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Chapter One

A NEW BOOK BY STEVE BAER OF ZOMEWORKS

BEING SERIALIZED IN THE TRIBAL MESSENGER..

ENERGY IN A CAR CRASH

Mechanical energy seems pathetic when it subsides to thermal energy. If you came upon a smashed automobile that had just collided at 60 mph with a concrete retaining wall, all of its kinetic energy would have recently been converted to heat. Yet, neither the car nor the retaining wall would be very hot.

The kinetic energy of an object weighing m lbs. and going v feet per second equals:

$$\frac{mv^2}{2g}$$

The car weighs 2000 lbs., it is travelling 60 miles each hour which is the same rate as 88 ft. each second. Gravity increases the speed of a falling body 32 feet a second each second that it is falling. The kinetic energy then equals:

$$\frac{2000 \text{ lbs } (88 \text{ ft/sec})^2}{(2)\,32 \text{ ft/sec}^2}$$

242,000 foot pounds 311 BTU's

311 BTU's is very nearly the same amount of energy that falls on a foot square directed at the sun.

The 242,000 foot pounds. We could store this energy by lifting the 2000 lb. car 121 feet in the air.

The 242,000 foot pounds of potential energy then could be cashed in as kinetic energy by dropping the car 121 feet. It would reach a speed of 60 miles an hour just before it hit. When the car hits, the kinetic energy turns into heat.

"Author Drinking Beer"

DAMS AND HYDROELECTRIC STATIONS

Look at dams and hydroelectric generating stations - they produce enormous amounts of electricity (it amounts to a few percent of the national consumption). Yet, if this energy were returned to heat the river that is passing through the turbines, it would change the temperature very little. The hydroelectric plant or the water fall is the perfect scene to compare thermal energy and mechanical energy.

A British thermal Unit. BTU, is the quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit. The precise definition states that it is the heat required to raise the temperature one degree when water is at its densest, or at a temperature of 39.2 degrees F. Water takes about the same amount of heat for each degree step that it climbs in temperature, and most of our work will be within the comfortable and predictable range between freezing and boiling.

The mechanical equivalent of one BTU is 778 ft. lbs. A weight of 1 lb. lifted 778 ft. in the air has had 1 BTU invested in it as potential energy. Or, to store 1 BTU as mechanical energy we could lift 778 lbs. one foot.

Jacking up a car to change a tire requires increasing the potential energy of the car one or two BTU's. This is not the amount of work you have done - for most jacks have a great deal of friction. But it is all that you have to show at the end, for the warm parts of the jack won't do you any good. Hydraulic jacks are efficient.

After the car is jacked up we have stored perhaps one or two BTU's - lifted 1000 lbs. one foot or so.

Drink a pint of beer, a 16 ounce can. The beer is largely water and therefore will take close to 1 BTU for each one degree F. that it rises in temperature. You drink the beer at 40 degrees F. and it warms in your stomach to 98 degrees F. or 99 degrees F. which takes 58 or 59 BTUs, which is an enormous amount of energy compared to the raised automobile.

One BTU equals 778 ft. lbs. If a pound of water fell 778 feet, when it hit its kinetic energy would be converted to thermal energy and the temperature would rise one degree F. Then a dam 778 ft. high is a one degree fahrenheit dam.

Boulder Dam on the Colorado is 726 ft. high, Grand Coulee is 550 ft. high, Bridal Veil Falls are 620 ft. high. None of them high enough to heat their water one degree F. on impact.

The water going through the turbines of a hydroelectric plant can do two things - it can give its energy to the turbine wheels, then the generators and finally someone's light bulb. (Given the speed of electricity this happens very fast.) Or, if the turbine wheels were stalled, it can just churn and splash and warm up.

"ACQUAINTANCE WITH ENERGY UNITS"

BY STEVE BAER, [ZOMEWORKS]

One could test the efficiency of a turbine by checking with a very accurate thermometer the temperature difference between the incoming and outgoing water. Heat in such situations is a measure of the mistakes and inefficiencies of the generating mechanisms.

James Joule was the first person to measure the equivalent amount of mechanical energy to a given amount of thermal energy. He did this in the 1840's by means of churning water mechanically, by falling weights and measuring temperature rises.

Joule also visited waterfalls with a thermometer, but had difficulty because of spray at the bottom. As we have seen, there are no large hydroelectric plants in the United States high enough to warm the rivers that power them even one degree fahrenheit. Why then, is there all the fuss about thermal pollution of rivers by coal, oil or gas fired power generating plants? The rivers are too small and the generating plants are too big. In an electric generating plant, for each unit of energy delivered as electricity, about two units have to be produced as heat.

WATERFALLS OF LEAD, COPPER, FREON AND MERCURY

If, instead of water going over the 778 ft. high falls, we had lead bbs, the lead bbs would warm 32 degrees F; a waterfall of copper bbs would be 11 degrees F. warmer; a waterfall of mercury would be 30 degrees F. warmer; a waterfall of freon would be 4 degrees F. warmer, and one of hydrogen .29 degrees F. warmer. Wood balls would rise 2 degrees F. There differences are because different materials have different reluctance to change temperature. A pound of lead changes its temperature 32 times as much as a pound of water on absorbing the same amount of heat. This quality of a material is spoken of as its specific heat. Equal volumes are more nearly equivalent since generally it is light materials with high specific heats and heavy materials, such as lead, with lower specific heats.

A 50 WATT DOG

How much energy is used by burning a 100 watt light bulb? A 100 watt light bulb uses 1/10 of a kilowatt (1000 watt) hour of electricity each hour. One kilowatt hour is equivalent to 3413 BTUs. You can't compare watts to BTUs, but only watt hours. For BTUs are a measure of heat or energy and watts are a measure of the flow of energy. BTUs are the British measure of heat, calories are the metric measure of heat. Who has ever heard of a man's diet described as so many BTUs per day? Different terms and units settle in different fields and, thus, discourage comparisons between the one and the other. The diet of an automobile and a man are certainly very distinct. The one is gasoline and the other food, but in terms of energy, they can be compared quite accurately. Who ever heard of someone's metabolism as so many watts?

In a way it is more comfortable to give the light bulb and hot plate species their own terminology to describe their energy diets and again to fuel up at the gas station with gallons rather than with BTUs or calories. It places a protective distinction around the human and his necessities. The heating and ventilating engineer finally comes to look at people as 100 watt light bulbs - big people burning even better than that and this extends. of course, to other animals. Thus, it makes sense to let the dogs inside on a cold night, not just for their sake, but to help heat the house. They may be creating heat at 50 or 100 watts.

GRAM CALORIES AND KILOGRAM CALORIES

A gram calorie is the quantity of heat required to raise 1 gram of water one degree Centigrade. Gram calories are the calories you see referred to in the physics and chemistry books, but are not the calories used in describing a person's diet. Those calories are kilogram calories, being equal to 1000 small calories. A diet of 3000 small calories a day would not be enough energy to warm up the liquids you drink.

One kilogram calorie equals 3.97 BTUs. Then a 3000 kilogram calorie a day diet is approximately 12,000 BTUs/day which is equal to about 3½ kilowatt hours of electricity a day or the rate at which a 150 watt light bulb burns. A south facing window in a house can easily pick up 1000 BTUs/ ft. squared during a winter day. So we see that a 3' x 4' window can admit as much energy each day as that required to feed a man.

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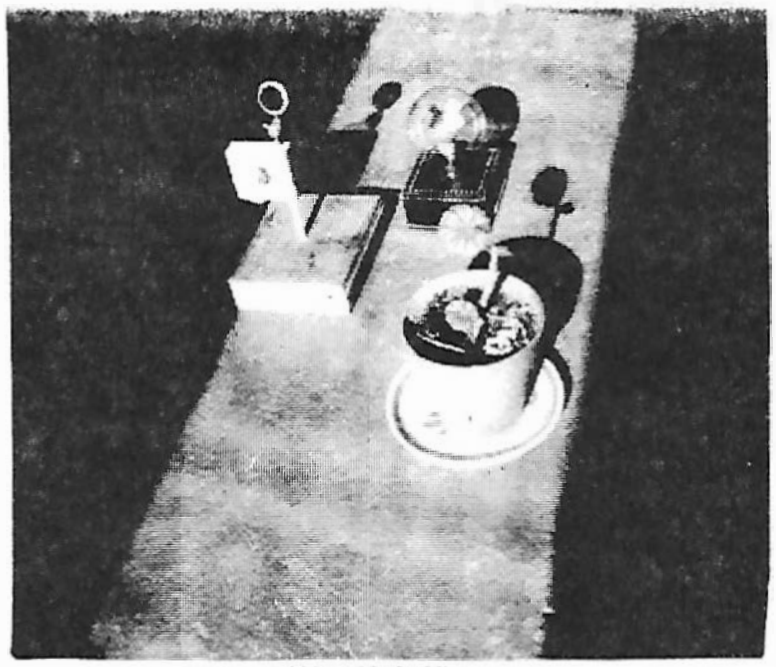

"Sunlight"

THE GULF STREAM

The sun does such enormous quantities of heating each day that an owner of a piecd of land might exclaim at the enormous energy flows that occur to keep his night and day temperatures flowing normally. A farmer could talk about his 10,000 kilowatt production plant.

How much energy do you suppose is delivered by the Gulf Stream to England and northern Europe? The Carribean countries. from whose vicinity much of Europe's heat is drawn, cannot send a bill to Europe for this heat. People don't call sunny weather thermal pollution.

HOW MUCH IS ONE MAN WORTH

How much work can a man do? A man running up a flight of stairs can develop a couple of horse power. Let us say he weighs 200 lbs., then if he climbs 2 3/4 feet each second, this is one horsepower. For 200 lbs. x 2 3/4 equals 550 ft. lb. / second, or one horse power. A horse obviously can do much more than one horse power for a short time. 550 ft. lb./ sec. is the rate at which a horse can work continuously for one day - and a man can work at approximately 1/10 this rate.

BUBBLE WORK

In our table what does 1 cubic foot atmosphere mean? Why is this equivalent to an amount of energy? This is the work required to puff something out against the pressure of the earth's atmosphere to a volume of 1 foot cubed. You do not do this work when you breathe since the air flowing down your throat to fill your lungs is precisely as eager to do this as the air around your chest is reluctant to make room for your chest swelling.

If you breathe through a tube while you are under water, you can feel that it is a different matter. Your chest must push out against a higher pressure than supplies the incoming air from above the pool. You must do work to blow bubbles underneath water, but none to blow soap bubbles in the air except the slight amount you do in stretching the soapy film.

MEN EQUALING SUNLIGHT

If a man can do 1/10 horsepower work over a period of 8 hours and we wished to duplicate the heat the sun pours down on the ground by men rubbing the ground with blocks to create heat, we would need at least 1 man for every square foot.

SUNLIGHT

The strength of sunlight is a variable. The closer the sun is to being directly overhead the warmer it is. The clearer the sky the warmer the sun. The closer the earth the warmer the sun. Sunlight is not a commodity although there is plenty of it. You can concentrate it with lenses, you can reflect it with mirrors or white paint, you can stop it dead with black paint or you can let it go to hit the trees, shrubs, weeds and dirt. At sea level the sun may give energy at a rate of 1.5 cal/square cm min which translates to 332.1 BTUs/square foot hour. - British thermal units per square foot each hour. To convert Langleys to BTUs per square foot, multiply by 3.69. One cal per square centimeter is called a Langley after an early investigator of solar radiation. The radiation recording stations use the Langley as their measure of radiation. On high mountains the radiation may be as strong as 1.75 Langleys per min, or 388.2 BTUs per square foot per hour

PORTRAIT OF A GASOLINE DRINKER

Jerry, small, quiet and apparently amiable fellow in his 20's, from Louisiana - lacked distinctive southern accent.

Boss at the service station on outskirts of large Midwestern city - at first liked him. Even in cold and wet weather Jerry needed no prompting to go out and man the pumps. He was naturally agreeable to this function.

Early in the morning they would find him at the station in the same soiled blue overalls - did he sleep there? He lacked the strong body odor of those who sleep in cars and never bathe. When he did not lock up he usually left with the words that he'd stop back by to pick something up.

Eventually the others at the station identified an occasional peculiar and vile odor in the restroom with Jerry, but it was only a suspicion.

It was several weeks before anyone noticed that Jerry, who seemed to subsist on an occasional chocolate bar and never bringing sandwiches or wasting quarters on the large soft drink machine, was actually drinking gasoline.

When one of the other attendants questioned him about this he replied that he "only liked the smell of it."

He generally fed a few times a week and, if he could arrange it, in the mid-afternoon before the 5 o'clock rush.

Large expensive new automobiles driven by the elderly - unlikely to get out of the car and chat or inspect their tires.

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At 4:07 the sun, a red ball through the smoke and haze, only about 8 degrees above the horizon - temperature 34 degrees F., a large new Cadillac curves into the station from the east entrance—an old and uncertain driver.

His small bald head within the huge Cadillac like the head of some gigantic reptile whose body grows and grows until it is killed.. Jerry knelt in the shadow by the rear bumper, after properly topping off the tank.

He squeezes the trigger again with his left hand spooning the chilly gasoline up with his cupped right hand - like a man drinking from a stream - quickly swallowing 7 or 8 handfulls.

Jerry was dismissed from his job. The other attendants had become uneasy about him though he'd only been seen to drink once. His strange pleasantness about the difficulties of the station and the suspicion about the odor others bumped into in the restroom - a strange mixture of acetone and ammonia. The boss decided he just "didn't fit in."

MECHANICAL EQUIVALENT OF SOLAR ENERGY

1000 BTUs per day is a conservative average for solar radiation absorbed by the earth. How deep a pool could this sunshine raise 778 feet high above the ground against the force of gravity? Water weighs about 62 lbs./cubic foot.

So that if all the energy reaching the earth were convertible to raising a weight of water above the earth, this could amount to a layer 16 ft..deep each day raised 778 feet.

If a man were able to use all the sunlight falling on his body for his own metabolism what share of his diet would be sunlight? Let us say a man is able to shade an area of 6 feet square. By laying flat on the ground it would be a quite simple matter to pick up half of one's energy needs on fairly sunny days - and then by positioning - moving to well exposed slopes – and changing as the sun orientation changes the way lizards do during the day it would be easy to multiply this pickup by 2 or 3 - depending on the time of year.

THE "BASKERS"

Spread it on, the super sun oil, then stand out in the sun - that's all you need to do. Your oily skin can produce the materials your body needs if you are exposed to sunlight. The ultimate in solar energy devices.

You must practice. The more you use it, the better it works. First week of so it will just take the edge off your hunger. After a year you don't need to eat any more often than a snake. The oil's development is still a little unclear, it seems it was first tested as a weed killer. It is known to be poisonous to plants. And the plants suffer from it all around. Trampled and flattened bushes in city parks, trees with limbs broken off by the oily climbers moving toward the sun.

Yes, a great migration to the Southwest. No, it isn't what you'd call a boom. These people aren't staying in motels or eating in restaurants or building houses or buying much clothing. Of course, the oil is selling great. It's very difficult to know what kind of stand to take about it. Some see it as a cure to mankind's problems. Others have formed vigilante groups to go "hoe weeds," murdering dozens of lethargic baskers.

"Damn it Ray, go out and get a job."

"Sure Dad." Later in the day find he's not done anything, just out in the yard, stripped to his shorts. Starting in on the oil.

You look close at one of them under a very strong flourescent light - and there is a definite green tinge. The only time they ever come into town is during the cloudy weather - and we'd just as soon not see them then - all they are doing is waiting for the sun.

EQUATIONS & ENERGY EQUIVALENCES

You can always turn mechanical energy into thermal energy, but it is not so easy to turn thermal energy into mechanical energy. An equation that reads 2546.14 BTUs equals 1 horsepower hour can be misleading.

I can supply you with heat --let us say a bath tub full of hot water, but it is no easy matter, after you agree that you have been presented with such and such a quantity of BTUs, to balance the equation by converting this to mechanical energy. Mechanical energy can be taken back from thermal energy but only as a kind of tax on the transfer of heat between two temperatures. It is a difficult tax to collect and requires very careful contrivances and can never exceed very definite properties. More about this later.

EQUATIONS ARE STRANGE

Why should two plus four equal two times three? If you object to such an equation, 2 plus 4 equals 2 times 3, saying that you understand that to be equal the two sides must be just the same, you will be told that they are abstractions, qualities derived from both sides that are equal and that it is missing the point to belabor such trivial matters as that the two sides don't even look the same. But you press your point - how can two things that are born of different processes possibly be the same.

Standing a car in the sunshine for one minute and crashing a car at the bottom of a 120 ft. cliff are equal thermally, but you have very different objects at the end of each operation.

What sense can it make to turn to numbers and equations when it is heat or energy that we want and not numbers.

In house solar heating systems the final test is how the inhabitants feel about the house. With a solar water heater the test of the system is not just how many gallons of hot water you get each day, but how you feel about it - how you use the hot water. A man can stand under a hot shower heated by gas or electricity and stay and stay soothing himself by the heat of the water. When he runs out of hot water he feels a bitterness towards the hot water heater. When he takes a long shower he feels guilty because his gas or electricity bill will be higher that month.

With a solar hot water heater he takes long hot showers when it is sunny and feels fine about it - when it is cloudy he takes a short shower or if it continues cloudy for several days he doesn't shower at all.

Science, engineering, technology can be wonderful arts. Often they are practiced very sloppily. Much of this has to do with poor handling of equations and equivalences.

After a thousand simple equations have been employed in manufacturing and designing things they gain a kind of momentum and those involved in the design and use are reluctant to give up a good thing, namely, the simple equations, and deal with how they feel. Instead, the people feel obliged to try and become the way that the contraption or machine was designed to have them be.

ROBOTS IN COMMAND

If you doubt this notice what happens the next time you are in a store and the telephone rings. The customer who has walked in with his head and body is left standing while the business of the person who has called on the telephone is taken care of. The heirarchy in a drive-up liquor store is usually car, telephone, human.

The equation with its balancing equals sign is a forceful invitation to our minds to jump from one side to the other. Sometimes we later find that a balance existed between relatively tiny aspects of what we believed stood on one side and the other. A story and a wordy explanation are much more trustworthy.

We hold enormous animals in fields with thin wires and relatively weak posts - later we gather them and kill them. They never understand what the wire is for - they don't break through it. The cattle won't move through our flimsy fences. We are just the opposite, we won't stop from leaping each time we see an equals sign.

P.W. Bridgeman, the American physicist and philosopher, filled his books with lengthy descriptions and explanations and very few equations. I quote a passage from his book, Dimensional Analysis:

"...we have treated the dimensional formula as if it expressed operations actually performed on physical entities, as if we took a certain number of feet and divided them by a certain number of seconds. Of course, we actually do nothing of the sort. It is meaningless to talk of dividing a length by a time; what we actually do is to operate with numbers which are the measure of these quantities. We may, however, use this shorthand method of statement, if we like, with great advantage in treating problems of this sort, but we must not think that we are actually operating with the physical things in any other than a symbolical way."

EVAPORATING WATER

It takes 1 BTU to raise 1 pound of water 1 degree Fahrenheit.

It takes about 1000 BTUs to boil away or evaporate 1 pound of water.

A quart of gasoline gives off about 30,000 BTUs when burned. Burning a quart of gasoline could boil away about 4 gallons of water. It could also boil away about 12 gallons of alcohol and about 25 gallons of gasoline. Water is very reluctant to evaporate. When water condenses it gives back the 1000 BTUs used in evaporating it. Clouds, which are made up of condensed droplets, are gigantic heat dumps. As clouds grow, heat is released.

If the oceans were gasoline we could expect to have much more gasoline rain than we now have water rain. Gasoline evaporates and condenses so much more easily.

BURNING A QUART OF MILK

The calorie content of 1 quart of milk is about 660 kilocalories or 2640 BTUs. About 1/10 the calorie value of 1 quart of gasoline.

BOOKS

Dimensional Analysis
P.W. Bridgeman
Yale Press, 1922

Energy and Society
Fred Cottrell
McGraw Hill, 1955

End of Chapter