Electron Affinity and The Dry Pile

Horace Heffner October 2, 2007 Draft #6

BACKGROUND

Jones Beene theorized that electron affinity might be used to spontaneously transport electrons between electrodes of the right kind in a gas modality.[1]

> "take two electrodes and a working medium, and hydrogen is the only working medium that fits into this concept very well (73 kj/mol)...
>
> - such that one electrode has a much lower electron affinity than does the H2 (zinc works well ~0) and the other has a much higher (gold plated copper works here ~223). You need a source of energy to convert - like focused sunlight onto the back side of the zinc. The other electrode is finned and air-cooled. The zinc emitter can be a Zn plated bimetal, so that there is already a small thermoelectric effect."

This concept was explored by Jones Beene and this author on the vortex-l news list through discussion of variations of the concept, methods to practically develop the concept, possible relationship of the concept to dry pile operation, and the possible tapping of zero point energy.

OBJECTIVE

It is the objective here to document and further explore electron affinity[2] based charge transport as well as dry pile and other related concepts.

DEFINITION OF SOME TERMS

Here "donor electrode", "electron donor", or simply "**donor**" refers to a donor electrode and especially the donor electrode surface which can spontaneously transfer electrons to transporter molecules upon contact.

Here "acceptor surface", "acceptor electrode", or simply "**acceptor**" refers to the acceptor electrode and especially the acceptor electrode surface which can, upon contact, spontaneously accept an electron from a transporter molecule having negative charge, leaving it neutral.

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"**Transport**" means the process which achieves movement of electrons from a donor to an acceptor.

The term "electron transport molecule", "transporter molecule", "electron transporter" or just "**transporter**" means a molecule of intermediate electron affinity capable of, upon contact, in gas form, obtaining an electron from the donor surface, and, upon subsequent contact, donating the excess electron to the acceptor surface, thus leaving the transporter neutral. The term transporter can also be extended to mean multiple molecule types which, in a sequence of steps, achieve the same final outcome of transporting an electron from the donor to the acceptor across the gap between them.

The term "**gap**" here means the space containing a volume of gas between a donor and acceptor and through which transport occurs.

The term "**cell**" here means a donor, gap, acceptor in sequence, or multiple occurrences of donor, gap, acceptor in sequence and electrically connected in series in some fashion, as well as any containment envelope and connecting conductors.

DISCUSSION OF INITIAL POTENTIAL HURDLES

One problem may be the tendency for many of the possible electron donor candidates to form hydrides, and thus decay and slough off in powdered form and/or reduce the surface area available for donating, as well as the electron affinity due to large numbers of hydrogen atoms already adjacent to each potential donor. Phosphorous at above 277 deg. C may be a good transporter candidate - but that would take a solar concentrator to drive it, which might still be OK. There again, a problem might be the tendency of the donor metals to form phosphides and thus reduce their effectiveness. An alloy would have to be used for a donor metal and it might take a lot of research to find just the right one. The transporter can be a compound molecule, and that is probably the best choice. The best candidate molecule would probably be a dipole, so steam, which can also exist at normal temperatures if at less than atmospheric pressure, is probably right up there in the top candidates. In fact, steam is well known for its static electric effects around differing metals.[3] Stainless steel might make a good donor metal for a steam based electron transporter.

The gap between donor and acceptor surfaces should be made as small as possible, possibly by using a fine dielectric powder as a separator, or by using computer chip type construction techniques. The smaller the gap the higher the current level that will be supported, all else being constant.

Based solely on electron affinity, ignoring other problems, gold looks ideal as an acceptor.

A choice of donor, transporter, and acceptor should also be consistent with the electronegativity chart.[4] In any event, electronegativity considerations may be important if battery charging is involved.

A significant problem is that an electron transport cell of this kind is heat driven. The transport molecule must be driven kinetically from the donor surface to the acceptor surface against an electric field. The peak voltage the cell can produce, as well as its current to voltage ratio, is determined by operating temperature of that gap, and the field across it. The peak power is limited by the percentage of transport particles having energies in the Boltzmann tail sufficient to transport an electron across the potential difference between the donor and acceptor.

There is a need to place numerous cells in series, because the operating voltage of the gap is limited by the thermal energies of the molecules, e.g. about 26 millivolts at 300 K. The series achievement would likely have to engineered at a micro level, because it would take about 1000 cells in series to generate 26 volts or so. The main difficulty with achieving series operation is the fact it is necessary to transition current from the receiver metal back to the donor metal at each stage, i.e. to make electrical connections between cells, so therefore, depending on choice of donor and acceptor materials, it can be necessary to climb right back up the energy hill again at the metal to metal interfaces, losing what was gained. What remains in that case is some of the thermal energy that kicked the electrons across the barrier in the first place, against the operating potential of the cell, and which thus highly limits the cell voltage and current. If some kind of energy extraction scheme can be employed in the process of getting the electrons to transition from the acceptor metal back to the donor metal through the return circuit, then a lot more energy can be had. This trick can be carried out using metals providing a gain at their interfaces due to differences in work function.

The molecules that transport electrons successfully from donor to acceptor reduce the thermal energy of both electrodes. They leave the donor as fast particles, thus taking heat from the donor, and arrive at the acceptor cold. This, by convection and conduction, ultimately drives the temperature of the whole system down. The heat energy has to be replaced by solar or other sources.

One possibility is to use energy derived from, say, battery charging, to maintain a small potential bias across the gap between the donor and acceptor electrodes. This then avoids the limits on charge transport placed by the requirement to kinetically transport electrons across the potential of the gap. In this way the energy derived from the system is due to whatever energy can be derived from the difference between the two electron affinities plus whatever can be gained from the work function differences. In other words, any energy coming out of this kind of biased gap system is then tied to what use can be made of the resulting flow of electrons into the acceptor metal, because no potential exists across the gap from which to extract energy due to the current across the gap.

NEGATIVE ELECTRON AFFINITY

It is possible to use a negative electron affinity electron (NEA) donor, such as aluminum nitride, and various doped semiconductors, like diamond or sapphire. A material of possible interest is cesium doped diamond, which has an electron affinity of about -0.7 eV.[5] Of special interest is the electron photo yield of hydrogen terminated diamond films, which suggests the possibility of a dry pile type cell which is directly light fueled.[6] A wide variety of NEA materials are very effective photo emitters. Combined with very narrow gaps, this suggests the possibility of very efficient light to energy conversion through use of NEA materials.

PULSED OPERATION

Numerous cells linked capacitively in series would make a good pulse amplifier. A negative pulse hitting the first cell eliminates the thermal bias required for electrons to be transported cross the cell by the transporter molecules, and the net electron affinity of the transaction adds to the negative voltage applied to the cell acceptor electrode, which then transmits it through a capacitive link to the next cell, thereby avoiding the metal to metal junction bias otherwise required to link the cells conductively. Following the pulse with a brief recovery time gives the cell donor electrode time to reload some molecules with electrons. The capacitive interface between acceptor at one level and donor at the next avoids the need for work function considerations at the interface. The pulse method also works even if capacitive linkage is not used, especially if gain from work function differences is also present.

The donor electrode might be a slightly conductive plastic, or other triboelectric donor material, which would thus also directly provide the capacitive linkage. The trickle current though it would have to be enough to recover for the next pulse. The electron donor - transporter combination is still important if triboelectric effects are used to achieve the donation because that is in fact an electron affinity effect.

Getting the electron affinity benefit, which may in fact be a zero point energy (ZPE) benefit, may require avoiding the metal-metal type conversion in the return circuit. This can be done using pulsed mode and capacitive linkage between cells.

SOME TRANSPORT CANDIDATES

In addition to hydrogen, and water vapor, candidate electron transporter molecules might include "accumulator oils", oils known to be capable of accumulating negative charge: gasoline, kerosene, jet fuel, turpentine, as well as heating, diesel and lubricating oils. [7]

CO2 might be a candidate transporter molecule, and a CO2-steam mix might be effective, with one being more effective acceptor, the other a more effective donor, with gas born electron exchanges involved in addition. The ideal transport mechanism might be a hybrid, with one transporter (e.g. gasoline or CO2) accumulating charge from a donor (e.g. plastic) by a triboelectric effect, and then transferring some of that charge in gas form to a transporter (e.g. water) better able to carry the charge to the acceptor (e.g. gold). This would give the oil multiple roles as acceptor, transporter, and donor, but all transporters have to play all three roles anyway.

Above 640 K mercury , having negligible electron affinity, makes a good charge transporter if used with a negative electron affinity donor. This suggests the use of a mercury transporter in a cell at the focal point of a solar concentrator.

THE DRY PILE

Use of a low electron affinity donor electrode (e.g. zinc, nil affinity) located opposite a high electron affinity electrode (e.g. silver, affinity 128) using a thin charge transport bearing separator medium (e.g. paper) which is sensitive to humidity (i.e. the charge transporter water vapor) is a terrific alternative (and new?) explanation of the dry pile.[8]

It is plausible that the dry pile is driven by thermal energy, not electrolytic energy, and that the plates are not substantially consumed in the process.

One dry pile, the Clarendon Dry Pile has been in operation more than 160 years.[9]

Let us see if an analysis can tell us anything of interest about it.

A 2 mm diameter sphere is driven between battery poles at a rate of 2 Hz. The voltage is not given, but for dry piles it is typically "thousands" so assume it is 2000 V.

The potential of a sphere or radius r with charge Q is:

V = Q/(4 Pi e0 r)

so the capacitance C is

C = Q/V = 4 Pi e0 r

and for the 2 mm ball (assuming it is on an insulating rod) is

C = Q/V = 4 Pi e0 (2 mm) = 1.265x10^-13 F

The current i it carries is:

i = Q (2 /sec) = 4x10^-10 A

and its power P is:

P = i v = 8.9x10^-8 W

which is totally credible as coming from ambient heat. The Clarendon cell could be a genuine Type II perpetual motion machine.

The total energy E produced by the machine in t=160 years is

E = P t = (8.9x10^-8 W) (160 y) = 449 J

Unfortunately this is too little to determine perpetual motion without disassembling the machine or possibly doing nondestructive testing to examine chemical changes.

Now, is it a practical source of power? It power surface area density rho_area is:

rho_area = P/A = (8.9x10^-8 W)/(Pi (1cm)^2)) = 8.9x10^-4 W/m^2

That's about .89 mW for a pile 1 meter square, about 1/3 meter high. Not very practical. That's a power density rho of

rho = rho_area/(.33 m) = 2.7 mW/m^3

However, if the cell were operated in pulsed mode, with capacitance separated acceptor and donor plates, an in a hot environment, using engineered components, engineered based on the stated principles that is, the energy output should be greater by orders of magnitude.

An ideal solar device would accept about 1000 W/m^2, while a thick pile produces about a mW/m^2, so the performance would have to be boosted 6 orders of magnitude to get a perfect solar cell, and at that it would be about 33 cm thick. Finding a very good triboelectric charge exchange mechanism at the donor end of the cell is key.

Even if the solar angle were out, the type II perpetual motion thing is definitely a worthwhile possibility to pursue. An efficiency boost of 5 orders of magnitude seems realistic. That would provide a power density of 270 W/m^3. A house could be comfortably run on a 10 m^3 device, or 2.7 kW continuous, assuming batteries are used and especially if other solar measures are used too. That's a box buried in the back yard which is about 1 meter square and 10 meters long. Spare solar hot water or solar or wind power driving a heat exchanger could be used to help keep it hot. Or..., if you really want to drive patent examiners crazy, and live in the south, just run it off of ambient heat.

THE PULSED PILE CONCEPT

Figure 1 illustrates the pulsed pile concept. When a negative pulse is applied to the negative end of the pile at V1, it permits electron charge transporters in the first gap to transition to the acceptor across the first gap. The difference in electron affinities amplifies the pulse, which is carried forward to the next donor electrode through the dielectric separator. This pulse amplification continues through the cell until the current at V2 is driven at a high voltage dependent primarily on the difference between electron affinities of the donor and acceptor electrodes, but multiplied by the number of transport gaps.

The donor and acceptor electrode can be separated by use of a dielectric nano-powder.

The dielectric material "==" used for the capacitive linkage needs to have a leakage current sufficient to reset the potential values between pulse cycles.

Another variation is to drive a pulsed pile by AC, with a transformer primary in the circuit. This would result in imbalanced current and voltages on alternate half-cycles. Twin primary coils on the transformer can each be driven in alternate half-cycles by a pair of pulsed piles operated in power generating mode on alternate half-cycles in order to give a balanced magnetic load on the transformer.

Note that the leakage current on the reset half-phase restores heat to the cell.

THE CASIMIR FORCE AND ZPE TAPPING

When a ZPE tapping electron transport molecule takes on an extra electron it creates a large orbital, i.e. it expands the size of the molecule. This creates an increased Casimir force between the transporter molecule and the donor surface. The low electron affinity plus thermal action allows the donor surface to overcome the Casimir force of the expanded transport molecule. This reduces the heat of the donor surface. However, free energy in the form of ZPE fueled orbital expansion also helps the transport molecule break the increased Casimir force bond.[10]

Thermal energy, i.e. momentum, is lost by the transporter as it covers the potential difference between the two plates.

When the charged electron transport molecule arrives at the acceptor surface, it is more strongly attracted to that surface than it was to the donor surface, due to the higher electron affinity of the acceptor surface. However, due to its large size, the charged transporter is also attracted by a large Casimir force to the acceptor. The result is that the transporter increases both the thermal energy and electrical energy of the acceptor electrode upon impact. After the discharge of the transported electron, the size of the remaining transporter molecule is reduced. Its Casimir force with the acceptor surface is reduced. It loses some energy to the Casimir force upon departing the acceptor surface, but not as much as it gained when it arrived. The Casimir forces at the donor and acceptor sites exactly balance. The net zero point effect is the ability to tap free energy from the vacuum in the form of atomic expansion energy at the donor site, plus the energy gained from the difference in electron affinities.

Summarizing: The transporter arrives small at the donor and leaves fat, but the incremental Casimir force due to being fatter is overcome by donor heat plus zero point field supplied atomic expansion energy. The transporter arrives fat at the acceptor but leaves small, thus gaining back the Casimir force energy lost at the donor site. The transporter gains the differential electron affinity energy due to the acceptor attracting the charged transporter upon arrival more than the donor did upon departure. The transporter keeps the atomic expansion energy acquired at the donor surface, less the cost of transporting a charge across the gap.

The net effect is the temperature and electrical potential of the system reaches an equilibrium point where the potential across the gap is exactly sufficient to tap any thermal energy coming into the system plus the zero point energy supplied to the system by atomic expansion and the energy due to the electron affinity differential, plus or minus any energy due to the contact potential between successive electrodes.

TRIBOELECTRIC MATERIALS

In addition to electron affinity, it may be of use to consider the triboelectric effect. For example, it is surprising that lead is a powerful triboelectric electron donor, supposedly as powerful as "cat fur".[11]

Positive charging, in strongest first order are: glass, quartz, nylon, lead, aluminum. Steel is neutral, taking on no charge. Negative charging, in strongest first order: ebonite, silicone rubber, teflon, silicon, platinum, gold, brass, silver, sulfur, nickel, copper.

This seems somewhat consistent with the electron affinity, because lead is 35 and Al is 42, but the *extreme* triboelectric donating ability of lead is surprising, and thus highly suspect.

It may be possible to add materials to ebonite or silicone rubber to make them sufficiently conducting to work, but neither would be good for high temperatures, nor would lead.

Though not a metal, silicon is listed as better than gold or platinum as an electron acceptor. Silicon is way up the triboelectric scale from gold, platinum and silver. A p-type doped silicon may be a terrific acceptor candidate. This would rule out water, ammonia, hydrogen, and many other things as transporters though. Something fairly inert would have to be used as a transporter, possibly silane. This would limit cell operating temperature to 420 deg. C. This might cause problems on the donor end. No donor, no current.

It would be very interesting to measure the conductivity of lead-silane-gold transport and zinc-silane-silver transport systems.

It appears a couple critical experimental thrusts are in order. One is measuring conductivity across single thin gaps for a wide range of donor-transporter-acceptor materials. It is important such conductivity does not involve some kind of cascade ionization plasma formation but maybe that too needs some thinking.

A second tier, given the identified good conductivity donor-transporter-acceptor triplets, is to look at their power generation capabilities, especially in stacked pulsed mode operation.

SOME TRANSPORT MEDIA COMBINATIONS

Hydrogen mixed with water vapor may be a powerful transport medium. This mix would also form hydrogen peroxide, H_3O^+ and OH^- in gas mode, by disassociation, a famous type II mechanism. The differing electron affinities for gold and and lead could even help spawn excess hydronium and hydroxyl ions, i.e. drive the

$$2\ H_2O \longrightarrow H_3O^+ + OH^-$$

reaction rate, catalyze it. A pulse across such a gaseous medium is going to drive OH^- to the acceptor and H_3O^+ to the donor very fast and thus possibly generate type II free energy from the follow-on dissociation, plus ZPE free energy due to *both* molecules arriving at the electrodes fat and departing thin, plus the pulse amplification due to electron affinity. Quickly there is hydrogen peroxide and OH in this gaseous mix. Then it is much easier energetically speaking to electronate OH into OH^- when it returns to the donor side. If the gap is about the size of the mean free path, a substantial current can be generated, sustained.

One reason H_2 or OH or any XH or XY dipole molecule should make a good transporter, provided its electron exchanges with the donor and acceptor work, is its size would probably change more than any larger molecules when electronated or de-electronated.

A problem with hydrogen is that any donor materials, especially negative electron affinity materials, BN for example, actually bond to hydrogen. This is not good because it reduces the ability of hydrogen to escape the donor. Further, the bonded hydrogen on the donor surface then presents an electroneutral face to hydrogen in the gas.

The main problems with hydrogen is it is highly reactive and it is very difficult to keep contained. Another is there is no evidence of devices existing in which it works, while it appears there is evidence a zinc-water/paper-silver system in the form of a dry pile does indeed work, even using the huge gap represented by the thickness of a piece of paper.

It would be truly incredible to design a gadget that could run a home for hundreds of years like the dry pile can. That actually seems possible now.

THE METAL-METAL INTERFACE

The numbers to use evaluate potential drops at metal-metal junctions are electron work functions. Table 1 shows selected acceptor candidates. Table 2 shows selected donor candidates.

El.	Wk.F.	Elec.AFF.
Pt	5.65	205
Au	5.1	223
Cu	4.65	119
Ag	4.26	126
Sb	4.55	101

Table 1 - Selected acceptor candidate
work functions and affinities

El.	Wk.F.	Elec.AFF.
Zn	4.33	0
Pb	4.25	35
Ti	4.33	8
Al	4.28	42
Fe	4.5	15
Mo	4.6	72
Mn	4.1	0
Co	5.0	64

Table 2 - Selected donor candidate
work functions and affinities

From Tables 1 and 2 it is immediately clear why silver, with its low work function, plus high conductivity, was useful in the Dry Pile. The objective then is to find a donor with a work function higher than the acceptor. Obvious candidates for donors are Zn, Ti, Fe, Mo, and Co. Various kinds of stainless steel might make feasible donor candidates. Interestingly, the Zn-Ag combination just makes the cut, though the fact zinc is a hole conductor should still make for a boundary problem. Lead is just barely out of the running. It may be possible to find alloys of either Pb or Zn that would make for a viable combination. Ti, Al, and Fe, all adsorb hydrogen and form oxides, so some work is required to find compatible transporters for them.

Zinc is a hole conductor. It acts like a p-type semiconductor at a junction with electron conductors, which then act like n-type conductors. The Zn-acceptor metal-metal interface thus should form a depletion region and thus a barrier potential. See Figure 2. There are plus charges on the n-region side and minus charges on the p-region zinc side of the barrier. Electrons have a fight uphill energy-wise going from the n-type conductor to the p-type zinc.

It is clear that, provided the electron affinity model describes the operation of the dry pile, that it may not be ideally engineered. Depending on materials used, the metal-to-metal interface can lose energy gained in the electron transport. This can be overcome by using a dielectric between the acceptor metal and the upstream donor, and operating in pulsed mode. The leakage current of the dielectric then must be engineered such that the system recovers prior to the next pulse.

One problem is cost of the gold, platinum, or silver used for the electron acceptor. This can be avoided by plating or deposition the acceptor metal on both sides of any metal foil, and then depositing on top of that the donor material on one side of that foil as the donor side of the foil. Energy lost at one metal-metal interface to the foil is then gained in the other. All that is needed then is a means of separating the multilayer foils to make the gaps so they can be stacked into a pile. These gaps can be formed by coating one side of the foil with a porous dielectric separating material or closely spaced powder granules sized to achieve the desired gap width.

GAP SIZE, ZPE, AND PERFORMANCE

The ZPE mechanisms suggested occur between the transport molecule and the donor and acceptor surfaces. These are the only places achieving a sub-nanometer spacing which is important. It is only useful to make the gap itself roughly as small as the transporter mean free path. If water vapor is used as a transporter at room temperature then pressure is on the order of 1/10 atmosphere, and the mean free path is on the order a micron.[12] Even if a one atmosphere H2 plus H2O gas mix is used, the gap need only be about 100 nm, a tenth of a micron. This is not a big deal with today's technology. The dry pile used paper separators to create an approximately 10^-4 m gap. A 100 nm gap is 10^-7 m, which provides a factor of 10^5 improvement. And then there is the idea of using the pile for pulse amplification, which might provide even more improvement, depending on the final choice of materials and operational details.

What performance ultimately boils down to is whether the electron affinity concept can be made to work at all, i.e. actual charge transfers obtained at both donor and acceptor surfaces with some useful frequency, and to some extent whether the concept has any applicability at all to the dry pile operation. It should be possible for an amateur to test this using a DC pulse train through a simple lead-transporter-gold cell, and zinc-transporter-silver cell, using various gasses as electron transporters, including steam, hydrogen, a steam-hydrogen mix, gasoline vapor, gasoline vapor steam mix, etc. Coming up with clean electrode materials might be difficult, but it is not an impossibility to come up with some basic tests of the concept.

MAXIMUM FEASIBLE CURRENT CALCULATION

Here is a maximum feasible current calculation using hydrogen as charge transporter at room temperature, to demonstrate the robust possibilities.

Assumptions:
Mean free path: 8x10^-8 m
Collisions per second per molecule: 10^10/sec
Wall-wall transfers/(second-molecule): 5x10^9
Density: 9 g/m^3
Gap width: 10^-7 m
Gap Area: 1 cm^2 = 10^-4 m^2

Computations:
Gap volume: (10^-7 m)(10^-4 M^2) = 10^-11 m^3
Hydrogen mass in gap = (10^-11 m^3)(9 g/m^3) = 9x10^-11 g
Molecules in gap = (9x10^-11 g)(6.022x10^23 molecules/mole)/(2 g/mol)
= 2.7x10^13 molecules
Transfers/second = (5x10^9 trans/s-molecules)(2.7x10^13 molecules)
= 1.35x10^23 trans/sec
Max amps = (1.35x10^23 electrons/sec)(6.24 electrons/coul) = 2.2x10^4 amps

So the maximum feasible current density is 21 kA per cm^2 of electrode area. If 1 in 21,000 electrode-to-electrode bounces produces an electron transfer, we have a about a 1 amp/cm^2 current density, which is just about right for electrolysis. This is robust.

AN APPLICATION

High conductivity dry piles could provide the DC bias to run an electrolysis cell.[13] See Figure 3. The piles DC1 and DC2 are oriented so as to provide the correct bias potential to electrolysis cells M1 and M2. Additional current is supplied by AC pulses supplied by the transformer alternately to M1 and M2. The incremental voltage of pulses through M1 and M2 is less than the bias potential required for the cells M1 and M2, thus no rectification is required. For example, M1 and M2 might consist of 10 electrolysis cells in series, and DC1 and DC2 each provide a bias potential of 8 volts. The transformer secondary is driven at 8 volts, giving an operational voltage of 1.6 volts per cell, which may be useful for high temperature high pressure cells. Example potentials for room temperature cells might be 14 volts for DC1 and DC2 and 14 volts peak for the AC square wave (28 volts peak-to-peak) giving an operational voltage of 2.8 volts per cell. The transformer can be driven with a saw tooth waveform such that the secondary output is a square wave. The useful forward current through the piles DC1 and DC2 is thus obtained when the piles are biased in the forward direction, thus eliminating the dependency on the transporter molecule Boltzmann tail thermal energy to transport electrons across the gap.

FIGURES

```
        V2
        o----------------
        |               |
  ddddddddddddd         |
=================       |
  aaaaaaaaaaaaa         |
.................       |
  ddddddddddddd         |
=================       |
  aaaaaaaaaaaaa        Load
.................       |
  ddddddddddddd         |

        .               .
        .  Repeated     .
        .               .

  aaaaaaaaaaaaa         |
.................       |
  ddddddddddddd        (+)
=================    Pulsed Supply
  aaaaaaaaaaaaa        (-)
.................       |
  ddddddddddddd         |
        |               |
        o----------------
        V1

  Key:

    == - Dielectric with leakage current
    aa - Electron acceptor
    dd - electron donor
    .. - Charge transport gap
    -| - Conductors
```

Figure. 1 - Pulsed Pile Diagram

```
   electron donor
 zzzzzzzzzzzzzzzzz
 - - - - - - - - -  Interface
 + + + + + + + + +  Depletion Region
 aaaaaaaaaaaaaaaaa
   electron acceptor

     ^
     |           Gap
     e-
  Transport


   electron donor
 zzzzzzzzzzzzzzzzz
 - - - - - - - - -  Interface
 + + + + + + + + +  Depletion Region
 aaaaaaaaaaaaaaaaa
   electron acceptor

Key:
   zz - Zinc electrode
   aa - Silver electrode
   ++ - Plus charge adjacent to depletion region
   -- - Minus charge adjacent to depletion region
```

Figure 2 - Diagram of Dry Pile Mechanics

Electron Affinity and The Dry Pile

Horace Heffner   October 2, 2007   Draft #6

```
              HF AC
         V1 o--- ---o V2
               | |
               OOO
             =======  T1
             OOOOOOO
             |  |  |
   i-->      |  |  |      <--i
-----M1-------  |  -------M2-----
|               |               |
|               |               |
o---(+)DC1(-)---o---(-)DC2(+)---o
```

Figure 3 - Method of superimposing AC signal
on dry pile DC potential

[1] Jones Beene, vortex-l post of Thu, 06 Sep 2007 20:26:42, http://www.mail-archive.com/vortex-l%40eskimo.com/msg22324.html and subsequent posts on the topic

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