**White Paper**
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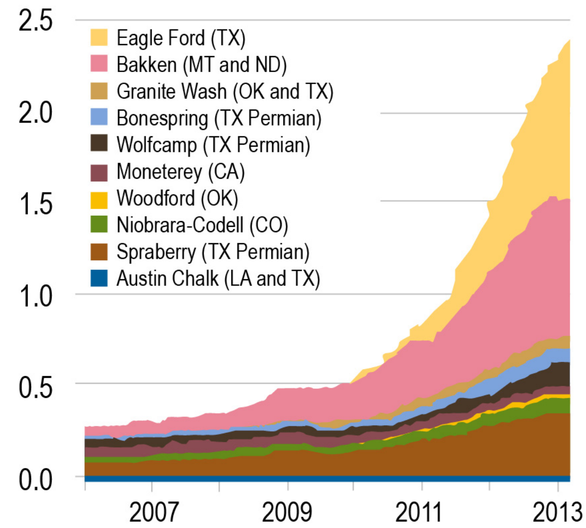
# Challenges with Light Tight Oil

Opportunity crudes from shale are more readily available in North America with incentives on cost. However, these typically lighter crude oils don't come without some challenges. Some of the challenges include high variability in API gravity, $H_2S$ entrained in the crude, amine-based $H_2S$ scavengers added in the pipeline or railcars prior to transporting, paraffin waxes, filterable solids, crude incompatibilities from blending, and balancing the intermediate cut point yields for downstream utilization.

**Figure 1-1. Shale and tight oil production million barrels per day**




*Source: U.S. Energy Information Administration*

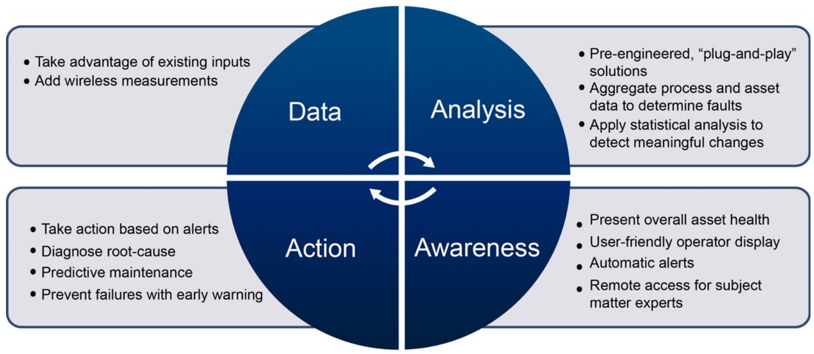
Heat exchanger fouling is one of the biggest challenges in refinery operations. Many refiners use a spreadsheet with monthly calculations typically based on incomplete data to determine heat exchanger condition, with manual checks on individual bundles just prior to a turnaround to determine if cleaning is required. The traditional approach to monitor heat exchanger fouling through spreadsheets with manual entry of temperatures and pressures that are not "on-line" (in the DCS) was often adequate before the increase in crude blending from opportunity crudes such as tight oil. However, some crude oil blends are not compatible leading to unanticipated accelerated fouling.

Because tight oils tend to be lighter, they need to be blended with other crude oils to get the right balance for best utilization of existing downstream units. Having a more consistent feed to the crude unit allows for the opportunity to optimize operation. If light tight oil feeds are not blended, the lighter oil can bottleneck the crude overhead and naphtha processing units, and limit production for bottom of the barrel processing. Some refiners are blending more than two crudes to get the right balance of feed qualities which creates unknown issues with crude incompatibilities. When crudes are incompatible, accelerated fouling occurs in the crude unit heat exchanger train due to additional asphaltene precipitation. Accelerated fouling can lead to additional energy costs with the crude unit fired heater, limited throughput when the fired heater becomes duty limited, or earlier shutdown for cleaning. All these negatively impact the profitability of the refinery. Traditional manual heat exchanger fouling monitoring with limited data and Excel spreadsheets does not always catch which crude blends are incompatible, thus the same condition for accelerated fouling can be repeated in the future.

Another change is the cold section heat exchangers prior to the desalter. With traditional crude oils, fouling occurs primarily in the hot section downstream of the desalter and not the cold section. Because of this, the cold section exchangers typically have minimal process measurements like temperatures in and out of each bundle for monitoring heat exchanger fouling. But tight oils have a paraffin wax and filterable solids that are now fouling the cold section heat exchangers. These waxes can trap amines against the pipes and vessels resulting in local corrosion. Refiners are now beginning to monitor these exchangers more closely and work with both automation and chemical companies to counter this fouling.

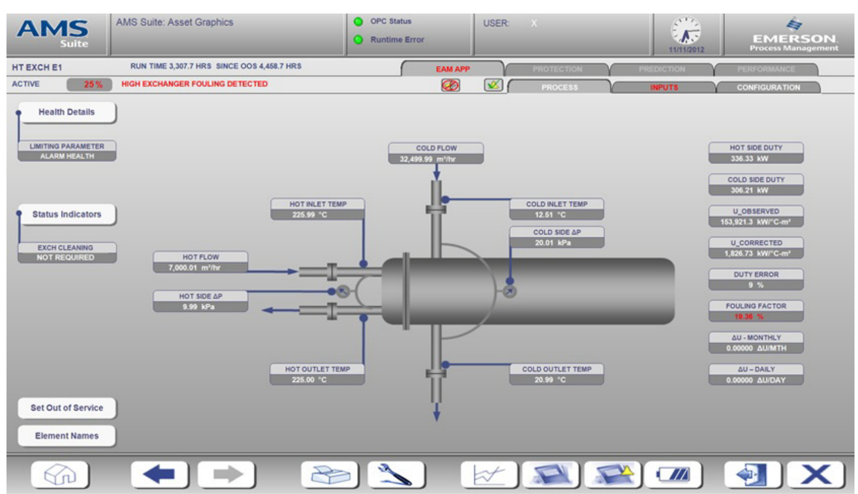
Today, refiners are installing temperature and pressure measurements around all crude unit heat exchanger bundles and implementing more sophisticated software applications to monitor and analyze heat exchanger performance and minimize energy and capacity losses. Improvements in online monitoring and analysis enables refineries to better understand accelerated fouling due to crude incompatibilities, and identify which tube bundles require cleaning. Typically there are temperature measurements in and out of a group of heat exchangers; what are lacking are measurements in-between tube bundles. Fouling across the bundles is not linear, so determining which bundle is fouled and needs cleaning can be difficult to determine without all the process measurements like temperature, flow, and differential pressure.

One viable and *fast to implement* solution available is to add wireless temperature and differential pressure measurements to acquire online operating conditions throughout the crude unit heat exchanger train. *Wireless*HART® (IEC 62591) technology has considerably lowered cost barriers to implementation, making it easy to implement and monitor the condition or "health" of process equipment - be it a process pump, heat exchanger, control valve, or other assets. However, having the process or asset health measurements online is just the first step. There still needs to be analysis, alerts (awareness), and finally action.




**Data collection alone is not sufficient for a monitoring strategy. A combination of data collection, analysis, awareness and action is necessary for a successful program.**

Among the strategies for monitoring heat exchangers is identification of accelerated fouling, and determination of when to clean a heat exchanger bundles. Some refiners have bypasses available to allow tube bundle cleaning without shutting down, although this is not typical. Other strategies include chemical injection to reduce fouling, changing the crude blend oils or ratios, improved filtering, and improved desalting. But many refiners may elect to reduce throughput and wait to clean until the next scheduled turnaround or when the fouling is severe enough to warrant an unscheduled shutdown for cleaning. In any case, online heat exchanger monitoring enables refiners to pinpoint only those bundles within the group that require cleaning.




When faced with selecting an asset management strategy, the ideal approach for increasing reliability and minimizing maintenance costs is an automated monitoring strategy-one that provides online indication of an asset's health. Online indication of asset health provides advanced warning and allows enough time for spare equipment to be safely brought online, eliminating process upsets, off-spec product and safety incidents that result from an unexpected trip. Advanced warning arms maintenance staff with the information they need to determine when servicing is necessary to prevent a failure, even on assets that do not have spares. An automated monitoring strategy can bring asset management where needed - crude unit process engineer, turnaround manager, reliability engineer, and maintenance.

An automated solution also improves health and safety. Manual data collection in the field can be minimized. This is important for the crude unit heat exchanger train as many refiners use an infrared gun where metal is exposed (not always the right place or accurate temperature) or using a step ladder around hot heat exchangers to use a handheld thermocouple in available empty test thermowells. The latter provides more accurate temperatures, but generates a higher probability of a safety incident. Also, those refiners using a differential pressure survey require opening and closing available access points which may not always close properly after use - a potential for leakage. These manual checks are typically done if there is suspicion of accelerated fouling or prior to a turnaround to determine which tube bundles should be pulled for cleaning. The better option would be to have online measurements and history, automated analysis, and automated alerts for abnormal operation. Those solutions are available today that take advantage of wireless process measurements with monitoring and analysis software.

**For more information about Heat Exchanger monitoring solutions visit: EmersonProcess.com/HeatExchanger**

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