TECH TIP

Maximum Intended Inventory

What is Maximum Intended Inventory?

The maximum intended inventory, as the name suggests, is the maximum amount of the regulated substance or chemical in a covered process, which the facility plans to store onsite. Facilities with a covered process typically will have various pressure vessels, storage tanks, heat exchangers, pipelines, etc., all of which contribute to the overall quantity of material. This Tech-Tip aims to briefly introduce the process safety information requirement listed under Occupational Safety Health Administration Process Safety Management / Environmental Protection Agency Risk Management Plan and California Accident Release Prevention programs.

How to Calculate the Facility's Maximum Intended Inventory?

The first step in calculating the maximum intended inventory is to obtain the maximum capacity of each vessel containing the regulated substance or chemical. Covered processes that consume the regulated chemical should always use the maximum allowable capacity of the vessel. For example in Figure 1, to calculate the capacity of the ammonia storage tank, the volume of a cylinder formula listed in Equation 1 can be used:

Eq. 1 $$V = \pi \cdot r^2 \cdot h$$

Where *r* in (ft) is the radius and *h* in (ft) is the height/length. Once the maximum capacity is calculated, multiply any administrative controls (i.e., procedural mechanisms used for hazard control) which limit the filling of the tank. Figure 1 depicts the administrative controls to 85%, therefore the volume is multiplied by 85% which corresponds to the total allowable capacity of liquid level within the vessel. The mass of the regulated substance or chemical in the liquid phase (M_L) is then calculated using Equation 2.

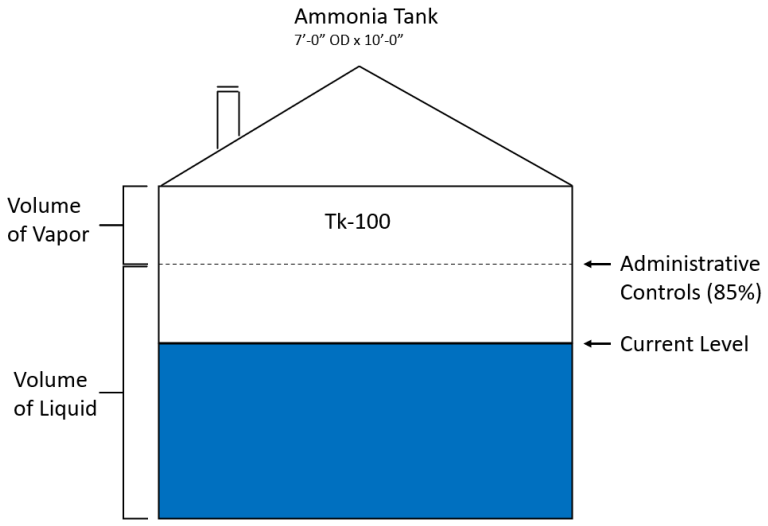

Figure 1. *Ammonia Storage Tank*

Eq. 2 $$M_L = V_L \cdot \rho$$

Where V_L is the volume of the liquid in (ft^3), and ρ is the density of the substance or chemical at the operating temperature and pressure in ($lb./ft^3$). The density of most substances or chemicals can be extracted from Perry's Chemical Engineers' Handbook[1] or from the chemical suppliers Safety Data Sheet (SDS).

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In this example, we can assume the mass of the vapor is negligible as ammonia has a high affinity to water[2] and high flash point[3]; however, for pressure vessels the mass of the vapor can be calculated utilizing Equation 3.

Eq. 3 $$M_v = \frac{v}{V_v}$$

Where v is the specific volume of the ammonia vapor in (ft^3/lb.), and V_v is the total volume of the vapor in (ft^3). The specific volume can be determined using Equation 4.

Eq. 4 $$v = \frac{RT}{PM}$$

Where R is the molar gas constant, T is the gas temperature, P is the pressure, and M is the molar mass. The molar gas constant and molar mass for various chemicals are listed in Perry's Chemical Engineers' Handbook[1]. The total mass (M_T) of the regulated chemical is then equal to the sum of the vapor and liquid mass (Equation 5).

Eq. 5 $$M_t = M_l + M_v$$

In summary, the maximum intended inventory is performed by adding the mass of the regulated substance within each piece of equipment in which the regulated substance is stored or processed for a given covered process. The volume calculation will differ for each equipment or piping run, but the overall principle will remain the same.

Resources

1. Maloney, J., 2021. *Perry's Chemical Engineers' Handbook, 9th Edition*. [online] McGraw-Hill Education. Available at: <https://www.mhprofessional.com/9780071834094-usa-perrys-chemical-engineers-handbook-9th-edition> [Accessed 24 August 2021].
2. Pubchem.ncbi.nlm.nih.gov. 2021. *Ammonia*. [online] Available at: <https://pubchem.ncbi.nlm.nih.gov/compound/ammonia#section=Melting-Point> [Accessed 24 August 2021].
3. Nowatzki, J., 2021. Anhydrous Ammonia: Managing The Risks. [online] Ag.ndsu.edu. Available at: <https://www.ag.ndsu.edu/publications/crops/anhydrous-ammonia-managing-the-risks.> [Accessed 24 August 2021].

About the Author:

Mr. Hernandez is a Project Engineer with Risk Management Professionals and has been immersed in multiple aspects of RMP, PSM, and CALARP Program development, PHAs utilizing HAZOP and What-If / Checklist Methodologies, regulatory Compliance Audits, P&ID review, Operating Procedure development, maximum inventory assessments and calculations and toxic dispersion modeling for Hazard Assessments / Offsite Consequence Analysis.
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