Truck Bed Liners and Filling Portable Gasoline Containers Safely

**Introduction**

An unusual number of fires have occurred during the filling of portable gasoline containers when the containers are in the back of pick-up trucks that are equipped with plastic bed liners. Incidents of this nature have occurred with both metal and plastic portable containers, such as those used to refuel lawn mowers, snow blowers, chain saws, and all terrain vehicles (ATVs).

- A man is filling a small gasoline container at a service station. The gasoline container is in the back of a truck bed equipped with a plastic liner. During refueling, the gasoline ignites spontaneously, severely burning the man.
How Does the Bed Liner Cause a Problem?

A *bed liner* is a polyvinyl plastic lining that fits inside the bed of a pick-up truck to protect the vehicle’s surface from wear and tear. The bed liner provides excellent insulation, preventing static electricity from bleeding off the gasoline container, to the truck body, through the truck tires, and off to the ground.

A static charge can accumulate on the gasoline container in either of two ways. First, as the vehicle travels from one place to another, a charge can accumulate from the friction of the can sliding on the pickup bed. Second, when fuel is dispensed into a portable container, static electricity is generated by the flow of fuel through the hose, or by the free fall of fuel into the container.

The bed liner isolates the portable container from the metal body of the pickup truck (through which the static charge would normally be dissipated) thus allowing the charge to build and the container to hold the charge. When the fuel nozzle touches the container, a spark can occur, igniting accumulated gasoline vapors, and causing a fire or explosion.
6:00–7:00PM THU 11 MAR:
Second Exam
(Chapters 24.9–28.8 / HW04–06)
Room Lockett 6
Lecture 13: THU 04 MAR 10
Magnetic fields
Ch.28.1–5
How Do You Use Magnetic Fields in Your Everyday Life!
Electric vs. Magnetic Fields

Electric fields are created:
• microscopically, by electric charges (fields) of elementary particles (electrons, protons)
• macroscopically, by adding the field of many elementary charges of the same sign

Magnetic fields are created:
• microscopically, by magnetic “moments” of elementary particles (electrons, protons, neutrons)
• macroscopically, by
  • adding many microscopic magnetic moments (magnetic materials); or by
  • electric charges that move (electric currents)
Magnetic Field Direction

FROM North Poles
TO South Poles

Compare to Electric Field Directions
Ritchie’s Rule for Magnets

Opposite Poles Attract

Like Poles Repel
We know that an electric fields exists because it accelerates electric charges, with a force independent of the velocity of the charge, proportional to the electric charge: $F_E = qE$

We know that a magnetic field exists because it accelerates electric charges in a direction perpendicular to the velocity of the charge, with a magnitude proportional to the velocity of the charge and to the magnitude of the charge: $F_B = qv \times B$

Magnetic forces are perpendicular to both the velocity of charges and to the magnetic field (electric forces are parallel to the field).

Since magnetic forces are perpendicular to the velocity, they do no work! ($W = F \cdot r$)

Speed of particles moving in a magnetic field remains constant in magnitude, ONLY the direction changes. Kinetic energy is constant! (no work).
Magnetic vs. Electric Forces

Electric Force on Charge Parallel to E:
\[ \vec{F}_E = q\vec{E} \]

Magnetic Force on Charge Perpendicular to B and v.
\[ \vec{F}_B = q\vec{v} \times \vec{B} \]
Definition of Magnetic Field

Definition of Electric Field:

\[ \vec{E} = \frac{\vec{F}_E}{q} \]

Definition of Magnetic Field:

\[ |B| = \frac{|\vec{F}_B|}{|q\vec{v}|} \]

Units:  

\[ B = \frac{\text{Newton}}{\text{Coulomb} \cdot (\text{meter/sec})} = \frac{\text{Newton}}{(\text{Coulomb/sec}) \cdot \text{meter}} = \frac{\text{Newton}}{\text{Ampere} \cdot \text{meter}} = \frac{\text{N}}{\text{A} \cdot \text{m}} \]
Thompson Experiment & The Discovery of the Electron

Forces Balance: $v = \frac{E}{B}$

Cross-section of a velocity selector

While in the magnetic field an electromagnetic force is felt as $F_B = qvB$. The right hand rule gives us the direction, with fingers into the page ($B$), thumb to the right ($l$), gives force in direction of the palm being UP.

As the ions enter the electric field a force $F_e = qE$ is created based on the charge of the ion and field strength. This force is directed downward as the positive plate repels the positive particle.

In order to pass undeflected through the crossed fields $F_B = F_e$ or $qvB = qE$. Factoring the charge gives us $vB = E$ or solving for $v$ gives $v = \frac{E}{B}$. Thus by controlling $E$ and $B$ we allow particles of only a specific velocity to pass through.

If the velocity of the particle is too high, then $F_B > F_e$ and the particle curves up hitting the plate at the end of the selector. If the velocity is too low, $F_B < F_e$ and the particle curves down hitting the lower portion of the same plate.
\[ E \neq 0, \ B = 0; \quad qE = F_E = ma \]
\[ a = \frac{F_E}{m} = \frac{qE}{m} \]
\[ L = \nu t; \quad y = \frac{1}{2} \alpha t^2; \quad \text{Solve:} \quad y = \frac{qEL^2}{2mv^2} \]

\[ \nu = \frac{E}{B}; \quad y = \frac{qEL^2}{2mv^2} \]
\[ y = \frac{qEL^2B^2}{2mE^2} = \frac{qL^2B^2}{2mE} \]
Magnetic Deflection of a TV Image

MIT Department of Physics Technical Services Group
The Hall Effect — Charge Flow in Conductors is From Electrons: Benjamin Franklin’s Biggest Blunder!
Hall Voltage for Positive Charge Carriers

\[ F_m = v_d B \sin 90^\circ \]

The current expressed in terms of the drift velocity is:

\[ I = n e A \nu_d \]

\[ F_m = \frac{e I B}{n e A} \]

At equilibrium:

\[ F_m = F_e = \frac{V_{H \varepsilon}}{W} \]

\[ A = Wd \]

\[ F_e = qE = qV/W \]