Colin Quinn
COSC 5610 Data Mining
October 8th, 2020
Professor Guha

Severe Incidents in Natural Gas Pipelines

Since the 1980's, the natural gas industry has evolved into a major segment of the United States economy. America's dependence on this clean-burning fossil fuel has steadily increased over the last several decades, meaning more gas at higher pressures is being flown through pipeline distribution networks. Severe incidents in natural gas pipelines causes catastrophic supply shortages, significant environmental impact, and potentially loss of life. The pipeline companies responsible for the safe and reliable transmission of natural gas can be held accountable if they do not properly maintain their distribution network. This seems reasonable, however the cost of maintaining a pipeline can be vast and limited resources call for a tool that can identify pipelines prone to severe accidents so companies know which pipe segments need to be repaired immediately.

The data set used in this project is found on ProPublica but originates from the Pipeline and Hazardous Materials Safety Administration (PHMSA). With the increase in natural gas usage, many governmental regulations and policies have been put in place to help ensure safe and reliable transportation. This data set is built from Title 49 of the Code of Federal Regulations (49 CFR Parts 191, 195), which requires pipeline operators to submit incident reports within 30 days of a pipeline incident or accident. Once a problem occurs in a natural gas network, it is required under penalty of law that both private and public companies fill out a Gas Distribution Incident Report.

This report is an 18-page document that asks the pipeline operator to explain the situation in full. Everything from assumed cause of the incident, pipeline installation year, pipe diameter, materials of pipe, and tens of other variables are inspected at the time of the accident. The report is submitted to PHMSA in order to verify if any regulations or policies were violated and for further analysis. Once the incident has been documented, it is added to PHMSA incident reporting database and labeled as SEVERE (1) or NOT SEVERE (0).

This project will use all available information to make an inference on this single descriptive metric the PHMSA uses to define a severe event. A severe incident is likely to cost more money to fix, fatally injure someone, involve an open flame/explosion, or release large abouts of hydrocarbons into the environment. To help a company decide which of their pipe segments is more likely to have a severe incident, a model will be used to makes inferences on such an event in the hopes that the company can preemptively repair or replace the risky pipe.

After an initial analysis, the leading factors that are statistically significant when categorizing a severe vs a non-severe event are pipe manufacture year, installation year, longitude, latitude, material of pipe, pipe diameter, and if the pipe was above or below ground. This project aims to ask if this database of pipeline accidents can help natural gas distribution companies learn to operate safer and more efficiently. Additionally, we hope to determine what factors that lead to a accident and how can a company identify them prior to a severe situation. Further analysis will be completed in phase two.

Data Source: https://www.propublica.org/datastore/dataset/pipeline-safety-data

Colin Quinn
COSC 5610 Data Mining
October 8th, 2020
Professor Guha

Bibliography

Timmer, R. P., & Lamb, P. J. (2007). Relations between temperature and residential natural gas consumption in the Central and Eastern United States. *Journal of Applied Meteorology and Climatology*, *46*(11), 1993–2013. https://doi.org/10.1175/2007JAMC1552.1

Sullivan, G., Pugh, R., Melendez, P., & Hunt, W. (2010). Operations & Maintenance Best Practices. In *Pacific Northwest National Laboratory for the Federal Energy Management Program U.S. Department of Energy* (Issue August).

Uraikul, V., Chan, C. W., & Tontiwachwuthikul, P. (2000). Development of an Expert System for Optimizing Natural Gas Pipeline Operations. *Expert Systems with Applications*, *18*, 271–282.

Obanijesu, E. O., Pareek, V., & Tade, M. O. (2014). Modeling the Contribution of Gas Hydrate to Corrosion Rate Along the Subsea Pipelines. *Petroleum Science and Technology*, *32*(21), 2538–2548. https://doi.org/10.1080/10916466.2013.842586

Zhao, W., Zhang, T., Wang, Y., Qiao, J., & Wang, Z. (2018). Corrosion Failure Mechanism of Associated Gas Transmission Pipeline. *Materials*, *11*(10). https://doi.org/10.3390/ma11101935

Javidi, M., & Bekhrad, S. (2018). Failure Analysis of a Wet Gas Pipeline Due to Localized CO2 Corrosion. *Engineering Failure Analysis*, *89*(December 2017), 46–56. https://doi.org/10.1016/j.engfailanal.2018.03.006

Bedairi, B., Cronin, D., Hosseini, A., & Plumtree, A. (2012). Failure Prediction for Crack-in-Corrosion Defects in Natural Gas Transmission Pipelines. *International Journal of Pressure Vessels and Piping*, *96–97*, 90–99. https://doi.org/10.1016/j.ijpvp.2012.06.002

Pouraria, H., Seo, J. K., & Paik, J. K. (2016). A Numerical Study on Water Wetting Associated with the Internal Corrosion of Oil Pipelines. *Ocean Engineering*, *122*, 105–117. https://doi.org/10.1016/j.oceaneng.2016.06.022

Pipeline and Hazardous Materials Safety Administration, & Office of Pipeline Safety. (2017). *Guidance Manual for Operators of Small Natural Gas Systems* (Issue January). https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/docs/Small_Natural_Gas_Operator_Guide_%28January_2017%29.pdf

Adegboye, M. A., Fung, W. K., & Karnik, A. (2019). Recent Advances in Pipeline Monitoring and Oil Leakage Detection Technologies: Principles and Approaches. *Sensors (Switzerland)*, *19*(11). https://doi.org/10.3390/s19112548

Lederhos, J. P., Long, J. P., Sum, A., Christiansen, R. L., & Sloan, E. D. (1996). Effective Kinetic Inhibitors for Natural Gas Hydrates. *Chemical Engineering Science*, *51*(8), 1221–1229. https://doi.org/10.1016/0009-2509(95)00370-3

Mokhatab, S., Poe, W., & Mak, J. (2018). *Handbook of Natural Gas Transmission and Processing* (Issue 2). Gulf Professional Publishing. https://doi.org/10.1016/B978-0-12-801499-8.00001-8.

Sadek, A. (2016). *A Guide to Failure Analysis for the Oil and Gas Industry*. https://ewi.org/eto/wp-content/uploads/2016/02/Sadek-Guide-to-Fialure-Analysis-for-OG-Industry-R2.pdf

Parrish, W., Kidnay, A., & McCartney, D. (2013). *Fundamentals of Natural Gas Processing* (2nd ed.). CRC Press. https://doi.org/10.1201/9781420014044

Data Source: https://www.propublica.org/datastore/dataset/pipeline-safety-data

Colin Quinn
COSC 5610 Data Mining
October 8th, 2020
Professor Guha

Sloan, E. D. (2003). Fundamental Principles and Applications of Natural Gas Hydrates. In *Nature* (Vol. 426, Issue 6964, pp. 353–359). https://doi.org/10.1038/nature02135

Xu, Y., Ma, Y., Zhang, X., Zhang, N., Wang, Y., & Li, S. (2013). The Optimization of the Operation Program for Natural Gas Pipeline Transmission and End Segment Storing Gas. *Proceedings - 2013 International Conference on Mechatronic Sciences, Electric Engineering and Computer, MEC 2013*, *1*, 10–14. https://doi.org/10.1109/MEC.2013.6885042

Haeseldonckx, D., & D'Haeseleer, W. (2007). The Use of the Natural-gas Pipeline Infrastructure for Hydrogen Transport in a Changing Market Structure. *International Journal of Hydrogen Energy*, *32*(10–11), 1381–1386. https://doi.org/10.1016/j.ijhydene.2006.10.018

Aliguliyev, R., & Imamverdiyev, Y. (2017). Big Data Strategy for the Oil and Gas Industry: General Directions. *Problems of Information Technology*, *08*(2), 31–42. https://doi.org/10.25045/jpit.v08.i2.04

Elhoud, A., Jewilli, F., Abouswa, K., & Rageai, O. (2012). Failure Analysis: Internal Corrosion Rupture of a 6-in Gas Line. *Materials Performance*, *51*, 70–73.

Wan, J., Yu, Y., Wu, Y., Feng, R., & Yu, N. (2012). Hierarchical Leak Detection and Localization Method in Natural Gas Pipeline Monitoring Sensor Networks. *Sensors*, *12*(1), 189–214. https://doi.org/10.3390/s120100189

Hribar, R., Potočnik, P., Šilc, J., & Papa, G. (2018). A Comparison of Models for Forecasting the Residential Natural Gas Demand of an Urban Area. *Energy*, *167*, 511–522. https://doi.org/10.1016/j.energy.2018.10.175

Koh, C. A. (2002). Towards a Fundamental Understanding of Natural Gas Hydrates. *Chemical Society Reviews*, *31*(3), 157–167. https://doi.org/10.1039/b008672j

Pipeline and Hazardous Materials Safety Administration. (2017). *Operations & Maintenance Enforcement Guidance*. https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/docs/regulatory-compliance/pipeline/enforcement/5776/o-m-enforcement-guidance-part-192-7-21-2017.pdf

Esmaeilzadeh, F., Mowla, D., & Asemani, M. (2009). Mathematical Modeling and Simulation of Pigging Operation in Gas and Liquid Pipelines. *Journal of Petroleum Science and Engineering*, *69*(1–2), 100–106. https://doi.org/10.1016/j.petrol.2009.08.006

Huntington, H. G. (2007). Industrial natural gas consumption in the United States: An empirical model for evaluating future trends. *Energy Economics*, *29*(4), 743–759. https://doi.org/10.1016/j.eneco.2006.12.005

Askari, M., Aliofkhazraei, M., & Afroukhteh, S. (2019). A Comprehensive Review on Internal Corrosion and Cracking of Oil and Gas Pipelines. *Journal of Natural Gas Science and Engineering*, *71*(August), 102971. https://doi.org/10.1016/j.jngse.2019.102971

Data Source: https://www.propublica.org/datastore/dataset/pipeline-safety-data