

The Burning Math of Steel Wool

Do some calculations then burn some steel wool?



Introduction:

Compare the volume and surface area of a block of steel to a wad of steel wool.

Materials:

- Steel wool – 00 and 000 sizes works best (0000 works good too)
- A small cube or rectangular prism of solid steel (often found in “density cube sets” from science supply houses)



Work sheet:

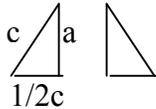
A. Find the average length of one side of your steel wool strand.

1. Steel wool is cut into very long triangular threads or prisms. The table to the right has various widths of the treads. Find your tread type and width.
2. Calculate the average width of your thread.



Average (a) = _____ mm

3. Convert this into centimeters: _____ cm (1cm = 10 mm)
4. Assume the triangular thread is an equilateral triangle. The width calculated above is the altitude of this triangle. Now, calculate the length of the side of triangle.



Length of side **c** = _____ cm
 Hint: cut the triangle in half and use $a^2 + (\frac{1}{2}c)^2 = c^2$

B. Find the volume of the block of steel to which you're comparing your steel wool too.

1. What are the dimensions of your given block of steel in cm.

Length = _____ cm Width = _____ cm Thickness = _____ cm

2. Volume of block = _____ cm³

C. Assume the steel wool was made from the exact same size block of steel (i.e. assume the volume of the block and the strand of steel wool are equal). Consider the strand as a long triangular thread or prism: Volume = $\frac{1}{2} \times \text{base} \times \text{height} \times \text{length}$

1. Calculate the length of the strand:

Volume (from B. 2 above) = $\frac{1}{2} \times \text{base (from A. 4)} \times \text{height (from A. 3)} \times \text{length}$

Length = _____ cm

3. Convert to Km this step is shows how long a strand can be. Remember, there are 100cm in 1 meter and 1000 meters in a Kilometer.

Length = _____ km

D. Find the surface area of a single strand of steel wool compared to given block of solid steel.

1. Total surface area (SA) of the block of solid steel (use L, W and T from B. 1)

Surface area of block = _____ cm²

Steel Wool fiber width, mm

Type	Lower specification limit	Upper specification limit
000#	0.00635	0.00889
00#	0.00889	0.0127
0#	0.0127	0.0381
1#	0.0381	0.0635
2#	0.0635	0.0889
3#	0.0889	0.1143
4#	0.1143	0.1778

2. Surface Area of the strand of steel wool. Don't worry about the ends of this Equilateral triangular thread. So, the formula for the surface area of the sides would be:

$$SA = (\text{Side1} + \text{Side2} + \text{Side3}) \times \text{Length}$$

or

$$SA = 3 \times (\text{Length of side c from A, 4 above}) \times \text{Length (from C. 1 in cm)}$$

$$SA = \underline{\hspace{2cm}} \text{ cm}^2$$

3. Compare the SA of the strand of steel wool vs. the block of solid steel.

$$\underline{\hspace{2cm}} \text{ cm}^2 \text{ of strand} / \underline{\hspace{2cm}} \text{ cm}^2 \text{ of block} = \underline{\hspace{2cm}}$$

(This is the number of times more surface area of the strand vs. the block of steel)

Optional...but you gotta do this!

Materials

- 9 volt Battery
- Goggles for safety
- Steel wool

Burn the Steel Wool!

For instruction on burning the steel wool, go to

http://www.exo.net/~emuller/activities/Fast_Rusting.doc.pdf by Eric Muller.

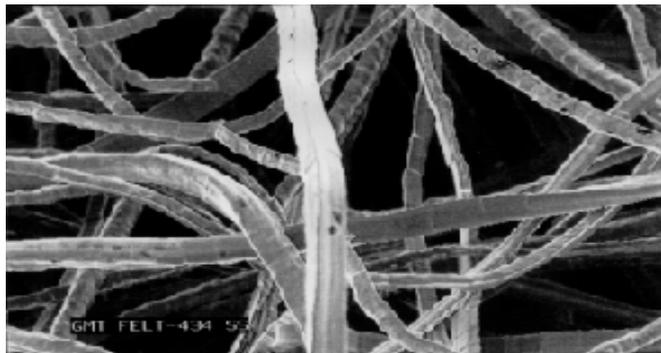
Use all safety precautions.

What's going on?

You might have calculated that steel wool has a huge amount of surface area when compared to the surface area of a solid block of steel. This surface area as well as the triangular shape is useful for a many applications. Steel wool is mostly used as filter material, as well as for cleaning and abrading surfaces.

If you burned the steel wool, you may have notice the amazing reaction that takes place.

The increase in surface area of steel wool allows for substantially more contact of the Iron, the main component of steel wool, with Oxygen in the air. The steel wool oxidizes or rusts in an incredibly short period of time.



100x Micrograph of 40 μ m Stainless Steel Fibers

Table and image of steel wool wad from: http://en.wikipedia.org/wiki/Steel_wool

Micrograph courtesy of David A. Colbert of GMT, Inc.