The Chemical and Physical Properties of Vampires in the Gaseous State

by
Scott Sandford, Santa Clara, California
Jason Dworkin, Arnold, Maryland
Max Bernstein, Mountain View, California

It is well known that vampires have a number of super-human powers (Melton 1994), although not all sources agree on the exact nature of these powers. This disagreement is presumably due, in large part, to a lack of careful *scientific* study of these creatures. According to early experts, one of the more interesting abilities of vampires is that they can turn into a mist/gas/vapor at will and move about in this gaseous state (Stoker 1897; Dean, Balderston et al. 1931; de Sangre 1952; Wallace et al. 1967). In the paper that follows we discuss a number of questions associated with the nature of vampires in the gaseous state, hereafter referred to as vampire(g),[1] and attempt to estimate some of the chemical and physical properties of vampires while in this state. While we make some progress in this regard, it is difficult to constrain many important properties of gas phase vampires on the basis of current information. In these cases we provide some discussion concerning the merits and difficulties associated with analytical techniques that might yield additional pertinent information.

Volume Analysis

Video ethnographic studies of vampires, for example the pioneering work of Méliès and d'Alcy (1896) (Figure 1) imply that gas phase vampires have similar total dimensions, albeit with fuzzy edges, to solid-state vampires (Hart et al. 1992). However, quantitative analysis is difficult since vampires are reported to not show up in mirrors (Spence 1960), which adds considerable complication to any imaging system used for volumetric analysis. Due to the invisibility of vampires in mirrors, a complex system of lenses and filters, sans mirrors, must be used to record them on video or film. It is unfortunate that the nature of the filters and lenses used by documentarians like Dean and Balderston is not listed in the acknowledgements to their presentations. However, it is apparent that the filters used in early video ethnographic studies produced a monochromatic moving picture. The use of mirror-free recording technology has improved in recent decades, as evidenced by the higher fidelity of the recordings of vampire. Despite all this, accurate measurements of volume have yet to be made, even by the most ambitious interviewers (Rice et al. 1994).

Figure 1 – A video ethnographic documentary of the formation of vampire(g) was first recorded in Le Manoir du Diable *(Méliès and d'Alcy, 1896)*

The Mean Molecular Weight of Gas Phase Vampires

Due to the inherent nature of vampires, it is unlikely that they behave ideally (as a gas or otherwise). However, we have been unable to find the van der Waals, Virial, or Berthelot constants for vampires(g) in the literature (de Sangre, 1952), so we are forced to neglect their probably non-ideal nature in order to make an initial estimate of the mean molecular weight of vampire(g). Fortunately, strategic handbooks of vampire behavior and combat (Williams et al. 2003) do provide an approximate minimum vampire(g) volume. With all intervening air removed, a vampire(g) occupies the volume of a cube 2 feet on a side [$(2\text{ft})^3 = 8\text{ft}^3 = 226.6$ L of vampire]. Thus,

$PV = nRT$

$P = 1$ atm

$V = 226.6$ L

$R = 0.0821$ (L atm)/(mol K)

$T = 285.3$ K [53.8°F][2] [that is, see note #2]

Figure 2 – The face of vampirism. Even the 2.2 Å x-ray crystal structure of the 157 residue protein vampirase (Zhang et al. 1998) appears menacing.

Substituting and solving for n yields the conclusion that one "cloud" of vampire(g) contains 9.675 moles of material. Until we have the opportunity to weigh a vampire, we assume that the mass of a vampire is 160 lbs (72.6 kg). This means that the average molecular weight for the material in a vampire is 72,575g/ 9.675 moles = 7,501 Da. After a quick internet search,[3] we found the description of a 70 amino acid protein having a molecular weight of 7,501 Da. It is called Human Protein Q8WW94, also knows as red cell acid phosphatase 1 (Figure 2). The association of a blood protein with vampirism is too unlikely to be a coincidence, thus it should be viewed as a validation of our calculations.

Figure 3 – A member of our research staff putting her life at risk to studying the properties of vampire(g). [She is smiling because we have told her she is handling something entirely different. It is unknown whether the vampire(g) enjoyed the experience.]

Notes About Blood Protein

We find it particularly significant (and a bit creepy) that a red blood cell protein should be so closely associated with vampires. It is likely that the activation of the gene that expresses this protein (perhaps by red cell acid phosphatase 1 excreted into the blood by saliva from, say, a bite to the neck) results in conversion of a mortal to a vampire. We strongly suggest that a test be developed to screen for the presence of red cell acid phosphatase 1 in the population as well as determining an antidote. This manuscript will serve as the beginning of our campaign with the Centers for Disease Control, the Food and Drug Administration, and the Department of Homeland Security to institute widespread screening of red cell acid phosphatase 1 in the general population. The security risks of vampires on commercial aircraft alone make the mandatory blood testing for the presence of red cell acid phosphatase 1 at airport security a necessity.

Furthermore, to reduce confusion, we also recommend that the protein red cell acid phosphatase 1 be renamed "vampirase." ("Undeadase" may be more accurate depending on whether the phenotypic alteration caused by its expression is specific or general. Only further in vivo studies of can determine the specificity; until then, we will conservatively refer to Q8WW94 as vampirase.)

Naturally, we anticipate that vampires(g) are not pure vampirase and likely contain a number of minor constituents. Thus, we are currently beginning a gas chromatography (GC) campaign to attempt to separate vampires into their constituent chemicals (Figure 3). It occurs to us that once vampire(g) is understood, tremendous advances in chemical and medical research can be achieved by feeding vampires intractable compounds of interest. The analyte be carried into the gas phase with the vaporization of the vampire, then both can be injected into the GC.

Further Fundamentals

Since we now have determined that, at least to first order, our approximations of the gas-phase compositions of vampires are correct, there are a number of other fundamental constants that require the attention of science. Here we outline some of the outstanding questions regarding vampire(g) which modern science needs to address.[4]

The Solubility of Vampiric Gas in Liquids

It is well established that vampires cannot cross running water (Carroll 1991). The reasons for this are now clear: their Henry's law constant (k_H) is such that they would quickly dissolve in agitated water, but not placid water. The determination of an accurate value of k_H with temperature is essential since it will determine if vampires can disguise themselves as carbonated beverages, or lurk dissolved in one's blood stream waiting for the right moment.

Conversely, it is also possible that when dissolved, vampires are rendered powerless. This would mean that the ideal prison for captured vampires is in a sealed bottle anchored to the bottom of the ocean and the best way to defeat a vampire cloud pursuing you is to deeply inhale it. Clearly, research of the highest caliber is required before this action can be recommended to the public. We have already left messages with the Occupational Safety & Health Administration (OSHA) to determine the hazards of vampire inhalation and they appear to have realized the magnitude of the issue, as they are now working on the problem with such diligence that they are unable to return our calls.

The associated question of conditions required for the production of vampire clathrate hydrates will not be addressed here, as it is clearly outside the scope of this manuscript.

The Condensation of Vampiric Gas

Another fundamental question relates to the phase diagram of vampires(s,l,g). We have already noted that vampires apparently can sublimate and condense at will. It is unclear whether this is done at constant pressure or temperature. Perhaps vampires' auto-vaporization is due to changes in body temperature. This is consistent with vampires' reported (see, for example, Galeen et al. 1922), but inconsistent (Daubeney et al. 1974; Fischer, Jeremias et al. 1987; Whedon et al. 1999; Whedon et al. 2000), pathological avoidance of sunlight and the total absence of reports of vampires' fevers.

Thus, it may be possible to defend oneself from a vampire(g) with dry (CO_2) ice. Perhaps even more casually frigid conditions are adequate. Would a vampire freeze to your car windshield in the winter? Must they stay away from windows in their homes in the winter (the often reported ability of vampires to own large manors (e.g. Curtis, et al. 1967) is consistent with their ability to afford double-glazing to minimize this problem)? Might it be better to protect yourself with, say, a Popsicle, rather than a cross, if attacked by a vampire(g)? This is clearly an area that deserves active investigation.

Likewise, pressure may be a similarly important variable. Could atmospheric pressure be responsible for vampires being more often observed in the solid phase in stormy (low pressure) conditions, than in fair and sunny (high pressure) weather? This study is more significant in the event of deep-ocean storage of vampires, or the presence of vampires in low-pressure conditions normally hazardous for humans. If so, the National Aeronautics and Space Administration (NASA) must be prepared for possible vampire infestations in the permanently shadowed craters of the Moon.

Of course, we have focused solely on the solid to gas transition of vampires. The solid-liquid and liquid-gas transitions have never been observed by credible sources. In fact, the vampire(l) phase may be impractical under experimentally obtainable conditions, and the phase diagram of vampires remains a matter of some mystery (Figure 4).

The Absorption/Emission Spectra of Vampires

Beyond the physical chemistry of vampire(g) there are still remaining questions concerning the properties of vampire(s). One of the central questions is described here. Vampires are observed not to cast a shadow, and it is also well documented that they do not produce a reflection in mirrors (Stoker, 1897). The lack of a shadow indicates that vampires do not absorb or scatter any of the light impinging on them, or at least not in the *visible* portion of the spectrum. This would appear to preclude any form of traditional absorption spectroscopy at visible wavelengths. We would note, however, that there is essentially no information on whether vampires absorb light at other wavelengths. Thus, absorption spectroscopy remains a future possibility at non-visible (infrared, x-ray, etc.) wavelengths.

It should be noted that the fact that vampires do not cast visible shadows raises a dilemma. If vampires do not absorb or scatter visible light, i.e., they do not interact in any way with incident light, how is it that we can see them in both solid and gaseous state? The only possible solution is that vampires must *emit* light while in both their solid and gaseous forms. Given their propensity to lurk in shadows, it is likely that vampires fluoresce (or phosphoresce with fairly short triplet lifetimes to allow prompt intersystem crossing) as opposed to behaving like a blackbody. This suggests it may be worth considering various forms of emission spectroscopy. If ever there were something that vibrates and has a permanent dipole, it would be vampire(g)! Thus vibrational and rotational emission spectroscopy of vampires should be particularly fruitful once appropriate standards are measured in the laboratory. Since there are multiple reports of the possibility of vampires in space (e.g., Harrington et al. 1966; Wallace et al. 1967; Nowlan, Wyckoff et al.,1980;

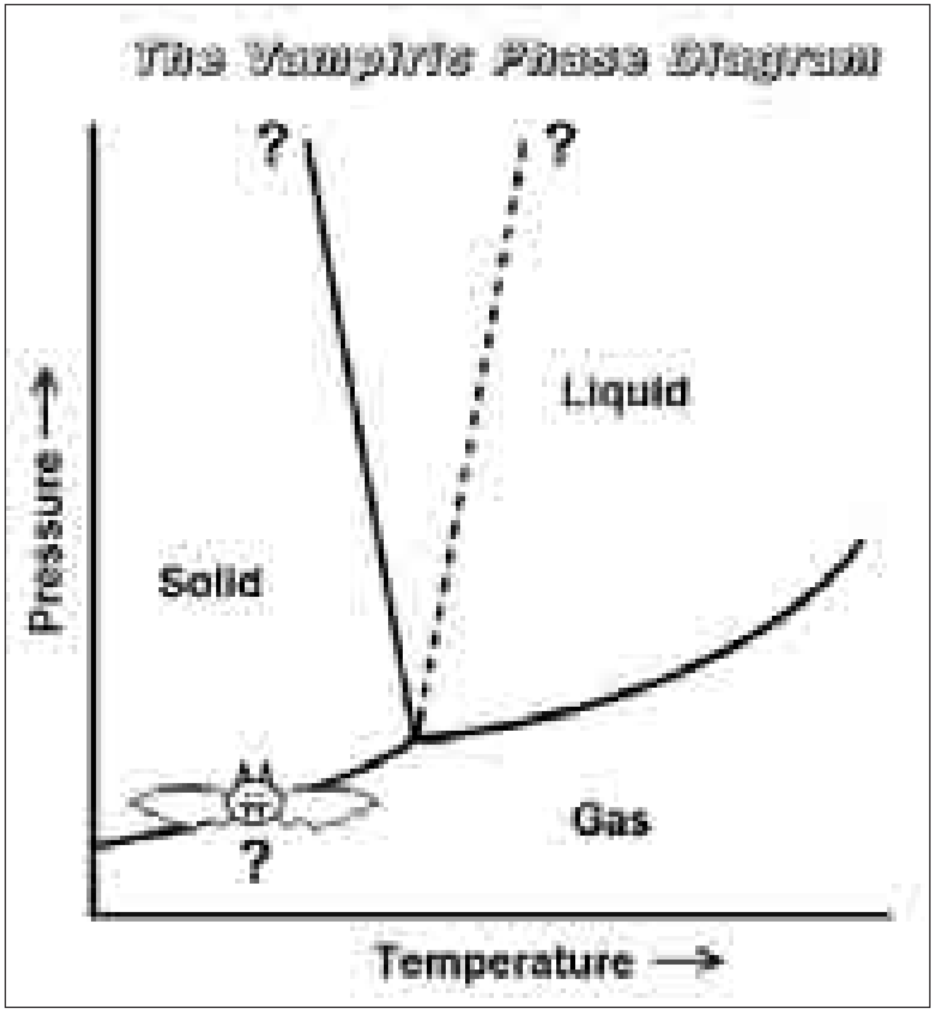

Figure 4 – A potential phase diagram for the solid, gaseous, and (possibly) liquid states of vampires. If vampire(l) exists, it is not known if the solid-liquid boundary slopes upward to the left (as for H_2O) or to the right (as for CO_2). Since it is probable that evil floats (Axelrod and Antinozzi 2002), we suspect the solid boundary is more likely to be correct, i.e., a solid vampire would float in a tub of liquid vampire. Note that while vampires have been observed to transform between biped↔gas and biped↔bat, there is no record of a bat↔gas transformation. Nonetheless, we anticipate some sort of biped-bat-gas triple point may exist in the lower left of the diagram.

Bohus et al. 1995), this raises the intriguing possibility of, for example, remote sensing of any space-faring vampires in some of the multi-wavelength all-sky surveys currently being conducted by NASA.

Unfortunately, we anticipate that such measurements will ultimately be very difficult to make. Again, since vampires do not produce a reflection in mirrors, they will be invisible to many of the optical elements found in devices that measure spectra.[5] Indeed, the lack of a reflection in mirrors may be a single manifestation of a larger problem, as there is little to no data on the detectability of vampires by a host of optical components like beam splitters, gratings, polarization filters, etc.

Summary

Of course, the issues we have discussed here represent only a partial list of the possible properties of gas phase vampires, and we have done more to illuminate our ignorance of vampires in this state than to quantify their properties. A host of additional questions easily come to mind. For example, are vampiric gases combustible? Can multiple vampires mix with each other in the gas state? What do gaseous vampires smell like? How does vampiric gas react with ozone? Could they cause ozone depletion? Are vampires in the gas phase subject to any environmental or OSHA regulations? What is the LD_{50}?[6]

Clearly this is an area rich in future research possibilities. Having dug up these issues and exposed them to the light of day, it is our hope that the scientific community will now consider ways in which we can nail down the lid on these problems.

Notes

1. Note that this effort only addresses a small portion of the questions we have in regards to vampires. For example, we know a vampire creates another vampire by biting a person, but is saliva-to-blood the only pathway for transmission?

What about blood-to-blood? Saliva-to-saliva? If a vampire spits in your eye or kisses you, do you catch vampirism? Suppose you share needles with a vampire? Have unprotected sex? Can a vampire slayer catch vampirism if he has an open sore on his hand while driving the wooden stake? What if a mosquito bites a vampire and then bites you? All practical questions! Another issue of interest: we know that vampires must respire. They take in blood, they grow hair, and they bleed. Do they urinate? What happens if a vampire pees in running water? On another vampire? What happens if you pee on a vampire? If water or food contaminated with vampire urine is consumed does one become a vampire? Oh, and one more: If a vampire gets athlete's foot, does the fungus become vampiric?

2. The average annual temperature of Transylvania from http://www.brevardncchamber.org/(we assume a castle in thermodynamic equilibrium with its surrounding environment).

3. See http://expasy.org/uniprot/Q8WW94_HUMAN and http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=gene&cmd=Retrieve&dopt=full_report&list_uids=52 .

4. Thereby placing a stake with our names in the heart of these issues, so to speak.

5. A vampire's inability to produce a reflection in a mirror has some interesting consequences. For example, a vampire could apparently be spotted from afar with a typical seaman's spyglass, but would be invisible to the world's most powerful Newtonian telescope.

6. Short for "Lethal Dose, 50%," i.e. the amount needed to kill half of a tested population.

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