CASE STUDY

Black Powder in Natural Gas Systems

December 2020

2 minute read

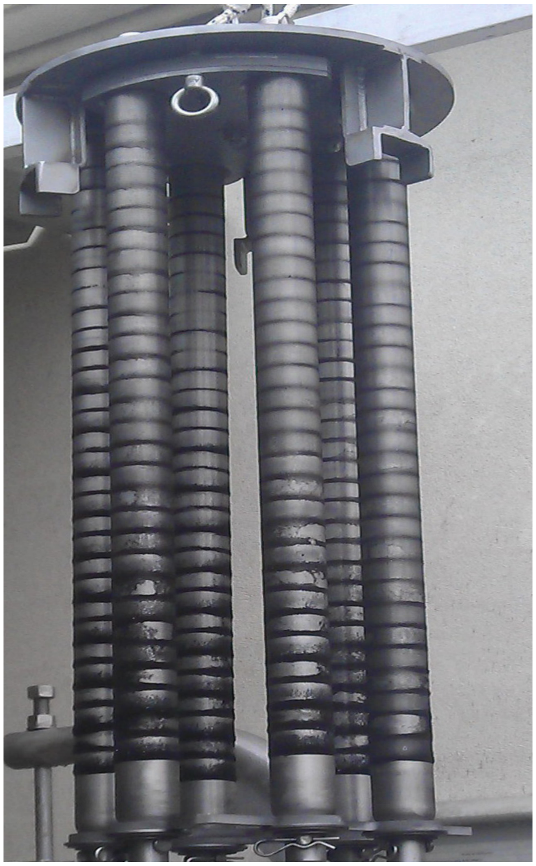
"Your separator is performing great [in operation from 2014 - 2020]. We have a depth media filter downstream of the magnetic separator that has been perfectly clean [so] we trust your solution."

- Technical Director

Background

Natural gas in pipeline systems, including gathering, transmission and distribution systems, often contains particulate contamination in it, typically known as black powder. Black powder consists of an erosive and abrasive mix of ferrous compounds such as iron sulfides and iron oxides (for reference, see Figure 3: XRD analysis), as well as other ferrous and non-ferrous metals and minerals. It originates in producing oil and gas reservoirs and continues through the natural gas value chain, all the way to the final point of consumption. It is costly to remove due to its mass and/or small size (for reference, see Figure 4: particle size distribution graph), and damages not only pipelines, but compressors, meters, valves and various types of process equipment. The source of black powder can be difficult to pinpoint, even in otherwise clean on-specification gas.

Figure 1. The magnetic array with black powder contamination on it after the array was removed for an initial inspection.



Problem

In this particular case, larger black powder contamination particles in a natural gas distribution system were plugging off traditional depth media filters, while the smaller particles passed through the filters and fouled the natural gas burner nozzles at an iron smelter. Typical delivery volumes to the iron smelter were in the 2,500 m3/hour range. The pipeline specification natural gas is sourced from pipeline sources in North Africa as well as LNG ship offloads that are comingled with the pipeline-sourced gas; the source of the black powder is unknown.

Solution

After numerous complaints by the end user, the gas distribution utility commenced evaluating alternatives for eliminating the black powder issue with its customer. The utility ultimately decided that magnetic separation offered the best alternatives for eliminating all of the black powder as well as the costly replacement of single use filters. The Black Powder Solutions magnetic separator system was installed in 2014 and continues to operate with the same high efficiency level. Figure 1 shows the magnetic array with black powder contamination on it after the array was removed for an initial inspection.

Figure 2. Removing the magnetic array from the magnetic separator for initial cleaning.

Results

The traditional filters positioned downstream of the BPS magnetic separator are void of any contamination, indicating that ~100% of the black powder was captured by the magnetic separator. In 2015, the utility's Technical Director stated "Your separator is performing great... we have a depth media filter downstream of the magnetic separator that has been perfectly clean [so] we trust your solution."

As shown in Figure 2 from 2018, the magnetic array is being removed from the magnetic separator housing to be cleaned and then re-installed for use. As of late 2020, the utility confirmed that the magnetic separator system continues to operate with the same high efficiency as it did in 2014.

Figure 3. XRD quantitative analysis.

Mineral Name	Compound Name	Chemical Formula	Weight
Sulfur	Sulfur	S	17.9
Mackinawite	Iron Sulfide	FeS	27.8
Greigite	Iron Sulfide	Fe3S4	16.0
Siderite	Iron Carbonate	Fe(CO3)	7.2
	Manganese Oxide	MnO2	2.0
Sulphur-beta	Sulfur	S	0.3
	Aluminum Oxide Hydroxide	AIO(OH)	0.3
Magnetite	Iron Oxide	Fe3O4	0.4
Goethite	Aluminum Oxide Hydroxide	FeO(OH)	3.4
Hydroniumjarosite	Hydronium Iron Sulfate Hydroxide	(H3O)FE3(SO4)2()H)6	1.1
Romerite	Iron Sulfate Hydrate	Fe(SO4)4(H2O)4	7.3
Rozenite	Iron Sulfate Hydrate	Fe(SO4)(H2O)4	15.8
Quartz	Silicon Oxide	SiO2	0.7
		Total	100

Figure 4. Histogram that illustrates particle size distribution.