DUKE ENERGY FIELD SERVICES
now DCP Midstream
Lea County, New Mexico

Linam Acid Gas Injection Well #1

Duke Energy Field Services, now DCP Midstream (DCP), contacted Geolex, Inc.® (Geolex) when their Sulfur Recovery Unit (SRU) had imposed problems at their Linam gas plant including: net costs of disposing sulfur (approximately 40 tons per day), carbon emissions to the atmosphere (approximately 300 tons per day of CO_2), operational costs, and problems with environmental compliance. The treated acid gas (TAG) stream, composed of hydrogen sulfide (H_2S) and Carbon Dioxide (CO_2), was piped to the SRU to reduce the H_2S to elemental sulfur using the Claus process. The Claus process involves oxidizing the H_2S to sulfur dioxide (SO_2), using atmospheric oxygen for combustion. Due to the high percentage of CO_2 in the TAG stream (82%), a significant amount of otherwise marketable natural gas was needed to be burned with the TAG to maintain combustion. In effect, the SRU acted as a bottleneck in the plant's operational capacity. Geolex's feasibility study showed that this was a viable site for an Acid Gas Injection (AGI) well and DCP further retained Geolex to design and oversee drilling and completion of the Linam AGI #1. By replacing the SRU with the AGI well, the Linam gas plant now has efficiently and permanently sequestered 3-7 million standard cubic feet per day (MMCFD) of TAG.

Phase I - AGI Feasibility Study:
Geolex collected, analyzed and evaluated the available geological information relevant to the area, and developed a feasibility study. This study included an evaluation of the regional and local geology and hydrogeology, and reservoir characterization and modeling through the analysis of well logs and geophysical data. This study identified a formation with the best injection target, and closely examined two major options: 1) drilling at the site; or 2) drilling at a more geologically promising site approximately one mile north of the plant. The latter was selected, based on the most favorable geological target and best compromise in capital operational costs. Following the selection of this location, Geolex began developing a detailed design and Authorization for Expenditures (AFE) for the proposed AGI well. The Linam AGI #1 was originally designed for the purpose of safely injecting up to 4.6 MMCFD of TAG. However, changes in the field gas stream and plant operations increased the daily production of TAG to 7.0 MMCFD, and the calculated 30-year radius of injection increased from 0.38 miles to 0.47 miles. The feasibility study also included evaluating land uses in the surrounding properties, and identifying/locating/mapping existing and potential oil and gas production in the area. Geolex also conducted a review of the New Mexico Oil Conservation Division (NMOCD) regulatory and permitting requirements for a successful application of an AGI well.

Phase II – Permitting:
New Mexico requires a C-108 application be submitted to the NMOCD for authorization to drill and inject. The permit process for the C-108 includes work produced from the feasibility study and notifications to all operators, oil, gas and mineral lessees, and surface owners within the area. Prior to acceptance of the Linam AGI #1 C-108 application, a New Mexico Oil Conservation Commission (NMOCC) public hearing took place where Alberto A. Gutiérrez, president of Geolex, provided testimony as an expert petroleum geologist and hydrogeologist. The NMOCC approved the application under Order R-12546, allowing DCP to inject TAG into the

Major Project Elements:

Phase I:
AGI Feasibility Study

Phase II:
Permitting and Expert Witness Testimony

Phase III:
Well Design, Drilling and Completion Supervision

Commissioning, Training, and Start-up Oversight

Phase IV:
Ongoing Maintenance, Support, and Compliance for existing AGI wells

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desired formation at pressures not to exceed 2,644 psi. The Order required submittal to and approval from the NMOCD of a Discharge Plan prior to commencing injection. While the Discharge Plan was being prepared and reviewed, problems with the SRU became acute, and DCP petitioned and received a new Order temporarily staying the Discharge Plan requirement and allowing DCP to begin injection. This new Order, however, capped the injection rate at 4.0 MMCFD and a pressure of 1,800 psi. Subsequent changes in NMOCD policy eliminated the requirement for a Discharge Plan and, after another NMOCC public hearing, Order 12546-I was issued rescinding the formerly required Discharge Plan, lifting the caps on volume, and restoring the original injection rate at 7.0 MMCFD and a pressure of 2,644 psi. In conjunction with the C-108 application a comprehensive H_2S Contingency Plan (Rule 11), which encompasses the gas plant, the pipeline, the compressor facility, and the well head, was submitted to and approved by NMOCD prior to commencement of injection operations.

Phase III - Well Design, Drilling and Completion Supervision:
Geolex was responsible for geologic and regulatory supervision associated with all drilling and completion activities. Collaboration with the drilling engineers in interpreting geophysical logs and selecting the correct perforation zones was confirmed through reservoir testing; satisfying the reservoirs capacity to accept TAG at the designated rates and injection pressures. Geolex supervised, instructed, and trained plant operators in start-up and in how to minimize technical problems in order to safely inject TAG.

The Linam AGI #1 has been operating since 2009 and over the first 18 months of operation experienced significant difficulties with maintaining adequate temperature control of the TAG stream. As a result of these fluctuations, phase changes occurred within the tubing that allowed for condensation of free water in the tubing. As a result of this condition, the basal 100-ft portion of the tubing experienced significant corrosion and resulted in a tubing leak. After the leak was discovered and reported to the appropriate regulatory agencies, the well was worked over and the tubing leak repaired. In addition, the temperature control problems were resolved by modifying the temperature control modules and the location of the compressor skid. Subsequent to the well workover, the operator has successfully improved the controls on the compression system to assure that a more reliable and consistent pressure/temperature (P/T) regime is maintained during injection, preventing the phase changes that allowed for condensation to occur within the tubing in the TAG stream.

Phase IV - Ongoing Maintenance, Support, and Compliance:
Geolex's ongoing activities include annual mechanical integrity tests, notifying DCP of any upcoming deadlines, and currently overseeing monitoring and maintenance of Linam AGI #1. Recently, DCP performed scheduled maintenance on the natural gas plant, requiring the plant and AGI system to shut down for four days. During the restart of the AGI system, hydrates formed, due to the spike in injection pressure in a section of the system where unstable TAG temperatures fluctuated between critical and supercritical P/T conditions. To remove the hydrates, methanol was injected into the TAG line immediately upon restarting the compressors. Methanol was continuously injected until the elimination of hydrates could be observed in the rapid pressure decline. Stabilization of the AGI system occurred within 20 hours of the initiation of methanol injection and removal of hydrates from the system. The immediate action taken and built-in safety systems prevented any damage to injection equipment or well components; however, the situation may have been prevented by injection of a methanol pad prior to resuming injection and a TAG volume-based methanol feed rate into the TAG during startup.

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