of the entire plant, if the downtime has occurred on a unit that supports the entire plant (such as an amine unit, sulfur plant, sour water stripper unit, etc.).

Power outages are one of the leading causes of plant-wide downtime, and there are many reasons for them. The leading consequence of a power outage is lost throughput. Other issues related to power outages include safety and environmental impact (flaring, etc.), maintenance and related costs from instrumentation, and equipment failures triggered by the loss of power.

Process upsets

A 'process upset' is typically a transient episode when unit operations are unstable (e.g. foaming, emulsification and loss of level indication, carryover). Operators typically regain control of the unit either by reducing throughput, adding chemicals (dispersants, anti-foam agents, etc.) or by some other work around. The 'solution' to a process upset typically results in reduced throughput, but also in increased operating cost, both of which affect the operating economics.

Off-spec products

Meeting product specifications is critical to the sales process. One of the most common reasons for products failing to meet product quality specifications is related to visual quality of the product, most often expressed in terms of a colour or a haze. When this happens, the plant must either reprocess the feed or dilute it into a batch or tank that is within specification or dispose of the batch. These episodes result in the cost of reprocessing, but also result in customer dissatisfaction and lower premiums on the product sale. Colour or haze related failures are typically related to the presence of contamination in the product.

Identifying a path forward

Often, the cause of these issues is related to contamination. In many cases, the plant already has a separator in place, but it is not performing at the level that is required. As a result, contamination makes its way downstream. If the separator in question can be upgraded to mitigate the contamination, will it improve operating excellence? The contaminant must be characterised, and compatibility with the process must be verified before the capability is validated and the cost is estimated. In virtually all cases, a tremendous impact on operating excellence ensues without significant capital expense, or with exceptionally high return (< 1-yr ROI) capital expense.

Case study 1 – amine treater

Amine-based gas treating systems are notoriously subject to foaming incidents. Oftentimes foaming agents enter the system from the gas stream that is being treated as liquid aerosols. A 200 million ft^3/d amine unit was faced with regular foaming incidents that led to reductions in throughput.

Assuming natural gas costs US$3000/million standard ft^3, the cost of the process upset for a 20% reduction in throughput was estimated as:

200 million standard ft^3/d x US$3000/million standard ft^3 x 20% = US$120 000/d

The plant evaluated its inlet separator and determined that the elements being used were likely unable to remove the contaminants that were causing the problem.

The vessel was upgraded without any cutting or welding to accommodate high efficiency aerosol separation elements. Total time for installation of the internals was less than a day.

The upgrade involved the improvement of aerosol capture efficiency of the elements, improvements in the ability to disengage and remove the captured liquid, improvements in flow dynamics to minimise the potential for re-entrainment, and enhancement in the sealing mechanism of the elements. Figure 1 shows the housing, and Figure 2 shows the conventional elements, and the damage experienced by these elements.

Following this upgrade, as shown in Figure 3, the plant has not reported any foaming incidents.

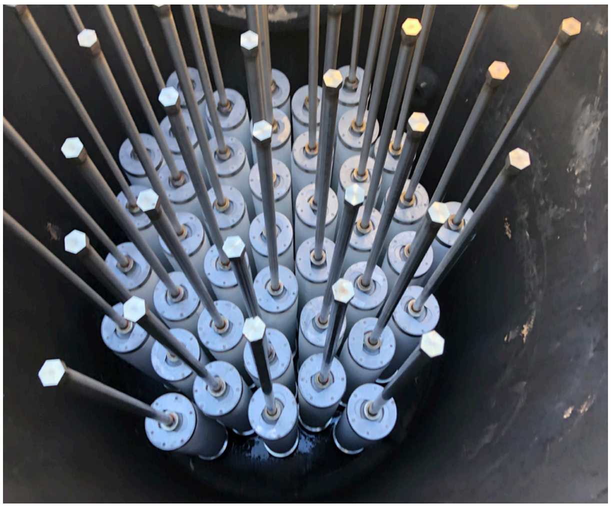


Figure 3. Upgraded housing.

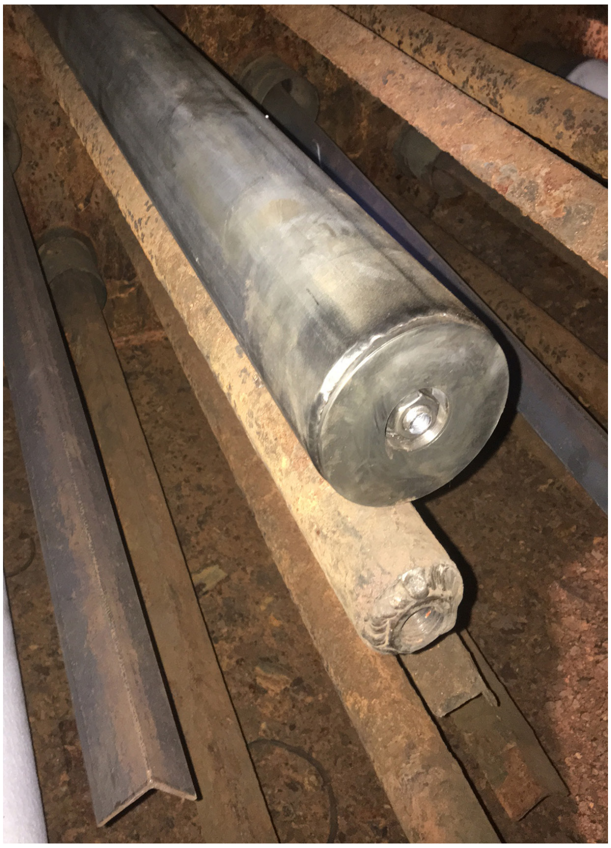


Figure 4. Internals of reformate/chloride separator showing existing risers.

Case study 2 – fractionation train

A refiner experienced chloride corrosion of a feed-bottoms exchanger feeding a 70 000 bpd fractionation train. The corrosion and fouling led to

Figure 5. Upgraded internals showing new emulsion separation elements installed.

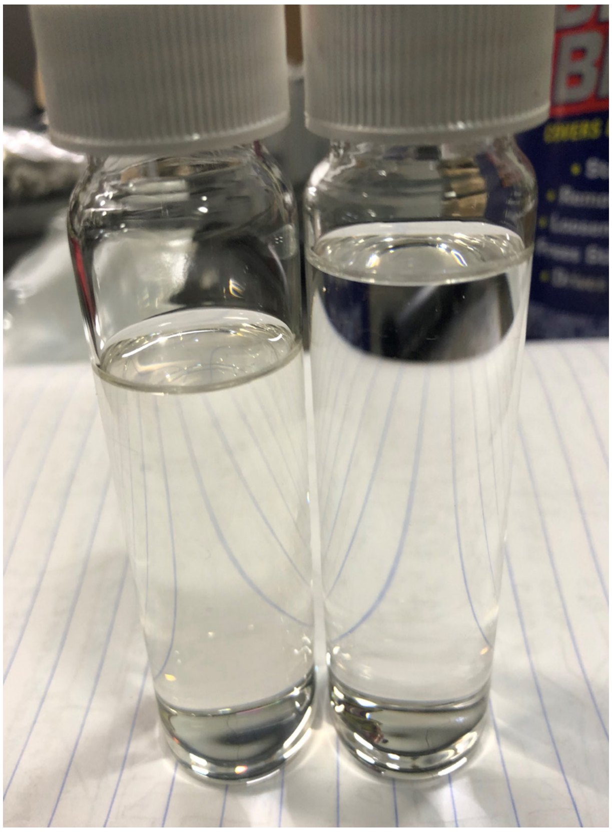


Figure 6. Off-spec product before (left) and after (right) upgrade.

annual shutdowns and periods of reduced throughput as fouling rates increased.

The foulant was chloride that was supposed to have been removed by extraction with a neutralising amine. However, the separator located after the neutralising amine injection was believed to be ineffective.

The cost of downtime was estimated at:

70 000 bpd x US$10/bbl = US$700 000/d.

Figure 4 shows the existing risers in the housing, with the inverted V-bar supports and the standpipe welded into the tube-sheet. A new element was designed with an innovative means of sealing to the existing framework. No cutting or welding was required, and the process did not have to go offline for the upgrade technology to be installed. Total installation time was less than a shift.

New elements were designed for this housing, employing improved separation media (Figure 5). Upon installation, the housing manifested a measurable differential pressure for the first time in over 40 years of operation. Chloride levels measured downstream evidenced non-detectable levels of chloride. For the first time, no annual shutdown was necessitated by heat exchanger fouling.

Case study 3 – off-spec product

A chemical plant had a consistent challenge with its product quality. The product did not meet the haze specification for sale to its customer. The solution involved reprocessing the product multiple times through its existing bag filters. The effect of reprocessing essentially reduced the throughput of the process, by the duration required to reprocess.

In this case, the production rate was approximately 10 gal./min, and effectively reduced to 7 gal./min. The off-spec product occurred approximately 10% of the time. The product value was approximately US$10/gal. The annualised impact on production rate was:

3 gal./min x 1440 min/d x 365 d/yr x 10% x US$10/gal. = US$1 576 800/yr

The haze was determined to be a fine particulate dispersion, requiring very high efficiency solids removal. A new filter was designed to upgrade the conventional bag filters, by improving seals to a positive O-ring seal, and to use high efficiency media, with an extended surface area configuration.

The result of the upgrade can be seen in Figure 6. The sample on the right is clearer and has a turbidity value of 0 compared to the sample on left which had a turbidity value of 2.

Summary

Process excellence is demanded by all industries and is essential for competitiveness in a global marketplace. When process units go down, are faced with a process upset, or produce off-spec product, it directly impacts the bottom line. Revenue is reduced and operating costs are increased. These issues reduce profitability and reduce competitiveness. Remarkably, many of these instances can be solved with advanced technology that exists today, without significant CAPEX, but with an intelligent application of contamination control technology.