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FLARE SYSTEM INSPECTIONS FOR OLEFINS FACILITIES

James Cleavinger
Fixed Equipment Technical Group Leader
Flint Hills Resources

Keith Wade
North American Ethylene Market Manager
ZEECO, Inc.

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Abstract

When evaluating the safety and environmental aspects of an olefins facility one must surely consider the flare. The flare is responsible for safely combusting enormous amounts of flammable material during plant upsets and it must perform its designed function in an environmentally acceptable manner. Tolerances are tight and regulations are strict. A flare operating at less than peak condition typically will not perform to the design criteria, creating safety and environmental concerns.

Regular and effective inspection of the flare is absolutely necessary to ensure the safety and compliance of the facility. This paper highlights components of a proper flare system inspection process. The paper will address two basic types of flare inspections: in-service and shutdown. Each type of inspection has its own challenges and advantages.

Flare System Inspection Challenges – An Introduction

Because of the critical role the ethylene unit emergency flare fills, it is one of the last unit process systems available for maintenance and one of the first required back in service after a unit turnaround. With such a short window for maintenance, the condition of the flare system must be understood prior to a unit turnaround. Flares can be inherently difficult to inspect because of the intense heat radiation and physical elevation. However, the flare is dedicated to the safety of the process equipment and the surrounding community and must operate as designed at all times. This paper will discuss the two different types of flare system inspections: in-service and out-of-service / turnaround, and keys to conducting them effectively to keep your flare operating as designed.

In-Service Inspection

Prior to the 1990s, the petrochemical industry standard for flare system maintenance scheduling was based upon time in service rather than detailed inspection. Unfortunately, this approach did not take into account the actual mechanical condition of the flare equipment at the minute level. If flare problems were evident during operation or visible from a ground level inspection, then maintenance time would be built into the turnaround schedule. Upon investigation during the outage, addressing the maintenance issues previously observed would typically reveal additional problems. Discovering maintenance issues in this way usually leads to extended downtime. Facilities were essentially forced to have various spare and often expensive flare parts on hand, or plan for a replacement of their flare tip at every outage to avoid extended downtime during turnarounds.

Alternatively, an in-service inspection from the air can detect problems in the flare system that cannot be identified from the ground. Correctly and completely identifying any flare system issues helps to define the turnaround scope of the flare early enough to procure the equipment and/or schedule the time needed for repairs during an outage. Each facility typically has criteria that determine the proper timing for an in-service inspection, though they are usually performed months in advance of a turnaround.

The main challenge during an in-service inspection of a flare system is getting to the correct vantage point to safely view the upper flare system components while the flare is in service. The original in-service inspection concept included the use of a professional photographer in a manned helicopter. This approach was limited by the direct industry knowledge of the photographer, because the only photos provided for review would be the ones the photographer decided to shoot. Knowing what to shoot to properly inspect a flare system was the key. Over time, the photographers became quite knowledgeable and provided superior quality inspection photos and video. This type of inspection required the owner to interpret the photos, usually in consultation with the Original Equipment Manufacturer (OEM).

A manned helicopter inspection can be performed when a flare unit is in stable operation and atmospheric conditions are favorable, i.e. little to no wind, and clear skies. Depending on the complexity of the flare system, this inspection can take 30 minutes to two hours of helicopter airtime. The inspection includes an evaluation of all photos and videos while the helicopter remains on-site to determine if further shooting is required. A formal flare inspection report is available within weeks and provides enough time for the maintenance groups to prepare for any upcoming plant turnarounds.

This particular type of inspection method was not universally accepted due to concerns of placing helicopter personnel in harm's way. Tight coordination between operations and maintenance is critical to minimize the exposure of the manned helicopter inspection team to potential hazards. The manned helicopter is equipped with a direct radio link to the plant's operations control room to communicate any plant upsets, allowing the helicopter adequate time to evacuate the flare area.

A second type of in-service flare inspection is inspection by a remote control helicopter. Early flare system inspections in the late 1990s and early 2000s using remote control helicopters were limited by the quality of the photographic equipment and the availability of experienced fliers. The helicopters are expensive and the concern over losing control on one while airborne over a process area requires a qualified flier. Today, photography and video capabilities have improved and more remote control fliers have acquired the necessary experience needed. Similar coordination between operations and maintenance is required for a remote control helicopter inspection. Real-time video is provided during the remote helicopter inspection process to determine if more in-depth or additional inspections are necessary.

The manned and remote control helicopter inspection methods are used to identify any issues within the flare system that may require maintenance but are not identifiable from ground level. Each facility has repair and replacement criteria to determine the proper timing for an in-service inspection and they are usually performed months in advance of a necessary plant turnaround.

During an in-service inspection, the main inspection area is the flare tip and upper structure. These areas are impossible to properly observe and inspect from the ground. The upper structure includes the ladders, platforms, flare stack, supporting structure, guy wire lugs and connections, aviation lighting fixtures and cabling. Any ancillary flare components such as the exterior of the molecular seal, steam piping, pilot gas piping, ignition gas piping and any retractable systems like the pilots, thermocouples, and aviation lights should also be inspected. The longest lead item is typically the flare tip itself and therefore, it should be the primary focus of the in-service inspection. The flare tip inspection checks for any indication of material failures including welds on steam manifolds, welds on the flare tip body, the muffler, the pilots and the internal steam/air tubes. Visual indication of internal burning could indicate a steam/air tube internal weld failure, insufficient center steam, or capping of the flare. Flare capping is the result of a large amount of steam being supplied to the upper steam ring while not enough steam is provided to the lower steam ring. The visual indication will be evidenced by discoloration of the flare body and/or muffler area and can be seen as a "hot spot" in low lighting. Repeated operation of the flare with internal burning will severely damage the flare body and internal steam / air tubes.

In-service inspections should also carefully observe the pilot gas connection to the pilot gas manifold. This area is prone to piping failure if too much pipe stress is introduced onto the pilot mixer. Piping supports, guides, and hangers need to be inspected for proper alignment and bolting. This is important on the pilot gas, ignition lines, and the steam lines. In the steam piping, the heat-affected components of the flare tip can be prone to weld failure caused by a lack of cooling steam or water hammer from wet steam. Steam piping insulations are a commonly overlooked area and should be considered when conducting the inspection process

If the flare system was supplied with ladders and platforms, they need to be visually inspected during the in-service inspection so that problems can be identified and corrected before personnel are allowed access. If the system is a structure-supported flare, the structure itself should be inspected for damage or missing bolting. In a guy wire supported system, the attachments to the flare stack and the lugs should be observed in the inspection. In a self-supported flare system, any flanged connections in the flare stack should be inspected. Visual inspection of the flare stack itself for indications of corrosion or internal burning will help determine the turnaround maintenance scope and ensure that parts and scheduling are accurate. A careful and complete in-service inspection reduces downtime during turnarounds by identifying long lead-time items and accurately forecasting the timeline necessary for flare system maintenance during the turnaround.

Out-of-Service or Turnaround Inspection

Even with the improvements in the photography and video capabilities of the remote control helicopters used for in-service inspections, there are still areas of the flare system that cannot be inspected until the flare is out of service. While the external components of the flare system can be inspected fairly well with the in-service inspection, accurate inspection of the internal components requires the flare system to be out of service and cleared for inspection. API standards 510 and 570 should be used as criteria in developing out of service inspection details.

Components such as the flare system knock out drum, molecular seal, and liquid seal drum must be internally inspected while the flare system is out of service and cleared. The OEM specifications require internal components inspections while the flare is out of service. The steam/air tubes, and the knock out and liquid seal drums should be examined for any weld failures, fouling, and internal corrosion issues. The results of each of these internal inspections can significantly impact a flare system outage and result in additional plant downtime.

Summary

Flare systems fill a critical role in the safe and environmentally compliant operation of an ethylene plant and therefore must operate as designed. Unfortunately, the useful life and performance of a flare are impacted by unexpected problems within the ethylene unit operations or supporting utility system. A combination of inspection approaches should be utilized in order to most effectively maintain and efficiently operate a large ethylene flare. In-service inspections are the right tool to help identify problems, schedule parts and prepare a turnaround scope of internal inspection or repair for a flare. The in-service inspection should be evaluated in conjunction with the flare OEM or other flare suppliers for an unbiased opinion. Some concerns raised during the in-service inspection may require more immediate attention while others identified can help define the scheduled turnaround scope and ensure needed parts are on-hand in advance.

Out-of-service inspection of the flare system will often yield unforeseen additions to the planned scope of work, but is necessary for proper inspection of internal engineered components. Some of these issues may be able to be deferred until the next scheduled maintenance window, while others will require immediate attention. Using both in-service and out-of-service inspections to proactively identify problems and plan necessary maintenance based on actual observed conditions reduces unplanned downtime and potential system failures.