AMMONIA STORAGE OPTIONS DECISION-MAKING PROCESS

With ammonia emerging as the practical energy solution that satisfies environmental aspects, as well as economic ones, the energy industry has more questions than ever about making the correct choice for gas storage.

A significant portion of the US gas storage is underground. This article will deal specifically with the choices for aboveground storage and the decision-making process for small and bulk gas storage.

The process will look at gas stored as a vapor or liquified. Although, every gas varies significantly in pressure, temperature, and processing, the storage decision-making process follows a similar outline, adjusting those components to deal with the specific gas at hand. Natural gas has been selected within some of our examples due to its highly regulated nature and industry experience. Other constituents of natural gas, as well as ammonia and hydrogen are also included in the overview of the decision-making process.

When considering ammonia storage, an important reference point is natural gas storage. As CNG or LNG, it represents one of the more dynamic storage decisions. Using the following considerations to establish a path simplifies and expedites developers' design phase and establishes storage facility guidelines for natural gas, its constituents, and ammonia.

There are 3 key decisions that need to be considered for any of the gas storage options. These are: Location; Storage Interface; and Storage Dynamics. The first sub-category under Location addresses the regulatory aspects for storage. For LNG, 49CFR193 will be the first consideration before progressing onward. It is important to note that applications to

storage of methane have developed technology and guidelines that are regularly applied to other gas constituents and ammonia. Consider the requirements for LNG storage when looking at other gas constituents and ammonia.

LOCATION

SUB-CATEGORY A - REGULATORY ASPECTS

a. Federal regulations: PHMSA & FERC: These federal agencies are the final authority on methane processes. For liquid storage, the threshold of 264,000 gallons at the site sets up a regulatory decision for permitting. Some allowed configurations, such as penetrations in the shell or bottom of liquid containing tanks, may be allowed by regulation, but make it difficult or impossible to ultimately receive federal approval. Review of federal codes and previous permitting decisions are a crucial part of any storage selection exercise.

b. State regulations: Some states have increased regulations regarding the storage of LNG or methane gas.

c. City and county municipal regulations: Although most city and counties have no specific regulations, some, such as Los Angeles, have gone out of their way to develop new codes that are far more stringent than applied elsewhere. The application in L A can act as a significant factor in the formula for storage type selection. Common city and county specific considerations are height or colour restrictions. Height restrictions can greatly affect price and storage concept selection.

d. FAA regulations: FAA issues may have a significant impact if the tank has to be designed to take impact from aircraft, or if proximity to an airport imposes dimensional restrictions.

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e. Local Fire Marshal: Traditionally, the Fire Marshal will have little impact on the overall economics of the project, but issues associated with permitting, due to public safety, and/or fire/rescue support systems can cause timing or economic complications.

The second sub-category, Site Specific Relationships, incorporates the potential impacts of adjacent neighbors and facilities. The issues to address include the following:

SUB-CATEGORY B - SITE-SPECIFIC RELATIONSHIPS

a.Adjacent property: There are a number of regulations on distance to property lines and siting calculations that deal with thermal exclusion and vapor dispersion models that may direct a customer to the proper storage type selection process. Fire from an adjacent source is also a common component in the basis of design. Proximity to bodies of water can also have an impact.

b.Insurance: Insurance carriers can dictate design choices because of proximity to other components in the facility or any anticipated liabilities.

c.Co-owners: Invested parties each have their own opinions and appetite for risk.

d.Public facilities (schools, hospitals & public transportation): Authorities and/or public concern can drive a design selection when a potential facility is in proximity to any of these. The last sub-a.-category under Location deals with the Site Specific Logistics. Some customers start with this category to see if the location has the ability to comply with an intended purpose and then look at the other categories. Dealing with a specific site, the following needs to be considered:

SUB-CATEGORY C - SITE-SPECIFIC LOGISTICS

a. Site layout: Potential site size, footprint, and land utilization are all key factors and can lead to specific storage containment concepts.

b. Site logistics: Geotechnical data can heavily influence design and storage concept selection. Additional local considerations, such as flood plains and historic weather anomalies can also have impacts.

c. Construction access: Site access and road or bridge conditions can impact both construction and future operational logistics. The second category of consideration deals with the Storage interface. This includes inbound and outbound sources and potential changes to logistics and through-puts. The customer's operational style and level of automation also become factors in this decision-making process. Storage interface considerations will be discussed in the following section.

STORAGE INTERFACE

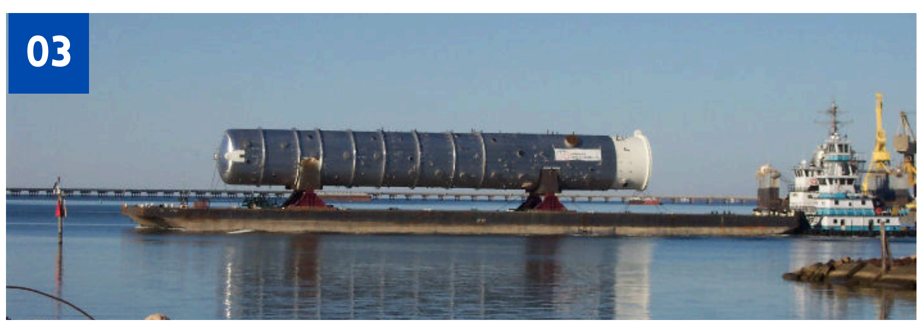
a. Inbound rates and pressure: Some storage applications can restrict inbound rates, while certain product sources may require rapid fill capabilities.

b. Inbound source: This variable defines how the product is brought into the facility. Inbound sources can include: a process unit, ship, rail, truck, pipeline, or a combination. Each support a set of dynamics to consider, including frequency and variability of delivery.

c**. Inbound state:** Product can arrive as a gas or a liquid. Other considerations include potential sub-cooling, additional refrigeration, product purification, or vaporization.

d. Outbound rates and pressure: Knowing outbound required rates, timing, frequency, and any guaranteed reliability is crucial to storage and operation design.

e. Outbound destinations: Outbound destinations can include a ship, rail, trucks, vaporizers, or a pipeline.



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f. Outbound state: The outbound product could be a gas or liquid, and each have considerations. considerations.

The third category of consideration deals with Storage Dynamics. This is the catch-all category. Here, issues such as future growth, moving the facility or even changing the service in the future should be addressed. This is the category where the customer's ideal dream and/or hedge for their worst nightmare is considered.

STORAGE DYNAMICS

a. Plant reconfiguration: This may involve adding storage, and/or even removing storage from the site in the future. Vessels can easily be removed while flat bottom tanks cannot.

b. Change of service: Many customers develop projects that would initially service one gas source, such as ethane, only to move to LNG. Therefore, the structures and designs need to consider future changes in their initial development. There must be a decision made as to CAPEX to minimize future retrofits.

c. Life of facility: Most customers want to build their facility to have an extended life, but this becomes a balance between CAPEX and OPEX.

GAS VS. LIQUID STORAGE

Methane can be stored as a liquid or a gas. Because the coefficient of expansion on methane is around 600:1, liquid storage is much more efficient space-wise, but liquid methane (LNG) is a cryogenic fluid and requires large energy and infrastructure investment. Gaseous methane pressure vessels typically range in size from as small as 5,000 gallons to several hundred-thousand gallons. There are also spheres for storing the gas, but traditionally most customers convert to liquid once they reach storage of 500,000 to 1,000,000 gallons of liquid. Once storage needs have reached this volume, liquid storage may become more practical. Cryogenic shop-built vessels typically range from 5,000 gallons up to 264,000 gallons, and cryogenic spheres that can go as large as 3,000,000 gallons. The other option is insulated flat bottom tanks that are low pressure and use pumps for send-out. These can range from as small as 300,000 gallons to over 45,000,000 gallons in size. It is also important to note that flat bottom storage comes in a variety of configurations using low temperature steel and concrete. API-625 outlines several of these configurations, including the distinction between single containment, double containment, and full containment.

Once you have gone through the initial steps of looking at the site, storage interface, and storage dynamics, it is time to examine the contractors who can deliver storage options for the project. A good contractor will have a full arsenal of options to ensure the best fit with the project and company needs. Customers often begin project development in methane storage with limited options and information.

FOR MORE INFORMATION

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