Mosaic's hazmat employees responsible for loading sulfuric acid tank cars, must be familiar with DOT rail car filling limits including the proper outage (unfilled portion of a tank car) and permitted gross weight to avoid shipping an overloaded car. A railcar can be overloaded by weight or by volume.

First example will walk you through the calculation to load a railcar to the maximum approved volume (innage); On the second example, we calculate railcar gross rail weight and outage using our typical target of 100 tons of product.

Outage and filling limits for Tank Cars are based on many variables, including, product type, density of the product, and temperature of the product.

1. DOT Regulations and definitions.

179.13 Tank car capacity and gross weight limitation.
Tank cars built after November 30, 1970, or any existing tank cars that are converted, **may not exceed 34,500 gallons capacity or 263,000 pounds gross weight on rail.**

173.24(b) Additional general requirements for bulk packagings (Tank Cars)
Outage and filling limits for liquids and gases

- 5% outage for materials Poisonous by Inhalation (PIH). Not applicable to Sulfuric Acid
- **1% outage for all other materials, this includes Sulfuric Acid 93-98**

At the following reference temperatures

1. **46 C (115 F) for a non-insulated tank. Applies to Sulfuric Acid tankcars**.
2. 43C (110 F) for tank car with a thermal protection jacket. Not applicable to Sulfuric Acid.
3. 41C (105 F) for an insulated tank. Not applicable to Sulfuric Acid tank cars.

Outage is defined as the unfilled portion of the tank car measured from the inside top of the tank shell down to the level of the product.

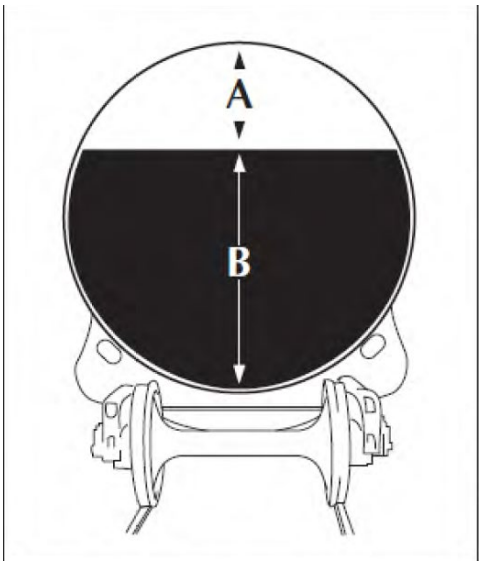
Innage is the depth of product in the tank measured from the bottom of the tank up to the liquid level of the product.

2. Formulas

Maximum Gallons = Railcar Capacity Gallons x Max Innage

Maximum Product Weight = Max Gallons x Specific Gravity @ Reference Temp x Weight of Water

Weight of water = 8.32828 lbs. / gallon



A = Outage; B = Innage

Example 1. Sulfuric Acid Tank Car GATX21413 filling limits calculation.

Tank Spec: DOT 111A100 W2	Non-Insulated
Load Limit	208,200 lbs.
Tare	54,800 lbs.
Gross Weight	263,000 lbs.
Railcar Capacity	13,937 gallons

Sulfuric Acid Characteristics 93% concentration
Specific Gravity of 1.8074 at 104F Reference Temperature
Specific Gravity of 1.8384 at 50F Loading Temperature

1. Railcar Maximum Innage in Gallons without overloading the car by volume at the reference temperature. Based on filling limits outlined under 173.24(b), we can load a sulfuric acid railcar to 99% capacity.
   Max Gallons = Railcar Capacity (Gallons) x Max Innage (99%)
   Max Gallons = 13,937 gallons x 0.99 = **13,797 gallons**

2. Max Product weight without overloading the car by volume at the reference temperature
   Max Product Weight = Max Gallons x Sp Gravity@ Ref Tempt x Weight of Water
   Max Product Weight = 13,797 gallons x 1.8074 x 8.32828
   Max Product Weight = **207,679 lbs. (103.83 tons)**
   Note: This is below the car's load limit of 208,200 lbs.

3. Railcar Gross Weight = 207,679 + 54,800 lbs. = **262,479 lbs.** with 1% outage.
   This is below the car's 263,000 lbs. Gross Rail Limit

   How many gallons Sulfuric Acid 93% can be loaded into GATX21413 at 50F without overloading the car by volume at the ref temp of 104F

   Max Gallons (at Loading Temp) = Max Product Weight / Sp Gravity at Loading Temp x Wt Water
   Max Gallons = 207,679 gallons / (1.8384 x 8.32828) = **13,564 gallons**

   We can load GATX21413 with up to 207,679 lbs. or 13,564 gallons Sulfuric Acid 93% and meet limits for Gross Rail Weight and 1% outage

Example 2. Loading same railcar GATX21413 with 100 tons Sulfuric Acid 93%

Tank Spec: DOT 111A100 W2	Non-Insulated
Load Limit	208,200 lbs.
Tare	54,800 lbs.
Gross Weight	263,000 lbs.
Railcar Capacity	13,937 gallons

1. Product Weight = 100 tons = 200, 000 lbs.

   Gross Rail Weight = Product Weight + Tare
   Gross Rail Weight = 200,000 lbs. + 54,800 lbs. = 254,800 lbs.

2. Overage = Product Weight – Max allowable weight
   Overage = 200,000 lbs. – 207, 679 lbs. = -7, 679 lbs.
   Car is not overloaded.

3. Railcar outage calculation

   Product Volume = Product weight / Density at Loading Temperature
   Product volume = 200,000 lbs. / 15.31 lbs./gal = 13,063 gallons

   Innage = Product Volume / Tank Capacity
   13,063 gallons / 13,937 gallons = 0.937

   Outage = 1 – 0.937 = 0.063 or 6.3%

We can load railcar GATX21413 with 200,000 lbs. or 13,063 gallons Sulfuric Acid 93% and the railcar will be within acceptable filling limits for Gross Rail Weight of 263,000 lbs. and 1% outage.