

UV + WATER, A DESIGN FOR A NEW CLEAN ENERGY FRONTIER

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It is well known that under 400 nm radiation can do photochemical work and over that does a thermochemical one. Also is known that UV is vital in plant growth. In the several years of our experimental research to harvest atmospheric water for the humid Peruvian coastal desert for afforestation using succulents like *Opuntia Indica* and *Aloe Vera*; which require extremely small irrigation (~40/60 m³/Ha/year) since they get most of their water requirements from atmospheric humidity. In the course of our extended lab & field experimentation, we discovered that the 99% liquid content of the *Aloe* plant, was in fact a solution of H₂O₂ and water, with 3 to 15% of that content. A solution of H₂O₂ in water modifies its vapor pressure by both raising the boiling point and decreasing the freezing point as a defense against big evapotranspiration of ~ 1m/year. We added salts like CaCl₂. These solutions depart from Raoul law which is based in the percentage of solvated materials and is more close to the experimental water activity formula of Ross, where proportions of solvates are not so important. We used a more handy approach as Critical humidity or RH₀. Mixing hygroscopic materials give a better H₂O(g) performance One example is i.e. a dramatic deviation by mixing Ammonium Nitrate (RH₀ 59.4%) and Urea (RH₀ 72.5 %) the mixture of both have an RH₀ of 18.1% (Peru coast RH is ~ 75%) In one of our experiments we put a CaCl₂ solution with some minor Urea in the open for 4 years and there was no change of the minimum level, except that it increased in nighttime (High RH) and was reduced in daytime to the minimum level (lower RH) and never went under that. In other experiments blending in a solution CaCl₂ (RH₀ 27%) and sugar (RH₀ ~ 50%) this solution was very much better than a pure CaCl₂ solution. Our mechanism for RH harvesting is feeding the harvesting solution contained in a pond in night time and extracting collected water in daytime since that in deserts, atmospheric water may be the only resource. What was interesting is that in comparing different harvester, we found “ice likes” floating at 7 am in the harvesting solution, without dissolving but keep floating as micro icebergs until ambient RH was lower and they sublimed That lead us, after other experiences an no few literature findings, to think that icelikes may indicate that the triple point of water is not really a point but a blurred area in the water diagram or more speculatively, the interphase of a system from ice to monomeric gas, as a continuum; where the icelikes would be the brain and heart of a self organized system, that includes, in Earth , plants, seas and even rain and clouds etc. The EZ concepts of Gerald Pollack’s as well as the extensive information compendia of Martin Chaplin, where most helpful. On further experimentation we found that, icelikes were lighter, conspicuous, kind of hydrophobic and sublimed when the ambient RH was reduced, and can become “liquid” with small pressure. Furthermore icelikes (or LDW) where an important content in seawater, from which it can be separated easily with immiscible liquids, like vegetable oil, much more cheaply than current technologies. As mentioned H₂O(g) harvesting is extremely important for *Aloe* afforestation to generate photosensitizers and enzymes as described hereunder.

Going back to H₂O₂, we went after the mechanism used by *Aloe* to make H₂O₂ and we extensively tested that it was in the so called “latex” of the plant which is in the inner lining of the leaves. Atex is composed of water soluble Anthraquinone glycosyls (photosensitizers like Aloin) and a group of enzymes similar to SOD (Superoxide Dismutase) and Catalase. Shortly the photosensitizers generate solvated electrons that excite dissolved Oxygen and generate a radical, which together with water, are processed by SOD to H₂O₂. Catalase acts in reverse by

decomposing H₂O₂ into water and Oxygen generating heat. Catalase prevents H₂O₂ saturation that can damage the plant. We decided to “deconstruct” the plant, by using Aloe latex in a brine contained in an open pad With the purpose of substantially decrease Catalase activity and increase area for UV and H₂O(g) harvesting. With our experience in hydrometallurgy we found that the easiest way to separate H₂O₂ (a liquid peroxide) was to bring that energy as an insoluble peroxide that can be precipitated and easily separated, in order to recycle the harvesting solution. Lime was very efficient precipitating Calcium Peroxide (CaO₂) that is tel quel a fertilizer, but also can be taken as mean to regenerate H₂O₂ by using CO₂ or spent acids at destination. Therefore CaO₂ can be an innocuous sink like Calcium Carbonate or Sulfate. Regenerated H₂O₂ can be for energy or chemical use or as i.e as oxidizing media for urban effluents. Because of our previous commodity experience, CaO₂ can be handled in bulk or pellets. The anhydrous product has over 40% H₂O₂ equivalent when regenerated Comparing with costly industrial H₂O₂ , that has a maximum 30% H₂O₂ content and needs to be transported in special cisterns/ tanks it is a very viable alternative. Other attractive is that it is Carbon Neutral since the CO₂ generated in Lime making is recovered at destination. In our plans is also to use other precipitants like Wollastonite (CaSiO₃) which is plentiful in the tailings of many big Copper operations in Peru or basic slags (Ca/Fe silicates and aluminates) from metallurgical operations. Phosphate rock concentrates, also plentiful in Peru, can be used to make directly a P/CaO₂ fertilizer very good for clayey soils present in many zones in the world. On the other hand we are designing and preliminary testing of using close reactors to convert UV/VL to low temperature phase change materials like waxes to store heat units that can be used for power generation and /or heating/refrigeration. The “ingredients” i.e. Aloe Latex can be lyophilized as a powder an transported anywhere. This was inspired in the needs of isolated high Andes communities or anywhere that has an UVI over 10 on average, either year round as in the tropics or seasonal as i.e. the Tibetan Plateau or Africa. We have, for direct power generation. Rankine systems seem viable. Unfortunately low temperature thermoelectrics will require more research since current ones use expensive metals, CuCl may be a choice, since it is cheap and simple, but its development will require research and experimentation. As resources, the main one, obviously, is high UVI. Reagents (latex) can be produced in one place and transported as a powder. We do not consider water as a resource but as an indispensable vehicle of our design. In fact water is present in both ends, as a Solar energy harvester at origin and a Solar energy releaser at destination. Notwithstanding some important questions remain: Is there a triple point or an area in the water diagram? Is water a self organized system, where the conventionally accepted phases of water are a Cultural biased point of view given the interactions between the “phases”? If one distinguish the “effects” from the “causes” and one excludes as effects preassure, temperature, winds, currents, etc ; one ends up with two players, water and radiation. Earth recursive events like El Nino, and even Marsflows , from that point of view can be interpreted as expressions of the self organized radiation/water system; some examples that will be exposed.

**Illatec is an open collaborative group composed of Peruvian and international, scientists, engineers, inventors, etc. on basis of generous crowdsourcing. Research funding came from our pockets, since it simply is a transgressive new idea. Contact: Pedro Flecha pedroflecha@yahoo.com*