

# BREAKING THROUGH EDITORIAL



## Is Friction a Source of Energy?

Peter Graneau

Is friction a source of energy? Of course not, but. . . Friction generates heat. Heat is a source of energy. It is kinetic energy stored in the motion and vibration of atoms and molecules. To extract heat from matter, we must reduce the motion and vibration of atoms and molecules in matter. The generation of frictional heat requires relative motion between matter. Yet heat does not oppose the relative motion between bodies. Frictional heat increases the temperature of the rubbing surfaces or particles.

If friction is not a source of energy, at least it must transfer mechanical energy from the rubbing surfaces to the particles which make up these surfaces. What is the nature of the energy stored in rubbing matter and transferred from one body to another by friction? To make sense of this confusing subject it is time to consider a practical example.

During the past two years, T.V. Prevenslik published a paper, titled "Bubbles and Steam Electricity," in the *ESD Journal*.<sup>1</sup> We would like to see this paper reprinted in *Infinite Energy* because it deals with very interesting experiments in which friction produces electrically charged steam and air. This strange phenomenon teaches something about energy transfer by friction. So far we have been unable to obtain permission to reprint the Prevenslik paper.

Prevenslik tells the story of the Seghill incident. Seghill is a location near Newcastle on Tyne in England. At this location in 1840 a man working on a steam boiler received a severe electric shock when a jet of leaking steam struck his hand, while his other hand rested on a valve of the boiler. It was deemed to be so amazing an event that it caused Lord William Armstrong—a well-known British industrialist of the nineteenth century and the founder of the University of Newcastle—to write a letter<sup>2</sup> about the Seghill incident to Michael Faraday, then Director of the Royal Institution Laboratory in London.

Faraday promptly initiated some experiments in London and found that the steam was charged positively. At the time Faraday thought the steam electrification was related to the impurities of the water from which the steam was produced. Changing the source of the water, he found, resulted in some difference in steam electrification. With his keen sense of observation, however, he discovered also that only wet steam would be charged. Dry steam produced no electrification. Wet steam he defined as a mixture of water molecules

and very small water droplets.

This discovery changed Faraday's mind. He no longer believed that small differences in the composition of the original water determined the steam electrification, but that the important event was friction between traveling water droplets and the metal of the nozzle. The function of the steam was to drive the water droplets through the nozzle and thereby cause friction.

If this explanation was correct, Faraday reasoned that driving the water droplets with compressed air should equally well give rise to the same effect and generate electric charges in the air escaping from the nozzle. Experiments with wet and dry compressed air confirmed his supposition. Hence the charging process required friction between liquid water droplets and metal. In the Faraday-Armstrong correspondence,<sup>2</sup> Faraday did not discuss the important question of how metal friction against liquid water produced electric charge which is absent in friction between gaseous water (steam) and metal.

The chemical difference between liquid water and dry steam are the hydrogen bonds between liquid water molecules. They were not known to Faraday in the 1840s. Hydrogen bonds made their entrance in the chemistry literature in 1923 when they were first proposed by Gilbert Lewis. The hydrogen bonds are very weak and easily ruptured by contact friction. In the nineteenth century Faraday went as far as to suggest that steam electrification is the result of contact electrification. He failed to mention that stationary contact of water droplets with metal will not produce electrical charges.

It has been pointed out that the energy stored in the hydrogen bonds is due to the repulsion between neighboring nuclei of hydrogen and oxygen atoms. This repulsion is brought into existence by the bonding attraction due to electrons.<sup>3</sup> Bond rupture implies the removal of the bonding electrons. It liberates the potential energy stored between the repelling nuclei. As a result of the rupture of many hydrogen bonds between water molecules of a droplet, smaller positively charged droplets are formed which, because of the positive charges, explode away from each other. In steam electrification, the smaller water droplets remain entrained in the steam and make it appear to be charged positively.

There is no discussion in the published literature of what happens to the two bonding electrons set free by hydrogen bond rupture. These electrons may attach themselves to other atoms and form negatively charged ions. Depending on how charge detection electrodes are set up, it would seem possible that negatively charged steam is also present.

If it were not for friction, flywheels would spin forever. Friction is the spoiler of perpetual motion. It also has advantages. Without under-foot friction, we would not be able to walk. Wheels grip the road and rails by friction to make overland travel possible. On the other hand, transport through air and over water is hindered by air and water friction with metal surfaces.

The most spectacular effect of friction on a water surface is not the Seghill incident, but the self-intensification of storms over the ocean and particularly of hurricanes.<sup>4</sup> In this case the important mechanism is not the friction drag opposing the storm, but the opposite effect of storm acceleration caused by the liberation of hydrogen bond energy. Friction drag is necessary to set up the tensile stress in the water which breaks hydrogen bonds and thereby forms fog droplets. Subsequently, liberated bond energy explodes the cloud of fog droplets. This adds kinetic energy to the storm and explains hurricane self-intensification.

It seems out of the question that hurricane energy intensification could be exploited for electricity generation. The related mechanism of water friction over turbine blades shows, however, considerable promise of furnishing hydrogen bond energy to turbo-generators of electric power.<sup>5</sup> The advantage of this proposal is that many hydroelectric plants are already installed and running. What is now required is the development of upgraded water turbines which add liberated bond energy to the gravitational drive energy of the water. Successfully upgraded turbines, making use of the bond energy, could then be installed to replace the existing, purely gravity driven water turbines. It has been argued that the upgrading process could as much as double the hydroelectric power output without increasing the flow of water. If true, this projection would be a major step forward in harnessing chemical energy without polluting the atmosphere with carbon dioxide.

Water droplet charging by friction also takes place in thunder clouds. A feature of thunder clouds is strong vertical up and down drafts. Air rushing through the cloud of fog droplets causes friction at the droplet surfaces, resulting in the tensile rupture of hydrogen bonds. Each bond rupture implies the escape of a pair of bonding electrons. This leaves many water droplets positively charged. Escaping electrons may attach themselves to other water droplets. Positive and negative charges in the thunder cloud then give rise to the lightning phenomenon.

Frictional electric charging of water droplets is seen to be a common occurrence in nature. It underlies the Seghill incident with wet steam jets and, as Faraday has shown, a similar experimental effect produced by wet air. The electrification of thunder clouds is a further instance of frictional charge production. On the other hand, it must be pointed out that the breaking of hydrogen bonds with heat, as in the boiling of water, does not charge water vapor molecules nor the body of the liquid which is being heated. The heat rupture of hydrogen bonds is not caused by tension between water molecules, but by the vibration and twisting and turn-

ing of neighboring water molecules. This explains why boiling of water does not charge the resulting steam nor the boiling liquid.

It is not understood why the relative motions between vibrating and twisting adjacent water molecules do not give rise to tensile stress in liquid water. In the heat rupture process, it seems the two bonding electrons split, each remaining in contact with its own water molecule. In this way no charges are set free by the bond breaking operation. The amount of chemical energy stored by the hydrogen bond is, of course, the same regardless of how the bond is subsequently ruptured. Therefore, the chemical bond energy liberated by shearing water droplets off the ocean surface requires far less mechanical work, to be supplied by the ocean water, than what would otherwise be expended by thermal evaporation of the same number of hydrogen bonds. This is the proposed mechanism of the self-intensification of hurricanes which cannot be explained with the thermal evaporation of sea water.

A way of experimentally confirming the proposed existence of sheared-off water droplets would be the detection of their electrical charge at the interface of the horizontal hurricane storm sliding over the ocean surface. It would be a very difficult, but not necessarily an impossible, experiment in which charge probe detectors have to be floated in the sea surface underneath the hurricane cloud.

Dry friction between two metal plates does not tap a significant amount of previously stored chemical energy. The heat produced by dry friction is mainly due to vibrations of metal atoms in the rubbing surfaces. This process does not allow for the liberation of more heat energy than provided by the mechanical work done by the friction driver. However, a small fraction of the applied mechanical work could possibly be used for breaking chemical bonds between metallic atoms. Anyhow, wearing down metal surfaces for generating energy does not appear to be an attractive proposition.

A useful source of energy must be stored energy. Trigger energy has to be expended to liberate stored energy. The trigger energy should be small compared with the released energy. An example is the rolling of a rock over the edge of a cliff. The liberated gravitational energy in the fall of the rock will be found to be much greater than the effort required to tip the rock over the edge.

In the upgraded hydroelectric turbine the trigger energy is the mechanical work that has to be done in overcoming the frictional drag of the water. Because of the weakness of the hydrogen bonds, the viscous drag of water is almost negligible. Water is a lubricant. All the indications are that the upgraded hydroelectric turbine will be a very efficient source of electrical energy.

## References

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