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Gesner Gas Works: FOrming THE FUTURE

Anthony McCreery wrote this case under the supervision of Julie Gosse solely to provide material for class discussion. The authors do not intend to illustrate either effective or ineffective handling of a managerial situation. The authors may have disguised certain names and other identifying information to protect confidentiality.

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It was June 2018 and Michelle Beauchesne, facilities engineer and project manager at the Brimstone Sulphur Forming Facility (Brimstone), was reviewing a memo from Brimstone’s parent company, Gesner Gas Works (Gesner). After several years of lacklustre sales figures, head office was demanding new initiatives that would increase profitability at each plant. Brimstone, located in Alberta, Canada, was no exception to the slump in profits. The recent oil and gas recession had significantly affected Alberta and left Brimstone in a precarious state. Beauchesne had several ideas for increasing profitability at the forming facility and wanted to ensure she was choosing the most feasible and lucrative option before presenting her proposal to head office.

ALBERTA, CANADA

Alberta was the fourth-most populous province in Canada and home to six UNESCO[[1]](#footnote-1) world heritage sites. One of the biggest drivers of Alberta’s economy was the energy sector, contributing over CA$71.5 billion[[2]](#footnote-2) to Canada’s gross domestic product (GDP). Alberta’s Athabasca oil sands contained the largest proven reserves of oil in the world outside Saudi Arabia. Globally, Canada was the fourth-largest producer and sixth-largest exporter of natural gas, with Alberta accounting for 69 per cent of Canada’s 16.7 billion cubic metres per day of production.[[3]](#footnote-3)

THE SULPHUR INDUSTRY

Elemental sulphur, yellow in colour, could be distinguished by its unique and unsavoury odour that paralleled rotten eggs. It was the fifth-most common element on earth and could be found occurring naturally near hot springs and volcanic regions. Sulphur was a by-product of processing natural gas and refining high-sulphur crude oils. It existed in natural gas as hydrogen sulphide (H2S), which was known as “sour gas” when the H2S content was greater than 5.7 milligrams per cubic metre of natural gas.

H2S was removed from natural gas through an amine treatment process—the use of a liquid solvent in a process known as “sweetening” because the solvent “sweetened” the smell of the natural gas by removing the malodorous sulphur.[[4]](#footnote-4) The liquid solution was then converted to elemental sulphur using the Claus process, which involved heat (thermal) and accelerated chemical (catalytic) reactions to extract the elemental sulphur from the mixture. Exposure to H2S could be serious and life-threatening: concentrations over 1,000 parts per million caused immediate collapse with loss of breathing that led to death. In the United States, 52 workers died of H2S toxicity in a seven-year period.[[5]](#footnote-5)

The majority of sulphur was transported as a bulk solid because its high melting point[[6]](#footnote-6) of 115degreesCelsius made it difficult or impractical to maintain sulphur as a liquid. Unfortunately, handling sulphur as a solid could create excessive amounts of sulphur dust, which was largely flammable, posing significant fire hazard risks. There had been considerable development in forming methods for sulphur over the years, one of which was the forming of sulphur pastilles. The grain-sized pellets of solidified sulphur, about 3 to 5 centimetres in diameter, could be handled without giving rise to excessive amounts of dust.

The sulphur industry in Canada was tied directly to the oil and gas industry, which, in Canada, made up 5.6 per cent of total GDP in 2018 and typically governed the economic position of the country.[[7]](#footnote-7) Sulphur was mainly used in the production of fertilizer and pharmaceuticals. As with any other commodity, pricing could be volatile and was dependent on market demand and a variety of other external factors. In 2016, the price of oil significantly dropped, leading to a decrease in the production of oil and natural gas that, in turn, impacted the production and price of sulphur. The resultant sluggish economy led to a loss of jobs in Alberta. By June 2018, while sulphur prices had risen compared with their 2016 lows, they were not yet at their pre-2016 level (see Exhibit 1).

MICHELLE BEAUCHESNE

Michelle Beauchesne graduated with a bachelor of engineering science degree in biochemical engineering from Western University in London, Ontario, Canada. Upon graduation, she began her career as a process engineer, designing gas processing facilities in Alberta and Australia. After two years, she decided to join Gesner as a facilities engineer and project manager at Brimstone. Her goal was to gain valuable field experience implementing design projects and working with plant operators.

GESNER ENERGY COMPANY

Gesner was a Canadian oil and gas company headquartered in Alberta, Canada. It was a vertically integrated company, active in almost every area of the oil and gas industry, including exploration and production, refining, transport, and power generation. The company had a proven record of growth and placed particular emphasis on employee health and safety alongside risk-mitigation strategies.

The company owned a collection of assets known as the Clarke Gas Complex. The complex consisted of three sour gas plants—Clarke, Flag, and Nibel; Brimstone, the sulphur processing facility; and gas fields that fed the assets.

Brimstone

Brimstone was a sulphur forming facility located in direct proximity to the three sour gas plants. Molten sulphur was delivered to Brimstone in two ways: by direct pipeline from Brimstone’s sister plant, Clarke, and by truck deliveries from nearby gas processing facilities, including Flag and Nibel. On average, trucks travelled 50 kilometres each way to make a sulphur delivery. Once at Brimstone, the molten sulphur was converted into pastilles so that they could be shipped by rail to Vancouver, British Columbia. From Vancouver, the sulphur pastilles were exported globally and used in the production of fertilizers.

Clarke was the largest of the three Gesner Gas processing facilities, earning average daily revenues of $1 million. The facility processed sour gas into natural gas and produced molten sulphur as a by-product. Clarke used the pipeline to send the sulphur to Brimstone to be processed into pastilles. Because Clarke had no on-site storage or truck loading capabilities, Clarke relied on Brimstone to be running simultaneously to accept Clarke’s sulphur as it was produced.

Sulphur Production Process

Brimestone operated three eight-hour shifts per day all year with little room for error or downtime. Shutting down the plant had direct repercussions for the upstream processing facility at Clarke, and every minute of downtime resulted in lost production time and financial losses.

Offloading capacity at Brimstone was based on the sulphur received from two sources. Clarke continuously fed sulphur to the forming plant through the pipeline at a rate of 107 tonnes per hour. Sulphur from the other plants was offloaded by truck every 20 minutes with each truck containing 22 tonnes of molten sulphur. Sulphur from both the trucks and the pipeline were offloaded into one inlet, creating a single step in the process. Next, sulphur would flow into a storage tank with a storage capacity of 20,000 tonnes of molten sulphur (see Exhibit 2). The purpose of the storage tank was to ensure that a continuous supply and flow of sulphur would be available at subsequent steps in the process while reducing volatility in inputs.

Four centrifugal pumps, each operating at a rate of 50 tonnes per hour, propelled sulphur to the next step in the process. An additional fifth centrifugal pump, with the same capacity as the other four, was held idle for emergency use only; the pumps were rotated offline to allow for regular maintenance. Four centrifugal pumps, propelled sulphur to the next step in the process. At this point, the molten sulphur could be poured into and solidified in large blocks if needed for storage. Otherwise, the molten sulphur proceeded to the next step, known as *rotoforming.*

In rotoforming, molten sulphur was sprayed onto stainless steel conveyors where the sulphur droplets were cooled into solid pastilles. There were 46 rotoform machines, each with a capacity of 13 tonnes per hour. Despite the large number of rotoforms, Brimstone ran only half of these machines at any given time to control the capacity. To avoid equipment malfunction, the plant ran the active rotoforms at only 80 per cent utilization.

The pastilles were then sent to one of two open-air silos and held in storage. These silos had a capacity of 62,500 tonnes each. From the open-air silos, the pastilles flowed to a granule hopper, which offloaded into rail freight at a rate of 270 tonnes per hour. The trains were routed to Vancouver for export of the sulphur product overseas. Customers were responsible for picking up product at a rate that kept up with the forming plant’s overall throughput, and they assumed responsibility for any cost of freight-out.

The average commodity price of sulphur was forecasted to be an average of $91 per tonne for fiscal year 2018. Brimstone saw a margin of 10 per cent on this commodity price.

THE PROPOSAL

Beauchesne was considering a range of alternatives with the objective of increasing profitability at Brimstone. Because sulphur pastilles were highly sought-after in the fertilizer industry, Beauchesne was not concerned with any limitations on demand.

Beauchesne was keen to implement an alternative that would limit downtime for the regular operations of the plant. Downtime would not only impact the cash flow position of the forming facility; it would also adversely affect upstream production at the Clarke gas processing facility.

Increase Truck Offloading Capacity

Beauchesne knew that some trucks containing sulphur from the area were not delivering their loads to Brimstone because Brimstone had insufficient offloading capacity. Beauchesne was contemplating the installation of a second truck offloading point that would allow one additional truck to offload every 20 minutes. This second offloading point would result in additional fuel expenses for deliveries with each truck spending $0.61 in fuel per kilometre travelled. The second offloading platform would also require excavation, concrete pouring, concrete cutting, and additions to the piping network that, in total, would require a one-time expense of $162,500. The labour and equipment rental needed to construct the offloading landing would cost an additional $112,500.

Beauchesne estimated that the project would require two weeks of construction after the design phase and approval from corporate. The regular throughput in the plant would not experience any interruptions during the construction of the additional truck offloading inlet.

Upgrade the Pumps

Another of Beauchesne’s considerations was upgrading all of the centrifugal pumps to increase capacity at the pumping step in the process. The upgrade would increase the output of each pump to 65 tonnes per hour and cost $76,000 per pump. Once installed, the estimated increase in energy consumption would be $22 per hour. The pump upgrades would require that daily operations at the plant cease. Downtime for the installation of the new pumps would be seven days, during which all production of sulphur pastilles would be temporarily shut down.

Beauchesne wondered whether it was worth upgrading the pumps without increasing offloading capacity. She theorized that to increase total system capacity, the pump upgrades would need to occur in tandem with the construction of a second truck offloading point.

Pour to Block

Brimstone had a large concrete storage pad, resembling a parking lot, that was used for emergency storage. Pouring to block would not influence capacity, but would serve as a contingency strategy when necessary. The block storage was 350 metres long by 120 metres wide by 10 metres high, providing a total volumetric storage space of 420,000 cubic metres with each cubic metre holding 1.82 tonnes of sulphur. In the past, this storage area had been used to pour sulphur to block; the molten sulphur was poured and allowed to cool and solidify as work-in-progress inventory rather than be prilled into its pastille end-state. The option to pour to block allowed for stockpiling, if necessary, during daily operations.

Currently, however, the pipes leading to the storage pad were corroded and unusable. A recent hazard and operability study (HAZOP)[[8]](#footnote-8) determined that the corroded piping leading to the block storage posed a high economic risk and medium personnel risk. The examination revealed that block pouring would be needed if the plant experienced a power outage and the backup generator failed to engage. The likelihood that this particular situation would occur was rated as extremely low; however, this risk-mitigation strategy could save the company from an unnecessary and costly shutdown.

If Beauchesne decided to pour to block, the plan would require a complete revamp of the corroded piping that connected the centrifugal pumps to the block pouring stage. This investment was quoted at a total price of $246,000. Once the sulphur was poured to block, Beauchesne would have to hire two additional contractors per shift for 60 days to melt the blocked sulphur back to its molten state so that it could be pumped back to the rotoforms and processed to finished goods. Contractors in this position would be paid $40 per hour and would be required whenever pouring to block was pursued.[[9]](#footnote-9)

A major inconvenience in the production of sulphur pastilles was sulphur dust. Sulphur tended to be warm and elastic when first solidified, but over time, sulphur would start to become chalky and create dust throughout the site. The problem of sulphur dust amplified when molten sulphur was poured to block because the concrete storage pad was not contained from external conditions. This meant that sulphur dust would occasionally blow into surrounding farmers’ fields and become a nuisance for livestock and farmers alike.

DECISION

Beauchesne leaned back in her seat and stared out her office window. She was growing increasingly tired of waiting for the price of sulphur to return to 2015 levels. She wondered whether Gesner’s upper management team would look favourably upon any of her proposed alternatives. Typically, to minimize production delays, capital expense projects and major upgrades were delayed until a turnaround was due, but the next scheduled plant-wide shutdown was not until 2022. Ultimately, Beauchesne was looking forward to the trip to head office to present her findings so she could spend one less day smelling like rotten eggs.

EXHIBIT 1: AVERAGE YEARLY PRICE OF SULPHUR, 2014–2018

Note: Averaged sulphur prices were converted from US$ to CA$ using the average currency exchange rate for the given year.

Source: M. Garside, “U.S. Sulfur Price 2014–2019,” Statista, October 7, 2020, www.statista.com/statistics/1031180/us-sulfur-price.

EXHIBIT 2: PROCESS DIAGRAM

Diagram

Description automatically generated

Note: m = metres; m3 = cubic metres; yr = year.

Source: Created by the authors.

1. United Nations Educational, Scientific and Cultural Organization. [↑](#footnote-ref-1)
2. All dollar amounts are in Canadian dollars (CAD) unless otherwise stated. [↑](#footnote-ref-2)
3. Government of Canada, “Natural Gas Facts,” accessed June 3, 2020, www.nrcan.gc.ca/science-data/data-analysis/energy-data-analysis/energy-facts/natural-gas-facts/20067. [↑](#footnote-ref-3)
4. Natural gas that did not contain H2S was called “sweet gas.” [↑](#footnote-ref-4)
5. Robert G. Hendrickson, Arthur Chang, and Richard J. Hamilton, “Co-Worker Fatalities from Hydrogen Sulfide,” American Journal of Industrial Medicine 45, no. 4 (2004): 346–350, https://pubmed.ncbi.nlm.nih.gov/15029566. [↑](#footnote-ref-5)
6. A melting point was the temperature at which a solid moved to a liquid state. [↑](#footnote-ref-6)
7. “Natural Gas Facts.” [“Natural Gas Facts,” Government of Canada, accessed June 7, 2020, https://www.nrcan.gc.ca/science-data/data-analysis/energy-data-analysis/energy-facts/natural-gas-facts/20067.] [↑](#footnote-ref-7)
8. HAZOP was a structured and systematic examination of a process used to identify risks to personnel and equipment. [↑](#footnote-ref-8)
9. All breaks for contractors at Gesner’s plants were fully paid. [↑](#footnote-ref-9)