

## Mitigation Strategy for Sulfur Deposits in Gas Pipelines



Deposits of “elemental sulfur” – which can block natural gas pipes and equipment – is becoming an increasing concern in the natural gas industry. As a consequence, research was conducted to develop a better understanding of the sources, causes, and mitigation possibilities for sulfur deposits found in gas operations.

### Project Description

For more than 50 years, “elemental sulfur” deposition has been recognized in the petroleum industry as presenting operational problems, particularly with the partial, and even complete, blocking of wellhead pipe work and associated equipment. However, the formation and deposition of elemental sulfur in natural gas transmission line systems and its associated infrastructure (e.g., regulators) has only been acknowledged since the 1980s.

Increased awareness among pipeline operators in recent years has resulted in more reported occurrences of sulfur deposits. Experts suggest that production of gas reservoirs containing increasing amounts of sulfur compounds, and changes in pipeline operating practices (e.g., increase of pipeline operating pressure, multiple gas suppliers, and gas processing/sweetening operations) will further increase the occurrence and magnitude of sulfur deposition in transmission pipelines.

The presence of elemental sulfur in natural gas streams can have serious consequences for gas production, processing, and pipeline operations. Elemental sulfur can result in equipment damage and extensive plant downtime. Sulfur deposits also can cause regulator erosion, foul pigging operations, and plug filters at regulator stations. In addition, elemental sulfur affects the accuracy of flow-measurement instruments (up to 2% error), damages turbine blades, and can cause severe plugging of exchangers.

Despite previous research and studies, the source of the sulfur in the gas and the circumstances and conditions under which this substance suddenly appears in the pipelines are still unclear. In response, for this project industry sponsors supported the development of information on sulfur deposits.

### Deliverable

Results of this research are presented in the GTI report *Literature Review for ‘Elemental Sulfur’ Deposits in Natural Gas Pipelines*, released in 2007.

### Benefits

From this project, natural gas companies, their customers, and the scientific community benefit through new knowledge that can be incorporated into company strategies for mitigating sulfur deposits.

### Technical Concept & Approach

An intensive, thorough literature search was conducted covering the following areas:

- The effect of elemental sulfur on pipeline systems and equipment
- Composition of elemental sulfur deposits
- “Black powder” and sulfur deposits
- The formation of elemental sulfur in natural gas pipelines
- Field observations
- Patents involving elemental sulfur in the natural gas industry.



***Elemental sulfur can significantly restrict or even stop the flow of gas through operations equipment.***

## Results

The principles and mechanisms associated with elemental sulfur formation/deposition processes in transmission pipelines have been identified, and the factors involved in the formation of elemental sulfur have been thoroughly investigated.

Research found that elemental sulfur deposition is dependent upon some, if not all, of the following items:

- The operating pressure and temperature conditions
- The rate of change of pressure
- The composition of the natural gas
- The presence of oxygen, hydrogen sulfide, carbonyl sulfide, and possibly other sulfur compounds in the gas stream,
- The extent of any retrograde condensation simultaneously occurring with the sulfur desublimation process
- The amount and type of other fine particle matter that is being transported in the gas stream
- The gas flow rate
- The variations in operating conditions
- The geometry of the pressure-reduction device
- The presence of other contaminants in the gas stream, and, in particular, volatile compounds.

Recommended means to prevent or minimize elemental sulfur formation/deposition include:

- Using a dual-stage pressure cut when a large pressure reduction is required.
- Heating the gas stream immediately before a single pressure reduction point when a large pressure reduction is required and dual-pressure reduction configuration is not practical
- Reducing the potential for retrograde condensation occurring at a pressure-reduction facility.
- Minimizing the entry and transmission of liquids and solid particles in the gas stream.
- Minimizing the sources of water (moisture) and oxygen that can enter the gas stream.
- Where possible, avoiding the application of labyrinth-type pressure control/regulation valves.
- Ensuring that carry-over from glycol processing plants is kept to a minimum.

- Ensuring dewatering processes are complete and thorough, especially when commissioning new pipelines. (Do not permit “puddling” of odorants or other like additives. Make sure pipe work is free of particle matter.)



**Control valve cage with elemental sulfur deposition.**

- Reviewing the type of material used in molecular sieve beds so that it does not favor the conversion of H<sub>2</sub>S to carbonyl sulfate.
- Minimizing H<sub>2</sub>S levels in the gas stream.
- Minimizing site conditions suitable for the colonization and maintenance of sulfur-reducing bacteria.
- Obtaining the gas supply at as low a temperature as possible from the gas processing plant.
- Minimizing large-temperature excursions along a pipeline route.
- Maintaining flowing gas temperature as high as practically possible.
- Using care in the interpretation of on-line and wellhead analysis results and when applying commercial models to gas processing and transportation conditions. (Ensure all gas component parameters are within the specified design criteria of the model.)
- Minimizing pipeline pigging operations and maintaining pig speeds at realistic, controlled levels.
- Avoiding an ingress of nitrogen gas rich in oxygen from repair operations.

## Status

This project is complete and a Final Report has been issued.

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