CASE STUDY

Black Powder in Natural Gas Systems

EDP Gas Porto, Portugal 2014 - 2021

"Your separator is performing great [in operation from 2014 - 2021]. 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 known as Black Powder. Black Powder consists of an erosive and abrasive mix of ferrous compounds such as iron sulfides and iron oxides (Figure 2: 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 process chain all the way to the final point of consumption. It is costly to remove due to its mass, and or small size (Figure 3: particle size distribution graph). It damages not only pipelines, but compressors, meters, valves, and various types of process equipment. The source of Black Powder can be difficult to pinpoint.

Problem

Larger Black Powder contamination particles in a natural gas distribution system were plugging off traditional depth media filters, while the smaller particles passed through and fouled the natural gas burner nozzles at an iron smelter. Typical delivery volumes to the iron smelter were in the 2,500 m^3/hour range. The pipeline natural gas is sourced from pipeline sources in North Africa as well as LNG ship offloads that are commingled with the pipeline-sourced gas; the source of the Black Powder is unknown.

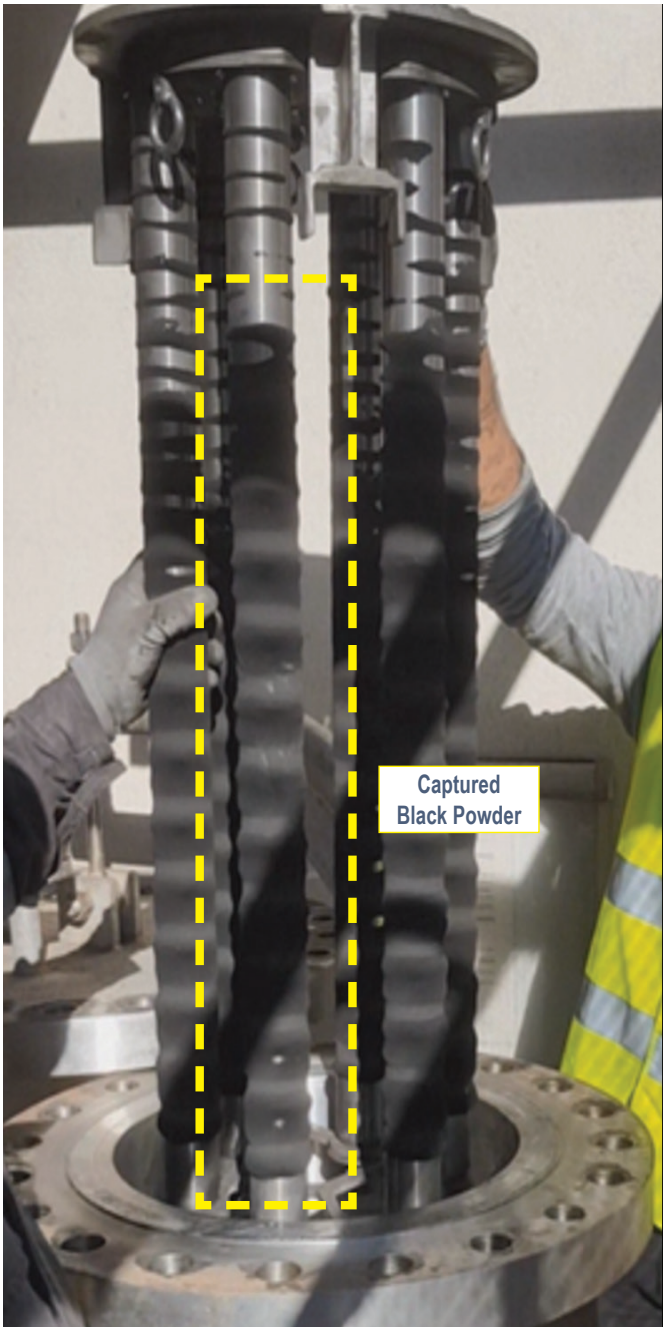

Figure 1. Black Powder contamination on the magnetic array after it was removed for an initial inspection.

Solution

After numerous complaints by the industrial gas customer, the gas distribution utility commenced evaluating alternatives for eliminating the Black Powder issue. They ultimately decided that BPS' Magnetic Separators offered the best alternatives for eliminating all of the Black Powder, as well as the costly replacement of single use filters. The BPS' 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.

Results

The 1.0 µ and 0.3 µ 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 of late 2020, the utility confirmed that the Magnetic Separator system continues to operate with the same high efficiency as it did in 2014.

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	AlO(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 2. XRD quantitative analysis.

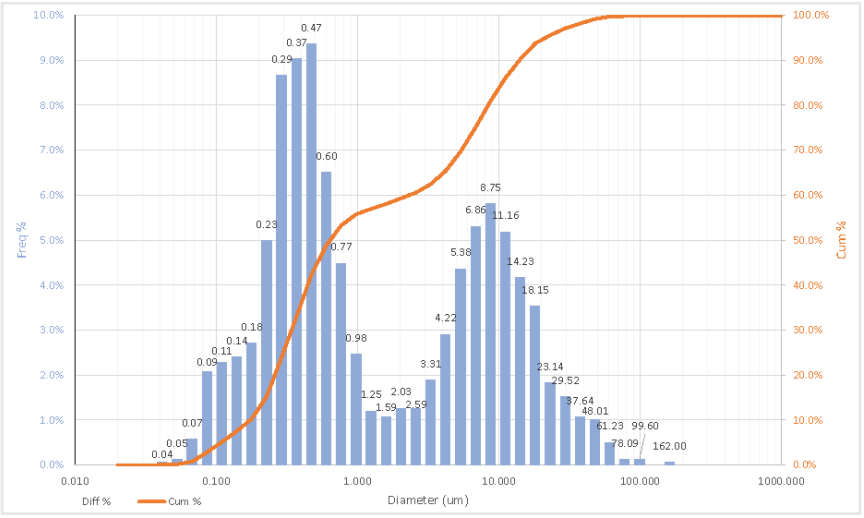

Figure 3. Histogram that illustrates particle size distribution.