International Journal of Psychosocial Rehabilitation, Vol. 23, Issue 03, 2019
ISSN: 1475-7192

Air Conditioning System Using Vechile Suspension

R. Hariharan, I. Aburarul Haq, R. Arun Kumar, E. Balaji and
M. Barath Kumar

Abstract--- *In this project we are collecting air cylinder and store this energy to the compressor tank as non-conventional method by simply driving the vehicle. Non-conventional energy system is very essential at this time to our nation. Compressed air production using vehicle suspensor needs no fuel input power to produce the output of the air. For this project the conversion of the force energy in to air. The control mechanism carries the air cylinder (vehicle suspension), quick exhaust valve, Non-return valve and spring arrangement. Then this compressed air is passed to the heat exchangers. That is used to convert the heat air into cold air. Cold air is passed to the vehicle. The conventional vehicle suspension dissipates the mechanical energy i.e. potential and kinetic energy. In spring potential energy is stored and kinetic energy is wasted. The aim of paper is this wasted energy is compressed by using single acting cylinder by proper arrangement. The main aim of this paper is the compressed air production using vehicle suspension is given to the air conditioning system. The pushing power is converted into compressed air energy by proper arrangement .The pneumatic single acting cylinder is used for this project to compress the air. The output air from the pneumatic cylinder is collected through quick exhaust valve and non return valve and this compressed air stored inside the storage tank. After this research we concluded in car there is a lot of fuel burn only for working of A.C. while driving the car. If A.C. will run on other system rather than fuel then there is lot of fuel save in car hence the efficiency of car will also increases.*

Keywords--- *Suspension System, Single Acting Cylinder, Non-Return Valve, Storage Tank, Heat Exchanger.*

I. INTRODUCTION

In the new age of electrical vehicle, everything has to be rethought. After one hundred years, people will laugh at today's hybrid and pure electric vehicle rather in the way we laugh at motor vehicle from 1880 that looked like something dragged along by a horse because that was starting point. Inside and out, today's vehicle almost look almost the same as what we went before. The function of vehicle suspension system is to support the weight of the vehicle body, to isolate the vehicle chassis form road disturbances, to enable the wheels to hold the road surface. Two main elements in suspension systems are spring and damper. The damper is designed to dissipate vibration energy into the heat to attenuate the vibration which is transmitted from road excitation. However, the dissipated heat is from fuel or electrical power. In hybrid vehicle recapture some of the energy usually lost in braking system but the dissipation of vibration energy by shock absorbers in the vehicle suspension remains untapped.

R. Hariharan, Assistant Professor, Department of Mechanical Engineering, BIST, BIHER, Bharath Institute of Higher Education & Research, Selaiyur, Chennai.
I. Aburarul Haq, UG Student, Department of Mechanical Engineering, BIST, BIHER, Bharath Institute of Higher Education & Research, Selaiyur, Chennai.
R. Arun Kumar, UG Student, Department of Mechanical Engineering, BIST, BIHER, Bharath Institute of Higher Education & Research, Selaiyur, Chennai.
E. Balaji, UG Student, Department of Mechanical Engineering, BIST, BIHER, Bharath Institute of Higher Education & Research, Selaiyur, Chennai.
M. Barath Kumar, UG Student, Department of Mechanical Engineering, BIST, BIHER, Bharath Institute of Higher Education & Research, Selaiyur, Chennai.

Received: 18 Feb 2019 | Revised: 06 Mar 2019 | Accepted: 02 Apr 2019

In the past, we pay little attention to energy loss of vehicle suspension. However, how much energy dissipated by the shock absorber of vehicle suspension? According to reference, only 10-20% the fuel energy is used for vehicle mobility. The linear motion of suspension system is also use for compress the air by using piston cylinder arrangement. By using this compress air we can run A.C. system in the car and save fuel.

“Energy in motion when it is suddenly applied with a sort of obstacle means according to Newton’s law for every action there is an equal and opposite reaction. Utilisation of this reaction is the basic reason behind the selection of this project work. ”

Man has needed and used energy at an increasing rate for his sustenance and well being ever since he came on the earth a few million years ago. Primitive man required energy primarily in the form of food. He derived this by eating plants or animals, which he hunted. Subsequently he discovered fire and his energy needs increased as he started. To make use of wood and other bio mass to supply the energy needs for cooking as well as for keeping himself warm. With the passage of time, man started to cultivate land for agriculture. With further demand for energy, man began to use the wind for sailing ships and for driving windmills, and the force of falling water to turn water wheels. Till this time, it would not be wrong to say that the sun was supplying all the energy needs of man either directly or indirectly and that man was using only renewable sources of energy.

II. WORKING PRINCIPLE

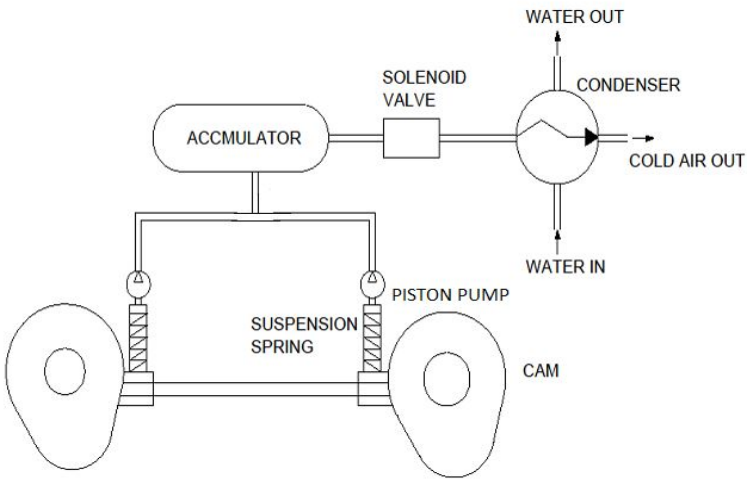

Fig. 1: Block Digarm

When vehicle is run on the rough or bumpy road surface then suspension spring continuously move up and down. We attach piston to the vehicle frame because of linear motion of piston, high pressure air comes out from cylinder. This high pressure air provides to air tank. In air tank high pressurized air is stored and when we want to turn on A.C. system this high pressurized air send to the heat exchanger by using knob. Low temperature coolant i.e. water (3.24°c) pass through the heat exchanger and also high temperature air pass through the heat exchanger by using knob (pipe). Here heat exchange occurs and air temperature becomes 15 °c-30 °c which is further send at the required place which is to be cooled.

Received: 18 Feb 2019 | Revised: 06 Mar 2019 | Accepted: 02 Apr 2019

III. MAIN COMPONENTS OF SYSTEM AND ITS WORKING

- Cam
- Spring
- Storage tank(accumulator)
- valve
- Heat exchanger

Spring

A spring is an elastic object used to store mechanical energy. Springs are usually made out of spring steel. There are a large number of spring designs; in everyday usage the term often refers to coil springs.

Small springs can be wound from pre-hardened stock, while larger ones are made from annealed steel and hardened after fabrication. Some non-ferrous metals are also used including phosphor bronze and titanium for parts requiring corrosion resistance and beryllium copper for springs carrying electrical current (because of its low electrical resistance).

When a coil spring is compressed or stretched slightly from rest, the force it exerts is approximately proportional to its change in length (this approximation breaks down for larger deflections). The rate or spring constant of a spring is the change in the force it exerts, divided by the change in deflection of the spring. That is, it is the gradient of the force versus deflection curve. An extension or compression spring has units of force divided by distance, for example lbf/in or N/m. Torsion springs have units of torque divided by angle, such as N·m/rad or ft·lbf/degree. The inverse of spring rate is compliance, that is: if a spring has a rate of 10 N/mm, it has a compliance of 0.1 mm/N. The stiffness (or rate) of springs in parallel is additive, as is the compliance of springs in series.

Depending on the design and required operating environment, any material can be used to construct a spring, so long as the material has the required combination of rigidity and elasticity: technically, a wooden bow is a form of spring. When vehicle is running on a bumpy or rough road surface, then shocks and vibrations transmitted to persons, which is very uncomfortable that’s why we use shock absorber to absorb shocks and vibrations to become comfort. Shock absorber is nothing but a spring.

Storage Tank

Air tank is made up of mild steel. A hole is drilled at the upper side and threading is done to keep the pressure gauge and then fix two ends using welding and make input and output air connection. All pressurize air come in tank from various cylinder pipes connection. The use of storage tank to store pressurize compressed air and supply this pressurize air for various use when required. Storage tanks are available in many shapes: vertical and horizontal cylindrical; open top and closed top; flat bottom, cone bottom, slope bottom and dish bottom. Large tanks tend to be vertical cylindrical, or to have rounded corners transition from vertical side wall to bottom profile, to easier withstand hydraulic hydrostatically induced pressure of contained liquid. Most container tanks for handling liquids during transportation are designed to handle varying degrees of pressure. A large storage tank is sometimes mounted

Received: 18 Feb 2019 | Revised: 06 Mar 2019 | Accepted: 02 Apr 2019

on a lorry (truck) or on an articulated lorry trailer, which is then called a tanker.

CAM

A cam is a rotating or sliding piece in a mechanical linkage used especially in transforming rotary motion into linear motion or vice versa. It is often a part of a rotating wheel (e.g. an eccentric wheel) or shaft (e.g. a cylinder with an irregular shape) that strikes a leverat one or more points on its circular path. The cam can be a simple tooth, as is used to deliver pulses of power to a steam hammer, for example, or an eccentric disc or other shape that produces a smooth reciprocating (back and forth) motion in the follower, which is a lever making contact with the cam. Here, we use the cam as wheel setup.

The most commonly used cam is the plate cam (also disc cam or radial cam) which is cut out of a piece of flat metal or plate.[7] Here, the follower moves in a plane perpendicular to the axis of rotation of the camshaft.[8] Several key terms are relevant in such a construction of plate cams: base circle, prime circle (with radius equal to the sum of the follower radius and the base circle radius), pitch curve which is the radial curve traced out by applying the radial displacements away from the prime circle across all angles, and the lobe separation angle. The base circle is the smallest circle that can be drawn to the cam profile.

A once common, but now outdated, application of this type of cam was automatic machine tool programming cams. Each tool movement or operation was controlled directly by one or more cams. Instructions for producing programming cams and cam generation data for the most common makes of machine were included in engineering references well into the modern CNC era. This type of cam is used in many simple electromechanical appliance controllers, such as dishwashers and clothes washing machines, to actuate mechanical switches that control the various parts.

Heat Exchanger

It is used to exchange the heat between two medium in which heat transfer is takes place from high temperature to low temperature and maintain the temperature at mean temperature.

There are two main types of shell and tube heat exchanger.

1. Parallel flow heat exchanger
2. Counter flow heat exchanger

We are using parallel flow shell and single tube heat exchanger in our project. This project is made with pre planning, that it provides flexibility in operation.

This project “regenerative suspension system” is designed with the hope that it is very much economical and help full to all vehicles to produce the compressed air. This project helped us to know the periodic steps in completing a project work. Thus we have completed the project successfully.

It has been a great experience while completing our project we come across lot many practical knowledge as well as experience. We had an opportunity to learn how project are been done. We received a lot of practical experience while working on this project as well as got enough freedom to our ideas for the improvement in our

assigned project and check whether ideas are fruitful.

Therefore the design must be as perfect as possible and special attention is given during each manufacturing activity. In the manufacturing we come to know how theoretical aspects are implemented in actual practice, we got to learn about different manufacturing processes, welding, gear, cutting etc.

Fig. 2: CAM

Solenoid Valve

A solenoid valve is an electromechanically operated valve. The valve is controlled by an electric current through a solenoid: in the case of a two-port valve the flow is switched on or off; in the case of a three-port valve, the outflow is switched between the two outlet ports. Multiple solenoid valves can be placed together on a manifold.

Solenoid valves are the most frequently used control elements in fluidics. Their tasks are to shut off, release, dose, distribute or mix fluids. They are found in many application areas. Solenoids offer fast and safe switching, high reliability, long service life, good medium compatibility of the materials used, low control power and compact design. Besides the plunger-type actuator which is used most frequently, pivoted-armature actuators and rocker actuators are also used.

Fig. 3: Solenoid Valve

Advantages

This system has ability to reduce the in-car temperature to a comfortable level on exceedingly hot days, without having a seventy mile an hour gale buffeting you and being unable to hear the radio or your passengers because of the wind-noise.

Received: 18 Feb 2019 | Revised: 06 Mar 2019 | Accepted: 02 Apr 2019

- As aircon also conditions the air, the ability to remove the moisture from the air coming into the car on really muggy days and to achieve a comfortable atmosphere within the car, perhaps in conjunction with the heater control - the AC button will control the Relative Humidity and the heater if needed will control the temperature leaving you free to enjoy the warmth without being stuffy.
- The ability to be able to see through the windscreen and all the other glass clearly without a film of mist. The safety aspect of aircon is often overlooked but is extremely important, particularly to the people-carriers which are so popular now. Using the AC button to direct the air to the screen the moisture on the glass will be evaporated very rapidly, long before a screen-heater has had a chance to warm up and will continue this advantage around the side glasses and on to the rear screen. For best effect use the AC button, perhaps in conjunction with the heater in winter and on the fresh air setting (not recirculation). AC is usually extremely good at de-misting and this safety aspect of good all round visibility, even when picking up a crowd of wet noisy kids in winter, is one of AC's strong points. It has to be admitted that very occasionally the climate can be so very damp on odd days that even with the AC working effectively the demisting function can work only slowly but this is very much in the minority - for most days the AC will clear the screen like magic.
- The cleaner, fresher air with low Relative Humidity will enhance driver awareness and help prevent drowsiness making your journeys and those of your loved ones safer over long distances as drivers are better able to remain fresh and alert.
- Being caught in a long traffic jam on a hot day can be purgatory with all the exhaust fumes coming straight into your open windows, particularly if you are dressed for business - wet under the arms and hot under the collar - probably the time when you most wished that you had bought a car with aircon. This is when AC proves it is one of the nicest affordable luxuries.
- All the air coming into a car with aircon passes through a heat-exchanger, which as it is very cold, quickly becomes dripping with condensation, which collects and drains out under the car. Air entering this heat exchanger will contain dust and pollen grains, but by the time the air has passed through this heat-exchanger (called the evaporator) the vast majority of these pollutants will have been filtered out, trapped by the condensate and dripped back onto the road. It is estimated that approximately 80% of all dust and pollen is trapped in this way on each pass through the evaporator - this helps us all but is a source of particular relief to Hay Fever sufferers or Asthmatics, particularly children. Most modern cars now also include a filter to remove most pollen and dust, although frequently called a Pollen Filter it should really be called a Cabin Filter as it is very useful in both summer when pollen is rife and in the rest of the year to remove road dirt and other pollutants such as brake and tyre dust. The AC will simply assist the removal of these pollutants.
- By using this system we can reduce the fuel consumption rate by producing required air from the suspension
- By allowing all car windows to remain closed, even on the hottest days, the aerodynamics of the car remain at optimum, keeping fuel consumption low and exterior noise to a minimum, increasing safety to the driver and passengers.

Received: 18 Feb 2019 | Revised: 06 Mar 2019 | Accepted: 02 Apr 2019

IV. DESIGN CALCULATION

Selection of Compressor

Compressor specifications

Motor H.P= 0.5 H.P.

Speed= 640 r.p.m

Cylinder specifications

No of cylinders = 1

Bore diameter = 63.5 mm

Stroke length = 762 mm, Displacement = 4825cm³

Details of Design Evaporator

The selected evaporator for the design is natural convection bare tube, Dry Expansion, Shell and tube Evaporators.

Heat reaches the Evaporator by all three methods of heat transfer and conduction and Radiation.

Design of Evapourator

Inlet temperature of the evaporator coil (T1) = -1.6°C

Outlet temperature of evaporator coil (T2) = 3.4°C

Temperature difference between inside and outside of the evaporator = (3.4)+(1.6) = 5

The overall heat transfer, co-efficient "U" factor from data tables for copper = 400kcal/m2-hr-°C

Load taken by the evaporator = AU ΔT

i.e. Refrigerating capacity = AU ΔT

Refrigerating capacity = load taken by Evaporator =1555 = AU ΔT

A = 1555/ U ΔT = 1555/ (400 x 5) = 0.77 m2

Diameter of the coil (D) = 5mm

Then A = πDL

Length of the coil (L) = A/πD = 0.77/(π x 0.005) = 49.5m

Length of coil in one turn = 124+(62x2) = 248 cm

Number of turns in the tank = 4950/248 = 19.9506 turns, say 20 turns

Provide 10 cm gap between each turn of the coil. The evaporator coil should be arranged the side of the tank that will be easy for periodic cleaning.

Received: 18 Feb 2019 | Revised: 06 Mar 2019 | Accepted: 02 Apr 2019

Selection of Condenser

The condenser load can be calculated by the following equation:

Heat transfer Q=m Cpl (T3-T2)

Load on the condenser = m Cpl (T3-T4)

Q = heat absorbed in evaporator + heat of compressor.

Heat absorbed in evaporator = 1555 k cal/h

Heat of compressor = v x 1

= 220 x 3

=640w

= 640 x 0.86

= 550.4 kcal.

Q = 1555 + 550.4 = 2105.4 k cal

Q = UA ΔT

A = 2105.4/ 400 x 22

= 0.239

A = πdl

d = 5mm

Length of coil (L) = 0.239 / 0.005

= 15.23m

Length of turn = 126 cm

Number of turns required = 15.23 / 1.26

= 11.904

= 12

Calculations

Evaporator Temperature (T1) = -30ºC

Condenser Temperature ($T2^1$) = 30ºC

From charts,

At -30ºC, Enthalpy (h1) = 338.143 kJ/kg

Entropy (s1) = 1.57507 kJ/ (kg.K)

At 30ºC, Enthalpy ($h2^1$) = 363.566 kJ/kg

Entropy ($s2^1$) = 1.54334 kJ/ (kg.K)

Enthalpy (h3) = 228.540 kJ/kg

From the graph, s1 = s2 and h3 = h4

We know that,

$h2 = h2^1 + Cp (T2 – T2^1)$

Equation – A

Received: 18 Feb 2019 | Revised: 06 Mar 2019 | Accepted: 02 Apr 2019

$s2 = s2^1 + Cpln (T2/T2^1)$

1.57507 = 1.54334 + 0.7253 * ln (T2/303)

On simplification we get, T2 = 316.5 K

Substituting in Equation – A we have,

h2 = 363.566 + 0.7253 * (316.5 – 303)= 373.35 kJ/kg

(1)Refrigerating Effect = h1 – h4 = 109.603 kJ/kg

(2)Coefficient of Performance (C.O.P) =Refrigerating Effect / Work done by the Compressor

= (h1 – h4)/ (h2 – h1)

= 3.11

V. CONCLUSION

Vehicle Suspension Energy Generation is very efficient and useful in converting the Kinetic Energy from the movement of the vehicle, especially the suspension, which usually goes waste, to electric energy that can be used to fulfill needs of the auxiliaries in the vehicle. Currently the batteries of automobiles are charged by specific alternator which is attached to IC engine shaft. So that the fuel used in automobiles is also consumed for rotating the alternator to charge the battery, this consumption is found to be 4% of total consumption. By newly designed suspension, regeneration system presently using alternator is detached from the engine and attached to the suspension system. If we install this regeneration system for all 4 wheels then we can generate high amount of electric power. This high amount of electric power can be used for the working of car air conditioner or refrigeration system of vehicles. This suspension system will be mostly useful for heavy compressed vehicles, milk trucks, fire brigade trucks and also those having high requirement of electricity inside it. From result table we are observed that for a small number of teeth of gear we get the maximum voltage and current.

REFERENCES

[1] Thooyamani, K.P., Khanaa, V., & Udayakumar, R. (2014). Virtual instrumentation based process of agriculture by automation. *Middle-East Journal of Scientific Research*, *20*(12): 2604-2612.

[2] Udayakumar, R., Kaliyamurthie, K.P., & Khanaa, T.K. (2014). Data mining a boon: Predictive system for university topper women in academia. *World Applied Sciences Journal*, *29*(14): 86-90.

[3] Anbuselvi, S., Rebecca, L.J., Kumar, M.S., & Senthilvelan, T. (2012). GC-MS study of phytochemicals in black gram using two different organic manures. *J Chem Pharm Res*., *4*, 1246-1250.

[4] Subramanian, A.P., Jaganathan, S.K., Manikandan, A., Pandiaraj, K.N., Gomathi, N., & Supriyanto, E. (2016). Recent trends in nano-based drug delivery systems for efficient delivery of phytochemicals in chemotherapy. *RSC Advances*, *6*(54), 48294-48314.

[5] Thooyamani, K.P., Khanaa, V., & Udayakumar, R. (2014). Partial encryption and partial inference control based disclosure in effective cost cloud. *Middle-East Journal of Scientific Research*, 20(12), 2456-2459.

[6] Lingeswaran, K., Prasad Karamcheti, S.S., Gopikrishnan, M., & Ramu, G. (2014). Preparation and characterization of chemical bath deposited cds thin film for solar cell. *Middle-East Journal of Scientific Research*, *20*(7), 812-814.

[7] Maruthamani, D., Vadivel, S., Kumaravel, M., Saravanakumar, B., Paul, B., Dhar, S.S., Manikandan, A., & Ramadoss, G. (2017). Fine cutting edge shaped Bi2O3rods/reduced graphene oxide (RGO) composite for supercapacitor and visible-light photocatalytic applications. *Journal of colloid and interface science*, *498*, 449-459.

[8] Gopalakrishnan, K., Sundeep Aanand, J., & Udayakumar, R. (2014). Electrical properties of doped azopolyester. *Middle-East Journal of Scientific Research*, *20*(11). 1402-1412.

Received: 18 Feb 2019 | Revised: 06 Mar 2019 | Accepted: 02 Apr 2019

[9] Subhashree, A.R., Parameaswari, P.J., Shanthi, B., Revathy, C., & Parijatham, B.O. (2012). The reference intervals for the haematological parameters in healthy adult population of chennai, southern India. *Journal of Clinical and Diagnostic Research: JCDR*, *6*(10), 1675-1680.

[10] Niranjan, U., Subramanyam, R.B.V., & Khanaa, V. (2010, September). Developing a web recommendation system based on closed sequential patterns. In *International Conference on Advances in Information and Communication Technologies*, *101*, 171-179. Springer, Berlin, Heidelberg.

[11] Slimani, Y., Baykal, A., & Manikandan, A. (2018). Effect of Cr3+ substitution on AC susceptibility of Ba hexaferrite nanoparticles. *Journal of Magnetism and Magnetic Materials*, *458*, 204-212.

[12] Premkumar, S., Ramu, G., Gunasekaran, S., & Baskar, D. (2014). Solar industrial process heating associated with thermal energy storage for feed water heating. *Middle East Journal of Scientific Research*, *20*(11), 1686-1688.

[13] Kumar, S.S., Karrunakaran, C.M., Rao, M.R.K., & Balasubramanian, M.P. (2011). Inhibitory effects of Indigofera aspalathoides on 20-methylcholanthrene-induced chemical carcinogenesis in rats. *Journal of carcinogenesis*, *10*.

[14] Beula Devamalar, P.M., Thulasi Bai, V., & Srivatsa, S.K. (2009). Design and architecture of real time web-centric tele health diabetes diagnosis expert system. *International Journal of Medical Engineering and Informatics*, *1*(3), 307-317.

[15] Ravichandran, A.T., Srinivas, J., Karthick, R., Manikandan, A., & Baykal, A. (2018). Facile combustion synthesis, structural, morphological, optical and antibacterial studies of Bi1− xAlxFeO3 ($0.0 \leq x \leq 0.15$) nanoparticles. *Ceramics International*, *44*(11), 13247-13252.

[16] Thovhogi, N., Park, E., Manikandan, E., Maaza, M., & Gurib-Fakim, A. (2016). Physical properties of CdO nanoparticles synthesized by green chemistry via Hibiscus Sabdariffa flower extract. *Journal of Alloys and Compounds*, *655*, 314-320.

[17] Thooyamani, K.P., Khanaa, V., & Udayakumar, R. (2014). Wide area wireless networks-IETF. *Middle-East Journal of Scientific Research*, *20*(12), 2042-2046.

[18] Sundar Raj, M., Saravanan, T., & Srinivasan, V. (2014). Design of silicon-carbide based cascaded multilevel inverter. *Middle-East Journal of Scientific Research*, *20*(12), 1785- 1791.

[19] Achudhan, M., Jayakumar M.P. (2014). Mathematical modeling and control of an electrically-heated catalyst. *International Journal of Applied Engineering Research*, *9*(23), 23013.

[20] Thooyamani, K.P., Khanaa, V., & Udayakumar, R. (2013). Application of pattern recognition for farsi license plate recognition. *Middle-East Journal of Scientific Research*, *18*(12), 1768-1774.

[21] Jebaraj, S., Iniyan S. (2006). Renewable energy programmes in India. *International Journal of Global Energy Issues*, *26*(43528), 232-257.

[22] Sharmila, S., & Jeyanthi Rebecca, L. (2013). Md Saduzzaman., Biodegradation of domestic effluent using different solvent extracts of Murraya koenigii. *J Chem and Pharm Res*, *5*(2), 279-282.

[23] Asiri, S., Sertkol, M., Guner, S., Gungunes, H., Batoo, K.M., Saleh, T.A., Manikandan A., & Baykal, A. (2018). Hydrothermal synthesis of CoyZnyMn1-2yFe2O4 nanoferrites: magneto-optical investigation. *Ceramics International*, *44*(5), 5751-5759.

[24] Rani, A.J., & Mythili, S.V. (2014). Study on total antioxidant status in relation to oxidative stress in type 2 diabetes mellitus. *Journal of clinical and diagnostic research: JCDR*, *8*(3), 108-110.

[25] Karthik, B. (2014). Arulselvi, Noise removal using mixtures of projected gaussian scale mixtures. *Middle-East Journal of Scientific Research*, *20*(12), 2335-2340.

[26] Karthik, B., Arulselvi, & Selvaraj, A. (2014). Test data compression architecture for low power VLSI testing. *Middle - East Journal of Scientific Research*, *20*(12), 2331-2334.

[27] Vijayaragavan, S.P., Karthik, B., & Kiran Kumar, T.V.U. (2014). Privacy conscious screening framework for frequently moving objects. *Middle-East Journal of Scientific Research*, *20*(8), 1000-1005.

[28] Kaliyamurthie, K.P., Parameswari, D., & Udayakumar, R. (2013). QOS aware privacy preserving location monitoring in wireless sensor network. *Indian Journal of Science and Technology*, *6*(5), 4648-4652.

[29] Silambarasu, A., Manikandan, A., & Balakrishnan, K. (2017). Room-temperature superparamagnetism and enhanced photocatalytic activity of magnetically reusable spinel ZnFe 2 O 4 nanocatalysts. *Journal of Superconductivity and Novel Magnetism*, *30*(9), 2631-2640.

[30] Jasmin, M., Vigneshwaran, T., & Beulah Hemalatha, S. (2015). Design of power aware on chip embedded memory based FSM encoding in FPGA. *International Journal of Applied Engineering Research*, *10*(2), 4487-4496.

Received: 18 Feb 2019 | Revised: 06 Mar 2019 | Accepted: 02 Apr 2019

[31] Philomina, S., & Karthik, B. (2014). Wi-Fi energy meter implementation using embedded linux in ARM 9. *Middle-East Journal of Scientific Research*, *20*, 2434-2438.

[32] Vijayaragavan, S.P., Karthik, B., & Kiran Kumar, T.V.U. (2014). A DFIG based wind generation system with unbalanced stator and grid condition. *Middle-East Journal of Scientific Research*, *20*(8), 913-917.

[33] Rajakumari, S.B., & Nalini, C. (2014). An efficient data mining dataset preparation using aggregation in relational database. *Indian Journal of Science and Technology*, *7*, 44-46.

[34] Karthik, B., Kiran Kumar, T.V.U., Vijayaragavan, P., & Bharath Kumaran, E. (2013). Design of a digital PLL using 0.35 Î¼m CMOS technology. *Middle-East Journal of Scientific Research*, *18*(12), 1803-1806.

[35] Sudhakara, P., Jagadeesh, D., Wang, Y., Prasad, C.V., Devi, A.K., Balakrishnan, G., Kim B.S., & Song, J.I. (2013). Fabrication of Borassus fruit lignocellulose fiber/PP composites and comparison with jute, sisal and coir fibers. *Carbohydrate polymers*, *98*(1), 1002-1010.

[36] Kanniga, E., & Sundararajan, M. (2011). Modelling and characterization of DCO using pass transistors. In *Future Intelligent Information Systems*, 86(1), 451-457. Springer, Berlin, Heidelberg.

[37] Sachithanandam, P., Meikandaan, T.P., & Srividya, T. Steel framed multi storey residential building analysis and design. *International Journal of Applied Engineering Research*, *9*(22), 5527-5529.

[38] Kaliyamurthie, K.P., Udayakumar, R., Parameswari, D., & Mugunthan, S.N. (2013). Highly secured online voting system over network. *Indian Journal of Science and Technology*, *6*(S6), 4831-4836.

[39] Sathyaseelan, B., Manikandan, E., Lakshmanan, V., Baskaran, I., Sivakumar, K., Ladchumananandasivam, R., Kennedy, J., & Maaza, M. (2016). Structural, optical and morphological properties of post-growth calcined TiO2 nanopowder for opto-electronic device application: Ex-situ studies. *Journal of Alloys and Compounds*, *671*, 486-492.

[40] Saravanan, T., Sundar Raj M., & Gopalakrishnan K. (2014). SMES technology, SMES and facts system, applications, advantages and technical limitations. *Middle - East Journal of Scientific Research*, *20*(11), 1353-1358.

[41] Gomathy, S., Deepa, K.P., Revathi, T., & Visuwasam, L.M.M. (2013). Genre Specific Classification for Information Search and Multimodal Semantic Indexing for Data Retrieval. *The SIJ Transactions on Advances in Space Research & Earth Exploration*, *1*(1), 10-15.

[42] Poongodi, R.K., & Sivakumar, T. (2018). Enhanced Adaptive Multimedia Data Forwarding for Privacy Preservation in Vehicular Ad-Hoc Networks Using Authentication Group Key. *Bonfring International Journal of Software Engineering and Soft Computing*, *8*(1), 26-30.

[43] Renuga Devi, M., Pavithra, D., & Dharani, K.R. (2014).Isolation Enhancement in Microstrip Patch Antennas for WiMAX Applications. *The SIJ Transactions on Computer Networks & Communication Engineering (CNCE)*, *2*(2), 1-4.

[44] Ismail, K., & KHALIL, N. H. (2019). Estimation of Reliability of D Flip-Flops Using MC Analysis. *Journal of VLSI Circuits and Systems*, *1*(1), 10-12.

[45] Pooja, & Vishwakarma, S. (2016). Abnormal Crowd behavior Detection Using Structural Context Descriptor. *Bonfring International Journal of Advances in Image Processing*, *6*(3), 17-21.

[46] Venkatesh Kumar, S. (2018). Comparative Analyses of Swarm Intelligence Methods for Dimensionality Reduction in Hyper Spectral Images.*Journal of Computational Information Systems*, *14*(3), 94 - 100.

[47] Dr. Srivastava, S., Srivastava, K., Pandey, A., & Sharma, A. (2014). Data Mining in Telecommunication Industries. *International Journal of Advances in Engineering and Emerging Technology*, *5*(2), 75-79.

[48] Mohankumar, T. (2014). Area-Efficient and High Speed Carry Select Adder. *Excel International Journal of Technology, Engineering and Management*, *1*(4), 108-111.

[49] Malathi Ravindran, R., & Dr. Thanamani, A.S. (2015). K-Means Document Clustering using Vector Space Model. *Bonfring International Journal of Data Mining*, *5*(2), 10-14.

[50] Alborji, B., & Heibari, A.H.K. (2015). The simulation and analysis of the vacancy of 3- phase- 5 levels' inverter with diodes' cut topology (DCMLI) and sinusoidal pulses with modulations technique (SPWM). *International Academic Journal of Innovative Research*, *2*(9), 33-43.

Received: 18 Feb 2019 | Revised: 06 Mar 2019 | Accepted: 02 Apr 2019