

THERMODYNAMICS OF WATER-A PERSPECTIVE ON GLOBAL WARMING by George Silvestri

Introduction

You collectively represent a diverse group of adults with careers in many different fields. In my efforts to understand the issues concerning global warming, I have read the literature extensively and attempted to develop my position on the issue based largely on the writings of others.

About a month ago I came to the realization that I could confront the issue from an entirely different perspective. Throughout my engineering career I have focused on water in its various states and its use in a branch of science called Thermodynamics. Thermodynamics relates to the conversion of heat into work and vice versa.

In the essay that follows I have used some of the concepts presented in Thermodynamics and I have explained the various terms and processes in a way that would be understandable to all of you, many of whom have essentially no scientific background. If I have succeeded in this endeavor, I would be greatly gratified. Moreover, you may realize that global warming, as presented by its supporters, is inconsistent with a branch of science called Thermodynamics, despite the protestations to the contrary that global warming is based solely on science.

My thesis is that global warming is untrue in the acceptance of the proposition that it is caused by a particular greenhouse gas, carbon dioxide. Another greenhouse gas, water vapor, as well as liquid water are what makes the earth habitable. More about that in the main body of my essay.

I believe that climate change is a reality, is cyclical (warm periods followed by cold periods and other round of warm-cold periods, etc.) and has occurred for millenia.

Bear with me before I present the main text of my essay. MIT Professor Dr. Richard Lindzen is a noted climate expert. In conjunction with NASA researchers, he discovered the massive atmospheric heat vent over the warmest spot in the Pacific Ocean. Periodically a hole opens up in the clouds and allows heat to escape. Dr. Lindzen has published several articles and presented several lectures on his research, which take issue with the proposition that the observed global warming is attributable to carbon dioxide.

Dr. Lindzen and Dr. Y.S. Choi wrote a paper in 2001, which presented an interpretation of the data on the behavior of the atmospheric heat vent and its effects. This paper was critiqued by various scientists and revealed some deficiencies in the analysis of the data. These responses to that paper led Lindzen and his coauthor to examine all aspects of the original paper more carefully. The result has led them to some changes in analysis, some expanded explanations, and, finally, some changes in results- though the last has not been very great.

The authors evaluated eleven, 11, IPCC (International Panel on Climate Control) computer models that have been developed to simulate the behavior of the atmosphere in regard to long wave radiation emanating from the sun and the reflected short wave radiation. The agreement between the various models did not appear to be notable. Be mindful that these models are simulations and not a substitute for actual unadjusted data. The usual claims for the models are that a doubling of carbon dioxide in the atmosphere will lead to warming of from 1.5 degrees C (Centigrade) to 5 degrees C and even more. In contrast, it is widely accepted that the warming from a doubling of carbon dioxide would only be about 1 degrees C.

The atmospheric heat vent data indicate that there were substantive reasons for supporting the conclusion that the phenomenon was concentrated in the tropics or the Southern hemisphere, where the ratio of sea area to land area is more favorable. The satellite data, ERBE, were best for the tropics because the satellite field-of-view was between 60 degrees south and 60 degrees north.

The fixation on carbon dioxide by the AGW advocates has resulted in the advocacy position requiring the reduction of the so-called carbon footprint because of its danger to humankind. This is claimed to be the result of human activity, AGW. This assertion ignores the relative abundance in the atmosphere of two greenhouse gases, water vapor and carbon dioxide.

Main Text of my Essay

From my own perspective and independently of Dr. Lindzen's investigations, I have asked myself "Why did the AGW (Anthropogenic Global Warming) advocates selected Carbon Dioxide as the forcing function to bring the actual atmospheric temperature data into conformity with the GCM, Global Climate Model, predictions." One reason is that Carbon Dioxide met their requirement of being a greenhouse gas. It had to be a greenhouse gas to account for the warming. Just as importantly, the greenhouse gas had to be increasing with time. The combustion of fossil fuels met this criterion because of the increased use of those fuels, starting with the Industrial Age and continuing until now. The AGW advocates ignored the importance of another greenhouse gas, water vapor, which is present in much greater abundance than carbon dioxide and whose Thermodynamic properties are superior to those of carbon dioxide.

During my engineering career I have utilized the properties of steam for more than 40 active years of engineering practice. Moreover, I have been a contributor to the dissemination of information about these properties (behavior). Evidence of this is relates to my selection as one of the four preparers of the 1967 ASME Steam Tables. In addition to my tasks as a preparer of the properties of steam publication, I, also, wrote in co-authorship with R.B. McClintock (one of the other preparers of that compendium of steam properties) two ASME (American Society of Mechanical Engineers) technical papers where we presented the properties in the form of subroutines and functions for use on electronic computers. The first paper was reprinted by the society in booklet form for users. The second paper related to correcting glitches in the printed computer subroutines and functions, improvements in the calculational speed of the subroutines and the inclusion of additional computer functions and subroutines that would be useful to users of steam properties. This paper was reprinted in the ASME Transactions, Journal of Engineering for Gas Turbines and Power.

I believe this provides an experience base whereby I can opine on liquid water, ice and water vapor and how it can affect climate. Of special importance to the sustaining of human life is the density of liquid water and ice. Practically all materials, when they are cooled, increase in density, and this density progressively increases as the substances are cooled from the vapor state to the liquid state to the solid state. In contrast, the density of water increases with decreasing temperature until its density reaches its maximum level at 4 degrees C (Centigrade). Then the density decreases when it cools further, still in the liquid state to 0 degrees C, and decreases still further as it freezes as ice and cools further.

The response to this revelation may be "so what". If water did not have this property, life could not exist on earth. In such an instance our bodies of water would first freeze on the bottom and then the freezing would progress toward the top. Instead, water freezes at the top, which also results in circulating currents, and then works its way progressively lower. The ice stops the process whereby the heat energy in the liquid water beneath the ice is radiated to outer space. When the temperature begins to increase, the melting of the ice would be impeded if the water first froze on the bottom. By freezing at the top, melting is enhanced when the surrounding atmospheric temperature increases.

It is a source of frustration to me that the AGW proponents consistently divert discussion by raising the specter of other greenhouse gasses. Methane is a favorite and sometimes nitrous oxide as well as other minor constituents. A comparison of the abundance in the atmosphere of these other constituents reveals how miniscule they are, even when compared to carbon dioxide, let alone water.

Other dire predictions regarding environmental disasters, besides carbon dioxide, have been advanced, which would result in the extermination of life on the earth. There was the Nuclear Winter theory, which stated that with the advent of global nuclear conflict, the nitrogen and oxygen in the atmosphere would chemically combine to form nitrous oxide. The nitrous oxide gas (clouds) would encircle the earth and

blot out the sun's rays for possibly years. The ensuing drop in atmospheric temperature following this event, even ignoring the noxious effects of nitrous oxide, would result in starvation; crops could not grow.

The paper propounding this theory was submitted to "Foreign Affairs" magazine and printed without peer review because of the assurance of a noted astronomer, Carl Sagan, that the reviews would be forthcoming prior to publication. The peer reviews were never produced. The paper ignored the presence of water. The preexisting water vapor, present in the atmosphere prior to the detonation of the atomic weapons, in conjunction with the liquid water that was vaporized by the nuclear weapons, would cause rain to occur. The rain would scrub the nitrous oxide from the atmosphere. The end result would be an earth capable of being heated by the sun and allowing plants and animals to survive. The critiques of the article cited the failure of the authors to recognize the occurrence and influence of rain.

Another bogus theory, regarding situations where man made catastrophies would threaten life, occurred when Iraqi troops set fire to the Kuwaiti oil wells, producing vast amounts of smoke. A major calamity was predicted. The dire influence of the smoke was short lived once the fires were extinguished. Rain cleansed the atmosphere.

Water in its various forms has a moderating influence and is a cleansing agent in our environment that has been ill appreciated or ignored by AGW proponents.

There is a serious flaw in the AGW theory and which results from the proponents' ignorance of and/or unconcern about the impact of the thermodynamic properties of water and carbon dioxide. If they had been less hasty to render their judgment and were familiar with the basic thermodynamics and relative abundance of water and carbon dioxide they would have selected water as the source of global warming. This is illustrated by some examples cited in the following paragraphs.

The paragraph, which follows this one, was developed to explain the specific heat of a substance and how it relates to a change in temperature and the corresponding change in the energy level of the substance. While this explanation was initially developed for readers who have essentially no background in science, it also applies to individuals who have had scientific and engineering training. I make this assertion because many of the individuals who have training in those areas have either forgotten what they learned regarding the thermodynamic properties and behavior of water in its various phases: solid, liquid and vapor or their college courses have relegated water to a position of little relevance. Moreover, it has been my observation that the courses on liquid water and steam in many colleges and universities have essentially downgraded its importance and have shifted the emphasis to air and other gases, esp. because of the glamour or revolutionary aspects of combustion turbines. Steam and its application has, at best, been perceived as evolutionary and therefore old technology. This perception ignores the fact that steam is the working fluid in nuclear power plants, providing 20% of our electricity; that a host of processing industries use steam for such mundane purposes as paper making, food processing, sterilization; besides serving as the working fluid in a host of single purpose and dual purpose power plants using fossil fuels as the heat source.

Suppose that the atmosphere at sea level is 60 F and heating sets in and raises the temperature to 100 F. The specific heat of carbon dioxide is about 0.25 Btu per pound per degree F, that is, if the temperature changes by 1 degree F, the energy level changes by 0.25 Btu/lb. So for one pound of CO₂ and a 40 degree change in temperature, degrees F, the energy level of the CO₂ will change by 10 Btu. Water in the liquid state has a specific heat of 1.0, so a 40 F change in temperature causes a 40 Btu change in energy level. If water is in the superheated state, it is transparent and colorless and cannot be seen. You cannot see this gaseous form of water unless it is foggy or is in the form of rain or snow. The other major constituents of air, oxygen and nitrogen, are transparent and colorless and enable us to see rain and snow. This gaseous form of water has a specific heat of 0.5, which means for every degree F change in temperature, there will be a 0.5 Btu change in the energy content of the water vapor. So for a 40 degree change in temperature there will be a 20 Btu change in the water vapor. If the water goes from the liquid state and evaporates, at constant temperature, the change in its energy content is about 1000 Btu/lb.

The total change in the water from going from 60 F liquid to 100 F transparent vapor can be as high as 1040 Btu/lb, while the change in CO₂ is only 10 Btu/lb. The same changes in energy level would occur if the two fluids were cooled from 100 F to 60 F. Because of the large change in energy level when the water evaporates or condenses, 1000 Btu/lb, water exerts a major moderating effect on climate. This does not occur with carbon dioxide because its moderating effect would be so small, even if it were capable of doing so. Instead CO₂ would exacerbate the heating. Also, water vapor typically ranges between 1% to 3% of the atmosphere, while the amount of carbon dioxide is only about 0.059%. So water is about 17 to 51 times more prevalent in the atmosphere than carbon dioxide. So, if we increase the effectiveness of the water by 17 to 51 times, the influence of water ranges between 17,349 (17 multiplied by 1020) and 52,020 (51 multiplied by 1020) compared by a change of 10 for carbon dioxide. Does the tail wag the dog or does the dog wag the tail?

In the case of clouds only a fraction of the water is vapor. Clouds are a mixture of vapor and liquid. If only 10% of the cloud is vapor and the rest is suspended liquid, the energy present in the vapor and the liquid would range between about 1,735 Btu and 5,200 Btu as compared to a Btu change of 10 Btu for carbon dioxide. Can a person with an open mind then say that carbon dioxide controls our climate and water does not or has little influence? Clouds are what makes the earth habitable and even though clouds do not completely cover the earth, they fulfill their function of moderating temperature. Water vapor fulfills two roles as it reflects heat and it absorbs heat, primarily because it is present as clouds.

If you are still skeptical, consider the following: the lack of water vapor over deserts accounts for the greater disparity in day/night time temperatures (also called diurnal temperature range) than over nondeserts, water vapor and even clouds absorb and reradiate infrared, making the day/night difference less. In addition, atmospheric temperature levels (and changes) along and near bodies of water are more moderate than atmospheric temperature levels (and changes) in the interiors of the continents. It is no accident that Siberia has such frigid weather in winter and stifling heat in the summer.

I believe that the AGW proponents were either ignorant of the beneficial effects of water in its various forms on the earth and its atmosphere or they just ignored this information and relied on the increasing concentration of carbon dioxide (while still being so small compared to water) because of combustion of fossil fuels. Consequently they, apparently, did not apply the most elementary aspects of the thermodynamic properties of water and its behavior.

The failure to recognize the data presented in the preceding paragraphs (heat capacity and comparative abundance) led the AGW proponents to their fixation on carbon dioxide. Moreover, they ignored or minimized the major influence of the oceans and other bodies of water on the level of carbon dioxide in the atmosphere. When the temperature of bodies of water increases, they release carbon dioxide to the atmosphere. When the water temperature decreases, the bodies of water absorb carbon dioxide from the atmosphere.

Here is something else to consider. If you lived in a cold climate, had done a load of laundry, hung it outdoors to dry, and the air temperature was below freezing, in a short period time, the laundry would freeze and be stiff as a board. After a few hours and you went outside for the laundry and the temperature was still below freezing, the laundry would not be frozen and would be dry. A process called sublimation had occurred, where by the frozen water would go directly from ice to the vapor state, pass off into the atmosphere and the laundry would be dry.

Here is another example. You have an ice maker in your freezer. You go away for several days and there were ice cubes (pieces of ice in the ice receptacle) and you turned the ice maker off. If you looked into the receptacle when you returned, you would find that the pieces of ice had gotten smaller. Sublimation has occurred, the water goes directly from the solid state to the gaseous state. If the refrigerator door had been opened a number of times without turning on the ice maker, the sublimation process would be more rapid as you would allow the vapor that had formed to escape.

Sublimation has other implications regarding events that are cited as proof of AGW by its proponents. The proponents cite the retreat of the glaciers. This is not an open and shut case. Many of the glaciers

have not changed in size for the last 50 years. Some sources put the number that have stabilized at 50 % and cite examples of increased glacial growth and/or the thickening of the glacier's depth in the interior of Greenland and Antarctica. Even if we dismiss these clarifications as anecdotal or hearsay, we cannot ignore one of the factors contributing to the retreat of the glaciers. It is sublimation. Unless there is sufficient fresh snowfall to counteract the influence of sublimation, sublimation alone will result in the retreat or reduction in size of glaciers, without any melting having occurred.

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