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Safety-Related Ventilation for Battery Charging Areas

We often observe food-processing facilities where lift-truck battery charging areas are inadequately ventilated. Because these lead-acid batteries can emit flammable hydrogen gas, the National Fire Protection Association (NFPA) (and many other building code authorities) have established minimum ventilation guidelines for removing such hazardous emissions. Code-compliant ventilation systems are typically necessary, but they do not have to be elaborate or expensive. Engineers need to determine the minimum required ventilation airflow rate, in a defined space, in cubic feet per minute due to hydrogen gassing from Lead-Acid batteries during their charging process, as well as the amount of air changes per hour required in the space, and the time taken to produce a critical level of hydrogen. The process of determining these values is represented below.

Process

First, determine number of batteries, number of cells per battery, battery charge current, and volume of space for battery-charging where:

B = # of batteries
N = # of cells per battery
I = charge current (A)
V = volume of battery charging space

Next, determine the hydrogen generated battery, *H*, in ft^3/hr where:

$$H = N * I * k$$
and
$$k = 0.0158$$

(A typical lead-acid power battery will generate approximately 0.0158 cubic feet of hydrogen per cell per hour at sea level, when the ambient temperature is around 77 F, and where the electrolyte is "gassing".)

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EXPERIENCE IN BRIEF

Useful Flammable Limits (in volume %)

	Lower	Upper
Acetone	2.6	12.8
Acetylene	2.5	100
Ammonia	16.0	25.0
Butyl Alc.	1.4	11.2
Ethyl Alc.	3.3	19.0
Gasoline	1.4	7.4
Hydrogen	4.1	75
Isopropyl Alc.	2.0	12.0
Methyl Alc.	6.0	36.0
Natural Gas	5.0	15.0
Propane	2.1	9.5

Using the hydrogen generated per battery, determine the minimum required ventilation airflow rate per battery, *Q*, in cubic feet per minute (cfm)

$$Q = (H*(1\ hr)/(60\ min))/(PC\ \%)$$

where

$$PC = 1\%$$

(the allowable percent concentration of hydrogen in a room)

Add a 25% safety margin to the minimum required ventilation airflow rate, *Q*, to get the ventilation required per battery, *R*. This safety factor is to allow for hydrogen production variations with changes in temperature, charge controller failure, and reduction in net volume in battery room due to battery equipment and fixtures. It also accounts for deterioration in ventilation systems over time.

$$R = Q * (1.25)$$

To determine the total ventilation required for the defined space, multiply the ventilation required per battery by the number of batteries. Use this ventilation rate to size the exhaust fan that will serve the defined space.

$$Total\ Ventilation\ Required = R * B$$

The air change rate required in the space is calculated using the minimum required ventilation rate and space volume.

$$ACH = (Q*60)/V$$

Next, the critical volume of the room, *CV*, which is the maximum permissible hydrogen concentration can be calculated. Limit the value to below 1% of the space volume.

$$CV = V/100$$

Compare the critical volume of the space to the hydrogen generated per battery to determine the amount of time to produce a critical level of hydrogen, *t*.

$$t = CV/H$$

By following this process, engineers can calculate the ventilation and air change requirements for battery-charging spaces and understand the time it would take to produce critical levels of hydrogen to ensure ventilation systems are code-compliant.

CONTACT US

Direct any comments or questions to:

Scott McGlamery, P.E., Senior Vice President, Manager, Electrical Engineering
smcglamery@hixson-inc.com
Phone: 513.241.1230

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