BREAKING THROUGH EDITORIAL

Hydrogen Bonds at the Bottom of a Waterfall

Peter Graneau

Readers of *Infinite Energy* must be baffled by the silence of the press, other news media and the U.S. Department of Energy, with regard to the proposal that large amounts of useful energy (electricity) can be gained from common water at ambient temperature. One could argue that our magazine does not come to the attention of the right people, or its contents are deliberately ignored. I am afraid the root cause of this wall of silence lies deeper in a general misunderstanding of the rudiments of water science. Chemists are conversant with hydrogen bond energy in water. Unfortunately, they do not yet know that these bonds can be ruptured with mechanical tension and that the liberated bond energy can be captured in a variety of ways. It has not occurred to them that hurricanes are driven by the tensile release of hydrogen bond energy. With this in mind, let us look at what happens to hydrogen bonds at the bottom of a waterfall.

The latent heat of evaporation and condensation deals with the energy transferred in the reversible liquid/vapor phase transitions and so does the energy stored in the intermolecular bonds between liquid water molecules. We should therefore expect the hydrogen bond energy and the latent heat to be related to each other. There is no mention of this interdependence in the chemistry literature. Nor are we told what the destination of the latent heat of evaporation is. It is not made clear how much chemical energy is set free when the hydrogen bond is ruptured and what carries this liberated energy away.

The answers to such questions should have been discovered in the early 1920s after the famous American chemist Gilbert Lewis first outlined the nature of the chemical hydrogen bond between H_2O molecules. He failed to discuss the bond energy exchanges and nobody else has come forward since then with the missing answers.

A recent discovery has further added to the confusion in water science. Experiments with electric water arcs revealed that the hydrogen bond can be ruptured with mechanical tension between water molecules. Compared to the thermal (boiling) bond rupture, the tensile fracture consumes a much smaller amount of energy (work). This suggests the "latent heat of evaporation" is not a constant but a function of the method of breaking clusters of water molecules apart from the liquid. Therefore if tension can be applied to liquid water, it results in a much more efficient way of liberating the stored bond energy. We are very familiar with thermochemistry and electrochemistry, but mechanical chemistry is new to most of us. In the water arc it is the electric current which sets up mechanical tension in the arc column of water. This tension divides liquid water into fog droplets and the liberated energy accelerates the fog droplets to cause an explosion.

So the fascinating question arises: what is happening to hydrogen bonds at the bottom of a waterfall? With power-driven stirrers, the water temperature does increase markedly, up to the boiling temperature of water. An extreme example of such a stirrer is the Griggs hydrosonic pump.[1] In this device the stirring takes place in a high-speed rotating machine. Hydrogen bond rupture then creates hot droplets of water which are pumped through an external heat exchanger. Part of the energy liberated in this manner is then used for space heating. The remainder is reabsorbed in new hydrogen bonds of the pumped liquid.

In the case of electric water arcs, very small (1 – 100 µm) droplets of the liquid are ejected at high speed from the arc column. This is to say that tensile bond ruptures, first of all, convert hydrogen bond energy to kinetic water energy. Eventually the droplets are slowed down by air and their kinetic energy is, by randomized collisions, converted to heat. If the heat is not utilized, it will be reabsorbed by the amalgamation of droplets and the associated re-establishment of previous hydrogen bonds. The fog jet from the arc column can be directed at turbine blades of a hydroelectric generator and thereby convert kinetic energy of water to electricity. We have demonstrated this mechanism[2,3] and so proved that the amalgamation of fog droplets to liquid water can be forestalled with the hydroelectric generator.

Electric arc accelerators are able to drive fog jets to velocities as high as 1,000 m/s, which should make for high turbine efficiency. Unfortunately, the continuous power that can be extracted from a single arc cavity and energy storage capacitors, running at 50 pulses per second, is only of the order of kilowatts. To rival thermal power stations, a gigawatt plant would therefore require hundreds of thousands of arc cavities with associated capacitors and charging units. The complexity of such a plant looks formidable. To make hydrogen bond energy a commercial alternative to the combustion of fossil fuels and the operation of nuclear power plants requires a more practical process of liberating the internal water energy.

Compared to a power driven water stirrer, the impact of a waterfall on a hard rock or metal surface looks like a more simple process of continuous and massive rupture of hydrogen bonds. The extensive water literature appears to furnish no insight into what happens to hydrogen bonds at the bottom of a waterfall. Because of their mechanical weakness, it may be surmised that many—if not all—intermolecular bonds fail to survive as water crashes on a hard surface. On impact of the falling water on the hard surface, the liquid stream is turned through 90 degrees and continues to flow radially outward. This is consistent with inelastic impact. What is it that governs the radial water velocity?

Pressure in the fluid has to be involved. Energy conservation could ensure that the pressure energy in the impact zone is equal to the loss of kinetic energy due to the arrest of the vertical motion. For constant mass flow, ignoring energy losses due to turbulence, the initial horizontal water velocity should then be equal to the final vertical velocity. This process does not seem to generate tensile stress in the liquid and, contrary to the initial conjecture, no hydrogen bond ruptures may occur. In other words, the pressurization of a volume of water does not require tensile ruptures of hydrogen bonds.

The absence of any visible turbulence at the bottom of a waterfall may seem to be surprising. The existence of large water driving forces in the flow direction is unlikely to permit the small flow deviations implied by turbulence.

The radial flow relative to the stationary ground surface will, however, give rise to drag forces. The drag is very likely to break hydrogen bonds in tension and to accelerate water droplets in the radial direction. Boundary layer drag is the mechanism which self-intensifies hurricanes at the ocean surface.[4]

At this stage it pays to run some water into the kitchen sink and observe how the fluid spreads out over the sink bottom. One gains the impression that the water speeds away, and possibly accelerates, in a thin layer adhering to the sink bottom. The impact is certainly inelastic, as it should be. Then suddenly, at a certain radius, the thickness of the flow layer increases stepwise by a pronounced amount. The increased layer thickness implies a reduction in the horizontal water velocity. Something similar is likely to happen at a full scale waterfall in the mountains, except that the impact plateau is rarely large enough to show the step increase of the thickness of the radial flow layer.

Some definitive measurements of the water impact phenomenon, on the scale of the kitchen sink experiment, would certainly be helpful to research on turbine extraction of hydrogen bond energy. Water flow measurements with a high-speed video camera represent a promising experimental approach. It is not going to be easy to perform such measurements because of the transparency, and surface light reflection, of water. But the prospect of utilizing hydrogen bond energy for electricity generation makes such small-scale experimentation worthwhile.

On the basis of present-day knowledge, therefore, it cannot be claimed that the waterfall impact liberates substantial quantities of hydrogen bond energy. However, as a consequence of the impact, the lateral acceleration of a thin layer of water on the horizontal impact surface could become a significant discovery. To gather the kinetic energy of the expanding horizontal water layer, it would have to be blown into a spiral blade structure of a surrounding coaxial turbine. This has in fact been tried, but for a different reason. As such a turbine does not appear to exist, it has been given the name "spider turbine." Its first description of a small model, with photograph, will be found in *IE* #73.[3]

The spider turbine was invented for operation with a high-speed fog jet from water arc explosions. To prevent the fog jet from damaging the blades by impact, the fog had to be subdivided and distributed over a large number of blades. This aspect of the spider turbine was completely successful. Single fog jet pulses would accelerate the 6 cm diameter machine from stand-still to well over 2,000 rpm. Unfortunately, the fog jet from the water arc explosion is inevitably followed by an amount of slow water. As this slow water entered the turbine, it strongly decelerated the machine. No method of diverting the slow water around the turbine was found.

The kitchen sink experiment has not been the only experiment suggesting that hydrogen bond energy is liberated when water impinges on a metal plate and spreads out laterally. Prior to the construction of the first spider turbine in 1998, a vertical fog jet was directed to collide with a horizontal metal plate.[5] It was feared that the collision would cause much water turbulence and dispersion, subtracting kinetic energy from the fog jet. Unexpectedly, the inelastic collision resulted in a thin fog disc sliding radially away from the impact area without losing speed. In fact, the fog seemed to gain speed. The circular boundary of an approximately 2 mm thick fog disc advanced at an average speed of 900 m/s across the metal plate. The vertical jet velocity at impact was less than 500 m/s. It is only an isolated experiment which suggested a kinetic energy gain by a factor of three. The measurements were made with a high speed camera operating up to 30,000 frames per second. They call for confirmation in a second laboratory.

As far as the hydrogen bonds at the bottom of the waterfall are concerned, they must be subject to strong compressive forces which appear to leave the bonds intact. But the lateral pressure accelerates water radially outward to such an extent that tensile drag forces, exerted by the metal impact plate on the water, apparently rupture many intermolecular bonds. If the water driven outwards from the waterfall is allowed to shoot into the blade structure of a surrounding spider turbine, all of the kinetic energy due to gravitational forces and hydrogen bond ruptures can be tapped by a turbine which drives a rotating hydroelectric generator. This has been a totally unexpected discovery with great potential for renewable clean energy, as a by-product of hydroelectric energy generation.

In the early stages of investigating the liberation of hydrogen bond energy from water, research expenditures were kept low by concentrating on bond theory and tests with small-scale experimentation. The first spider turbine was only 6 cm diameter. It is quite fortunate that turbine experiments scale with linear dimensions. Waterfall experiments can also be kept small, as indicated by the kitchen sink experiment. The laboratory fall need only be 1 meter high. What has to be confirmed as securely and broadly as possible is the step-up in water velocity on the horizontal metal impact surface. This would virtually prove the liberation of hydrogen bond energy, as no other energy source has been found to be available for the acceleration.

In a full-scale hydroelectric project it is not necessary to let the water fall through air. Pipes and penstocks will achieve the same effect. For the same reason, in laboratory experimentation, the water may fall from a tank on the roof through a pipe on the small turbine in the laboratory. Incidentally, pipe friction should also break hydrogen bonds and make a small positive contribution to the energy output of the turbo-generator.

Today, in 2010, the most promising technology of a new, clean energy source is that of liberating hydrogen bond energy from ordinary water at ambient temperature. It requires a new form of water turbine which will break inter-molecular water bonds in addition to performing the normal duty of the Francis turbine of converting the kinetic energy, derived from stored gravitational energy, to electricity. Such an upgraded turbo-generator set would rely on the existing dam and water reservoir. It furnishes useable electricity directly to the national electricity transmission and distribution system at greatly reduced capital cost compared with all other existing energy sources.

It is not known precisely how much bond energy is stored in ambient temperature water but the chemistry literature suggests it is of the same order of magnitude as the latent heat of evaporation.[6] In their popular textbook, Flowers and Mendoza devote a section to the topic of "Binding Energy and Latent Heat" and conclude: ". . .if no better data is available or if only rough estimates are needed, we can say that the binding energy is not very different from the latent heat of evaporation."

A more precise prediction of the stored hydrogen bond energy in water is given by the meteorologist P.M. Tag,[7] who notes that the difference between the specific heat of liquid water and the specific heat of water vapor is a quantity of energy which is "entirely absorbed by the liquid water in order to ensure equilibrium in the post-condensation system. In the case of evaporation, this same energy difference would be liberated." This quantity is fairly constant between the freezing and boiling point of water and at 20°C this energy is 588 J/g.

The stored bond energy difference is much more than the gravitational energy per gram of water contained in the average existing hydroelectric reservoir. The world's tallest waterfall is 1,000 m high. Its stored gravitational energy above sea level is 10 J/g. Therefore, in order to double the power output of an existing turbo-generator, we may not have to extract more than 2% of the stored hydrogen bond energy of the water passing through the turbine. Engineers and scientists should be encouraged to pursue this potential boost to the efficiency of hydroelectric power generation.

In the current issue of *Infinite Energy*, Farzan Amini informs us of what is believed to be the first explosion of a hydroelectric water turbine. We are recording this historic event in which an Iranian author, relying on Russian papers, speaks to an American audience. Prime Minister Putin visited the scene of the disaster which claimed 72 lives. He returned six months later when the first of ten turbo-generators was restored to the Russian power grid.

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