Slash Filtration Costs and Improve Reliability

Seven ways magnetic separation is changing the game for midstream operators

December 2019

3 minute read

What is Black Powder contamination?

Black Powder particulate contamination in gas and liquid hydrocarbons has significant financial and operating impacts on pipelines, facilities and product quality. It is present in all hydrocarbon systems, consists of ferrous and non-ferrous particulate, typically with a primary iron sulfide and/or iron oxide component. It is not widely understood and is often referred to as "black dirt", "sludge" or "organic material". Its presence is often accepted as a cost of doing business, unnecessarily driving increased operating expenses due to equipment maintenance, downtime and replacement - as well as excessive filtration costs. It drives lower revenues due to lost production and off-specification products. Dealing with it proactively, such as with magnetic separation, can turn a systemic maintenance issue into a positive reliability story.

Figure 1: Disposed conventional filter cartridge waste.

Figure 2: Pig over-loaded with black powder.

Comparing Process and Equipment Reliability to Filter Costs

An example may help illustrate the issue. Many natural gas processing plants and crude oil refineries employ amine sweetening systems to remove H_2S and CO_2 from natural gas streams in those facilities. Iron sulfide particulate, a constituent of black powder, is a typical type of contamination in these amine systems. It forms easily in the presence of iron, H_2S and H_2O. Inlet gas filtration, along with rich and lean amine side filtration, is used to combat its presence in amine systems. However, iron sulfide particulate is typically under 10 microns in size, which can be very expensive to properly filter via conventional depth media filter elements.

As a result, some operators trade-off amine system reliability in favor of conventional filters that have a higher micron setting than required. This would keep filtration costs down, but cause ongoing maintenance issues in process equipment such as heat exchangers, regenerator columns, reboilers and carbon beds. These costs can often be viewed practically as a cost of doing business. Other operators set their filters at lower ratings, such as 5 microns, to combat these system reliability issues. However, their filter replacement costs are higher and often embedded in the company's P&L without consideration for improvement. Further, black powder in the sub-5 micron range continues through systems, allowing unnecessary maintenance expenses.

Top Contamination Issues

Black powder is often seen by facility-level operators in their day-to-day jobs, regardless of what type of oil and gas facility they work at or where in the world they are doing that work. Some notable occurrences of this type of particulate contamination are:

Upstream

- In produced oil and natural gas. It fills separators, drops out in pipelines, in crude batteries and in tankage.
- It causes erosion and excessive rotating equipment maintenance, increases filter and chemical costs and needs to be cleaned from vessels, batteries and tankage.

Natural Gas Pipelines

- In all natural gas streams. It collects in gathering, transmission and distribution pipeline systems, particularly in bends and risers; it enters compressors and gas plants.
- Drives pipeline erosion, drives compressor and pipeline maintenance, increases filtration costs and disrupts plant processes.

NGL Facilities

- In NGL mix, purity products and condensate. It collects in pipeline systems, enters fractionators, downstream pipelines and loading terminals.
- Causes pump repair and replacement, impacts meter calibration, plugs valves and filters, disrupts loading operations and causes off-spec product rejection.

Refineries

- In crude feedstock. It enters due to BS&W specifications, method of transport (ie. dirty barges), and introduced chemicals causing it to stay in solution.
- Disrupts desalter operations, plates out towers and trays, seizes pumps, excessively plugs filters, fills facility pipelines, disrupts amine processes and degrades intermediate and finished product quality.

Batch Product Pipelines

- Enters pipelines from contaminated refined product and condensate streams and builds via erosion.
- Drops out in tankage and storage, causes early retirement of pumps and excessive filter replacement, degrades fuel quality and performance.

Black powder is present in these types of applications and facilities around the globe. North American regions such as the Permian, the Bakken and parts of the Western Canadian Sedimentary Basin are particularly noteworthy for its presence. More broadly, operators in the Middle East often deal with thousands of pounds of black powder in natural gas pipeline systems during pigging activities, although its also present extensively in crude oil and produced water. Facility operators in Eastern Europe and Southeast Asia also deal with it on an extensive basis.

7 Ways Magnetic Separation Changes the Game

Magnetic separation offers a simple but elegant solution to manage both black powder and the maintenance vs. reliability trade-off. Magnetic separators offer high-efficiency removal of black powder contamination from all hydrocarbon systems without the need for extensive replacement of filter elements.

Figure 3: Uncaptured black powder built up in a conventional filter housing.

Figure 4: Black powder captured on magnetic separator elements.

Magnetic Separation Systems:

1. Utilize high-strength radial field permanent magnetics which do not require electricity.
2. Remove ferrous contamination to 95% + efficiency regardless of size, from below 0.1 microns to above 500 microns. Remove non-ferrous contamination due to the principals of electrostatic charge and particle adhesion.
3. Only require cleaning of the internal magnetic elements and then the system is put back into service – eliminating the management and disposal of thousands of single-use filter elements each maintenance period.
4. Can be located upstream of currently installed conventional filtration systems to reduce or eliminate conventional filter replacement;
5. Substantially decrease the environmental footprint associated with black powder removal and disposal;
6. Hold hundreds of pounds of contamination before cleaning is required. This minimizes employee interaction, reduces 'touch points' (ie. improving HS&E performance) and lowers costs; and
7. Do not wear out; magnetic separator systems are a permanent, long-term solution.

Finding the Low Hanging Fruit

Operators can conduct site, regional or even enterprise-wide contamination impact assessments to understand the financial, safety and environmental impacts of black powder contamination and estimate the ROI of addressing contamination. Such an audit provides key data needed to rank investments in advanced filtration solutions such as magnetic separation along with other corporate investment options.

The payback of investing in magnetic separation is typically less than 6 months, and often less than 1, due to reduced disposable filters costs, equipment repair and maintenance reductions, and improved uptime. The cost and operational advantages of these systems are significant and will improve operational reliability and drive sustainability within the organizations that use them.

Figure 5: Black Powder captured on magnetic elements.