Executive Summary

Risks and Potential Impacts from Carbon Steel Pipelines in Louisiana Transporting and Processing Variable Produced Gases such as Carbon Dioxide (CO_2), Hydrogen (H_2), Methane (CH_4)

By Dr. Steven Jansto

October 9, 2022

This expert report was funded by the 2030 group

EXECUTIVE SUMMARY

Regarding the proposed pipeline projects for Carbon Capture and Sequestration (CCS) in Louisiana, there are several major areas of metallurgical and operational/maintenance/financial concerns with the projects being considered for significant government funding. These points need to be seriously considered with engineering evaluations performed before the decision is made to spend public funds on costly projects that will not deliver the intended results and divert from true solutions that are needed to combat climate change.

Concerns about CCS and associated pipeline risks are many, including:

1. High risk of steel corrosion failures due to carbonic acid (H_2CO_3) and other impurities such as hydrogen sulfide (H_2S) and nitrogen dioxide (NO_2), in addition to variations of water (H_2O) concentrations in the carbon dioxide (CO_2) transported, and hydrogen embrittlement in some cases, making it difficult if not impossible to specify steel grades that could be safely used over time to carry such corrosive products have not been fully characterized with consistency. The variability in the concentrations (i.e., minimum and maximum values through the process) must be considered when selecting appropriate corrosion resistant materials, and the worst-case scenario needs to be used for material specifications to minimize the risk of failure, which could make CO_2 pipeline material prohibitively expensive.

2. CCS is not a well-proven operational/maintenance technology as demonstrated with documented case studies of natural and anthropogenic CO_2 production exhibiting many operational issues of concern that would make this technology exorbitantly expensive to safely deploy at the scale necessary to achieve required results. Although capturing CO_2 is technologically possible (as shown in the DOE Petra Nova project), operating the facility on a 24/7 scenario to cover operational and maintenance plant cost on a profitable basis is questionable and requires extensively more research, engineering analysis, design review and pilot plant facilities analyses.

3. The variations in the chemistry of the CO_2 streams being introduced into the pipeline will produce an inhomogeneous mixture of CO_2 plus impurities that create an internal corrosion risk. It is recommended

that the CO_2 pipeline and CCS partners submit the chemical analysis of the CO_2 from all of the parties introducing their waste CO_2 stream into the pipeline. A corrosion study with the submitted CO_2 chemical analysis would then be performed at an independent corrosion laboratory with different grades of carbon and alloyed pipeline steels to quantify the corrosion rate. Only then can a steel be specified for the CCS project.

4. Major risk to pipelines and the surrounding ecosystem is both external and internal corrosion. Numerous mechanisms embrittle the steel in which pipeline corrosion cracks and potential leakage of the CO_2 contaminants into the soil is possible. The soil aeration dynamics indigenous to a given area in the Bayou is a key consideration.

5. From a global perspective, the timeline for a CCS solution is longer term than the current European green hydrogen approach. Petra Nova CCS DOE project is an Enhanced Oil Recovery (EOR) solution and not a pure carbon capture solution, which even so, could not economically substantiate itself. Technical reasons for the premature closure of the plant should be further studied regarding operations, maintenance, and capital cost of materials/equipment deficiencies and not just CO_2 yield/recovery.

6. The Louisiana specific environmental impact (including subsidence issues) should be further studied and evaluated by the parties involved in the CCS project. It is beyond the scope of the materials engineering community to predict the environmental/corrosion/contamination impact without a specific understanding of the actual soil chemistry and subsidence conditions through which the pipeline traverses. Laboratory corrosion testing of alternative pipe materials is recommended before construction initiates.

7. Repurposing of pipelines is a deep metallurgical concern from both a corrosion and fatigue/fracture perspective. It must be emphasized that even recently constructed pipelines that were originally designed for natural gas transmission now being considered for transmission of CO_2 produced from the CCS process is a high-risk decision without additional corrosion studies of the proposed pipeline materials.

8. The materials engineering aspects and standard operating maintenance practices for a CCS facility are under development and continuous evaluation is recommended. This evaluation might be supported by a collaborative Materials Science and Engineering Research funded governmental and private industry sponsored project. There are numerous technological unknowns that require further study before facilities and pipelines are constructed. This evolution of CCS corrosive materials development activities would bridge the engineering gap before the facilities/pipelines are constructed.