Two Different Methods to Treat Unwanted Associated Gas
Reasons to Consider Zero Gas Venting/Flaring Future in the Permian Basin

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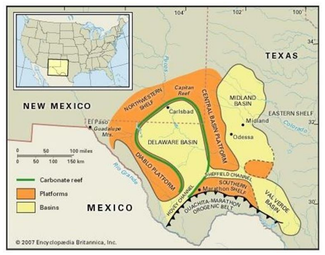
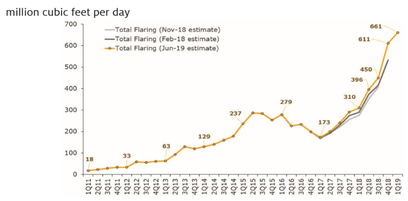
Introduction



- Permian basin covers half of West Texas and a quarter portion of southeast New Mexico with more than 7000 oil and natural gas fields.
- Permian basin is one of the highest oil and gas productivity areas in the United States.
- Beside crude oil production, there is natural gas production including associated gas and dissolved gas. The associated gas and dissolved gas can become unwanted gas when direct market access is not available or gas transportation is not economical.
- Venting is the action of releasing natural gas to atmosphere, while flaring is the burning of unwanted gas. Flaring is more popular because this process converts unwanted gas to CO2 - a less dangerous greenhouse gas.
- Both methods are bad for the environment. A zero gas flaring future for the Permian basin should be considered.

The Emission Reality in Permian Basin



1. Self Reports

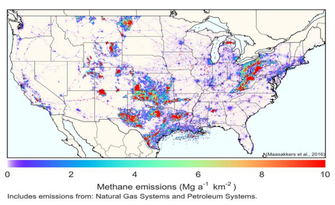
The figure above shows the total amount of natural gas flaring in the Permian Basin from the beginning of 2011 to the first quarter of 2019.

There is a steep increasing trend starting from 2017 after a 2-year-declining period. In June 2019, the total flaring has increased almost 400% due to the significant improvement of technology recently, which pushes hydrocarbon production to a higher level in both conventional and unconventional

2. Estimations based on emission sources

Tracking the main sources that cause emission is another method to estimate the greenhouse gas emission (including CO2 and CH4) in upstream hydrocarbon operations.

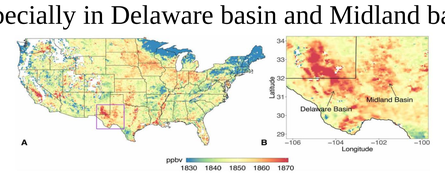
Major part of the Permian basin covered by red, which brings back the concerns about gas flaring practice.



3. Satellite Estimations

Satellite systems are potentially more accurate methods to predict the flare volumes.

In the figure below, the background has pollutant concentration of about 300ppbv. The hot color indicates a strong methane emission, especially in Delaware basin and Midland basin.



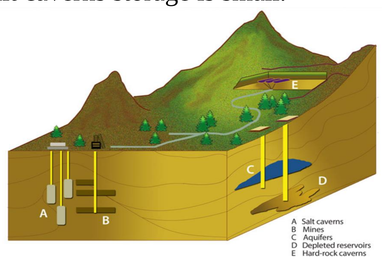
In short, no matter what methods are used to estimate the flaring/venting volume, Permian basin is confirmed to be one of largest sources of greenhouse gas emission in the US.

Gas Injection and The Basic Concepts

- There are two distinct processes: gas reinjection and gas lift.
- In gas reinjection, gas is injected via dedicated wells so the gas acts as a force to push oil molecules together to form an oil bank and migrate toward the producing wells. Because gas has lighter density, it will eventually bypass and leave oil behind.
- In gas lift process, gas from the compressor is injected in oil wells. Under the control of the gas lift system, gas flows into the production tubing. When fluid in the tubing and gas are mixed, the density of fluid decreases, which makes it lighter and flow to the surface easier.

Associated Gas Sequestration

- There are different types of underground storage facilities: depleted gas reservoirs, aquifers, and salt caverns.
- When storing gas underground, the injection rate, deliverability, and storage capacity (including total capacity, current capacity, base gas, and working gas capacity) must be considered.
- Depleted reservoirs are formations that were almost fully recovered. The available pore spaces capable of holding natural gas.
- Aquifers are natural water reservoirs. When they are porous and permeable, they can be used as underground storages. The geological characteristics of aquifers are unknown, therefore, it is costly to consider using them for gas storage purpose.
- Salt caverns are created out of salt dome or salt-bed formation by using water to dissolve the salt. Because salt caverns are large empty spaces, they allow large deliverability but the total capacity of salt caverns storage is small.

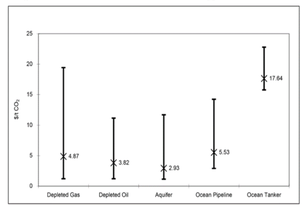


Storage in Depleted Reservoirs

- A disadvantage of gas injection is it works in a cycle. The amount of gas injected will eventually get recovered. The process needs to be run continuously to keep the gas useful, which may not be possible when the wells reach their economic limit. Therefore, underground associated gas storage should be a better option for the Permian Basin due to a grant amount of gas being produced in this area.
- Depleted reservoirs are suggested to be ideal storage facility for the Permian basin because it is the cheapest option with the largest storage capacity. There are many available depleted gas fields in the Permian basin, which make this suggestion more realistic.
- Permian basin also has high working gas capacity. Higher working gas capacity implies higher withdrawal rate. It is a good sign when the stored gas is easy to be recovered. When there is available market, associated gas can be recovered and sold thus leave empty space for more gas to be stored.

Challenges

- One of technical challenges for underground storage is having low permeability reservoirs in the Permian basin. Permeability will affect the injection rate. Low injection rate will not be efficient for large amount of unwanted gas, but high injection rate may break the formation.
- There are also uncertainties in storage facilities analysis. Not all data are recorded correctly, and storing gas is different than producing oil. Some current understandings about the fields based on fluid production history may not apply to underground gas storage. Errors or assumptions can cause gas leakage or migration, which may affect the fresh water aquifer or the environment around the area.
- Economic issues and the culture can be bigger challenges. Injection cost or transportation cost are extra investment. It may not possible for small companies. Also, Permian basin has a long history of venting/flaring practice, therefore it is difficult for everyone to be willing to do things differently.



State, Year	LA/TX, 2009/2010	TX, 2012	TX, 2013	TX,2015
Maximum Operating Pressure [psia]	2,220	1,825	2,220	2,319
Total Pipeline Cost ($/mile)	$3,044,000	$480,000	$3,190,000	$750,000
Pipeline Cost ($/ diameter inch mile)	$126,823	$80,000	$199,176	$125,000

Conclusion

- All emission estimation sources (self report, estimations based on emission sources, or satellite estimations) show a precise results of a bad emission reality in the Permian basin. There are more studies and practical projects on reducing gas flaring in Permian basin, which means people are taking actions. The old habits need to be changed because of significantly bad effects.
- Reducing gas flaring by considering underground storage is not only good for the environment but also a great way to save a clean energy source for the future use. In order to get closer to the zero-routine-flaring, depleted reservoirs should be considered. Deeper investigations should be done to gain fully understanding about this method.
- For small companies who have limited budget, there are other cheaper methods to avoid venting/flaring practice. Technologies are available to allow gas to be converted to liquid for higher price selling or to electricity to use on site.

References

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