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TAMING WASTE VIA LAWS OF PHYSICS

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ABSTRACT

Achieving sustainable solutions to today's burning environmental problems like atmospheric pollution, waste management etc requires some effective long term result oriented actions. These can be correlated with energy resources generations and its uses. An understanding of laws of Physics particularly thermodynamics laws can help in providing a sustainable solution to these serious problems. This article discuss how efficient energy resources utilization is related to waste and environmental problems. The renewable energy appear to provide an effective solution to waste production and its management . The various laws of physics give an idea of their future energy utilization patterns. These laws do not offer complete solution to such waste production and environmental degradation but provide ways to minimize them to such an extent that it remains within the limit of human tolerance. This can also show that efficient and economic utilization of energy resources particularly renewable energy can results in sustainable solution to waste.

Keywords: Environment, Waste, Renewable energy, Energy.

Contribution/ Originality

The paper's primary contribution is finding that it is renewable source of energy not only produce waste within tolerance limit but also help in managing many environmental issues.

1. INTRODUCTION

Every universal phenomena is related to either creation or destruction of some basic components. The basic necessity for such activities of nature is energy. It is not only component of nature, other equally important component is matter. These basic components of nature - matter & energy, are never independent but related through famous Einstein relation $E = MC^2$, where E denotes energy, M mass of matter and C the velocity of light. The organism captures matter and energy from its environment and transfers them into structures and processes that make life possible. In order to have such usable end product form of nature it require lot of energy .

Although laws of physics have been in existence since the creation of the universe, need of such laws did not emerge until human try to construct the first successful use of energy. The

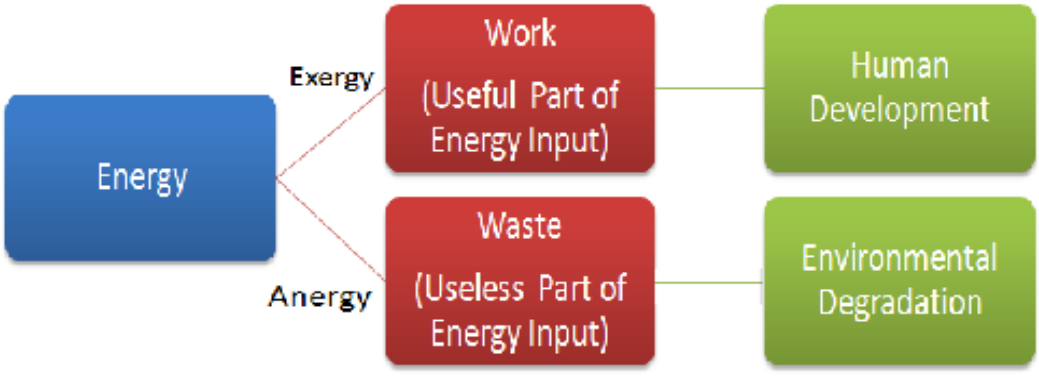
Laws of Physics particularly thermodynamics characterize such energy flow between system and surrounding. Here system may refer to living beings and surrounding with our environment. The system and surrounding nature cannot be understood completely without the reference of each other because they may exchange energy and matter. The state of equilibrium system can be described in terms of measurable property like temperature, pressure and entropy etc. These laws give an idea of slow and inefficient energy system that lead to production of waste. The waste is closely related with energy resources generation, transportation and use. The choice of energy resource and it degree of closeness in sense of thermo dynamical variable change play role in minimizing our waste production so it remains within the limit of human tolerance.

The term waste actually doesn't exist in nature, it only reflect inability of the human to use it or convert it to other usable form which is quite possible. But any such possibilities is outrightly denied by impatience and fictitious consumer urgency in human. While in nature conversion of waste into useful forms of energy effortlessly and silently going on in nature.Therefore to tame the waste we should follow nature rule and always opt for those energy resources that require less energy expense.

2. WASTE AND LAWS OF THERMODYNAMICS

Energy is basic requirement of all thermodynamic processes. The energy has many different manifestation such as electrical, sound, light, chemical, mechanical etc. The first law of thermodynamics simply express that total energy is always conserved i.e. it can be neither destroyed nor created. During development of any process there is change in the respective form of energy. The resultant form of energy may both be useful or not. It is better to have a useful part of convertible form of energy. It is second law of thermodynamics which express the impossibility of 100% conversion of input energy into useful energy. The every energy input to a system or machine always accommodated with useful work done and some unwanted form of energy. This unwanted form of energy represent waste. This waste dissipated in the environment and eventually contributes to environment degradation. It is energy efficiency that play a central role in waste production and environmental impacts. For example -

- **Construction Process :** The cement is basic requirement of all construction process. This is obtained from heating metal carbonate, on heating it gives a useful output part - cement along with large amount of byproduct CO_2 . This part of energy goes to degrade environment.
- **Yeast Fermentation Process :** It is for the production of ethanol in beers, wines, and other alcoholic drinks, along with the production of large quantities of carbon dioxide a by-product waste that contribute toward environmental degradation.

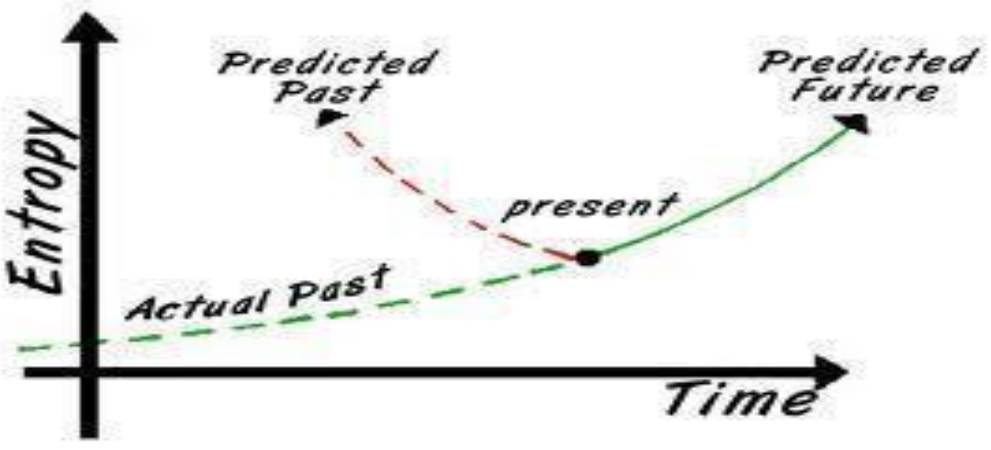


Form above examples and previous study one can easily claim that waste is related to laws of thermodynamics. So it is the quality of energy (quality represents degree of useful form of energy) which decided waste quality and quantity. The basic target is how to minimize waste with required development. Here maximum work obtained is known as EXERGY while the destructed part of energy is called ANERGY (Ibrahim, 2000; Jo Dewulf, 2002).There are many studies claiming close relationship between energy use and environmental impact from late 1980s by Szargut (1980), Gunnewiek and Rosen (1998) and many more (Wepfer and Gaggioli, 1980; Adrian, 2002; Helmut and Paul, 2002; Jo Dewulf, 2002).

So energy use with maximum efficiency is one of major problems and directly related to waste part of energy. The concept of zero waste is made impossible by 2nd law of thermodynamics (impossibility if a perpetual machine) so it can only be minimized under the direction of second law of thermodynamics. The waste can minimize by either undermining development process or having most efficient systems. Since human development cannot be point of compromise in today's time, so it comes to efficiency of system to improve.There is another thermodynamic quantity namely entropy which can directly related to efficiency of the system. The quantity Entropy is consider as an index of disorder (Rosen and Dincer, 1997).

A system state with high disorder means high energy states which always occur with the highest probability. The entropy of an open system (a system that exchanges matter / energy with its environment) can increase or decrease with energy use. The total entropy change (system plus surrounding) decide the possibility of any thermodynamic process. If total entropy change for any process is negative, it is impossible in practice unless outside energy is supplied. Entropy of a system decrease, it must be open. This is how biological systems decrease their entropy (increase their order); they do so by increasing the entropy of their environment. If the increase of entropy of a system is a low value, then system move towards openness and it is this openness which is the one of most importance for achieving sustainable development. To have low-entropy (sustainable) development it is necessary to redefine the "system" to be designed and built to include as much of the environment as possible (Wepfer and Gaggioli, 1980).

In a development context the "system" should be defined in the usual way as the part designed and built by humans and include the environment to which it is unavoidably open. So total entropy (system + surrounding) always increases . Figure (1) show that entropy is increasing with time. If one can decrease the entropy by simply reorganizing everything as it represent degree of disorderness but that reorganization would require energy forming heat or light or sound which indirectly creating more entropy (Jo Dewulf, 2002). For example -



If you were to start out with a perfectly clean room and put blocks or books or something in a organized way in the room zero entropy. Now say something comes and moves some of the items around thereby increasing the entropy of the room, now you might think that you could return the room back to zero entropy simply by rearranging the items but that would require some form of energy which would therefore produce more entropy as a result of friction and resistance from any atom or molecule encountered, once again increasing the entropy of the room. So basically what we say is that in order to decrease the entropy of a closed system you must use energy, which produces more entropy than you removed.

So entropy of universe is always increasing with time. The entropy play a link between energy and exergy as due to increase in entropy less energy is available to do useful work. This indirectly related with waste production of system. It is this destroyed energy of generated entropy which is responsible for less efficient system. The proportionality between exergy destruction and entropy generation provide a hind to machine designers in search of improved thermodynamic performance (Adrian, 2002). As entropy cannot zero so our society ultimate goal for zero waste (matter/energy) is unachievable as explained by thermodynamic laws .So in all process some unused matter/energy and will always results in waste produce . Hence it is worthless to discuss complete pollution free society but what we can do is that it comes down as much as possible to a tolerance limit.

3. WASTE AND ENTROPY EXPORT

Most natural system are open and can exchange matter with their environment simultaneously. The exchanging of mass and energy transfer with the environment through export of entropy. If this export is higher than the entropy production due to a process, then the

entropy of the system is reduced. A lower entropy is, however, equivalent to a higher state of order as in the environment. For example,

In an open system energy irradiated from the Sun is again emitted by our Earth. The sun irradiating energy to earth at approximate temperature 5800K to the Earth and the same amount of energy is emitted by the earth at around temperatute 300 K. So irradiated heat flux of the Sun is equal to emitted heat flux of the earth (i.e. $T_{sun} \times Entropy_{sun} = T_{Earth} \times Entropy_{earth}$). So iin Earth-Sun open system the entropy export of the Sun is about 20 times higher than the entropy import by Earth (Wolfgang and Karl, 2001).This large difference comes from the entropy production due to natural processes on the Earth, but it also enables the formation of higher structured systems and particularly the emergence of life. This interpretation can also be applied to subsystems on earth.

The entropy export is realized through the emission of heat and mass, in other words, through the emission of fluxes consisting mostly of waste energy and waste products. But the waste energy appears in a different view: as an entropy carrier it helps to maintain or establish the state of order within the system. So entropy export of waste is can be made possible by the approach to reversibility recycling but this require our save primary energy. The solution for entropy export can also be learn from nature. In nature there are cluster of systems where one system output is used as a main item of input by some other system. The next system is exist in close to previous one in order to cut down transportation entropy increases. This is a self-sufficient community. The carbon, nitrogen cycle are represent few example of entropy export with systems. Such reduction or better utilization of waste energy not only reduces the ecological damages but also helps to save primary energy.

Therefore waste multi-reuse and recycling should be given priority for a better solution of waste entropy export. A reduction or use of waste entropy, therefore, does not only reduce the ecological damage but also reduces the energy consumption and, thus, save primary energy.

4. WASTE AND ENERGY RESOURCES

The previous sections emphasizes that waste is the resultant from the limitation of laws of thermodynamic and has a close relationship with the quality and forms of energy. Various choice of energy resources are available to compete for our energy requirement. Most of the energy resources are not having good quality and on the other hand energy demand of society has been growing day by day either due to rise in population or increasing per capita energy consumption as a result of ever rising life standards . So a suitable choice of energy resource can play a major role in minimizing waste.

Today commonly use energy resources are non-renewable resources such as coal, petroleum etc. These resources are not only limited but also requires large amount of previous stored energy for its various process like mining, shipping , processing etc. All these steps accumulate lot of waste due large entropy change. Our environment can export that waste entropy but fails due to large quantity and short period. Therefore resulted in environmental damage and the human society has to face various problem like Oil Crises, Global Warming etc.

So change of energy resources can be a good option for all of us. A good energy resource must be –

1. Efficient so that produce less waste or less damage to environment.
2. Having infinite input capacity can have less waste generation capacity.
3. Zero or having minimum entropy change generate less waste.
4. Multipurpose and abundance can be a beneficial for less waste generation.

The most of these requirement are fulfilled by natural renewable resources such as the sun , water , heat , wind, plant waste products etc. These renewable energy resources comes directly of indirectly from the sun which makes life possible on earth so are constantly replenished and will never run out. These not only satisfies our increasing energy demand but also help in maintaining low entropy change as most of them can be used directly. The choice of renewable resource depends on availability , technological appropriateness and socio-cultural acceptability . Through such energy resource use one can also avoid unnecessary process like mining, shipping etc. so save energy and keep entropy change to a low value. These resources not only helps in producing low waste due to entropy export within system but also such resources waste can be reuse by other environmental components. All these help in maintaining a thermodynamical equilibrium of ecology and environment .

From physics point of view renewable energy is better than non renewable because –

1. In Solar energy main source is sun which has infinite input capacity.
2. Renewable energy will be available for future generation also so enhancing sustainable development while utilizing energy.
3. These sources must be opted that can produce such kind of waste which can be recycled into useful input so eco friendly also.
4. These resources not required any mining or shipping so cause less environmental damage

Hence Renewable energy technologies are clean sources of energy that have a much lower environmental impact than conventional energy technologies.

5. CONCLUSIONS

Today waste crisis and the continuing emphasis on energy efficiency (conservation of fuel resources) has led to a complete overhaul of the way in which power systems are analyzed and improved thermodynamically. The laws of physics himself do not offer any solution but can provide with an importance guidelines, insight and inspiration to direct our effort towards economic and ecological use of energy resources. The integration of these thermodynamic laws into energy resources hinges on a limits of environmental impacts. The entropy is almost related to waste or energy and a good choice of energy resource help in minimizing entropy change. It is renewable resources which produces low waste by maintaining low entropy change and

reuse within system. These resources help in maintaining thermodynamical equilibrium and also provide energy security for us.

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