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Design and Fabrication of Automatic Vegetable Cutting Machine

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***Abstract*: Automation is the growing technology of the engineering world. Automation by innovation has reduced human effort and time to higher rate. The main objective of the project is to manufacture an automatic vegetable cutting machine using slider crank mechanism, with simple design, that saves time and that is of affordable cost and efficient during the process of size reduction of vegetables. Manual slicing of vegetable has ended up to be a tedious and time consuming process and is prone to the risk of food contamination leading to high risk of food borne diseases. Vegetable cutting is important for nourishment in all houses and cafes. Today in Indian market, in light of the advancement in way of life of working couples, the road side restaurant has become a developing business. At last, these sort of issues can be prevented by building up an automatic vegetable cutting machine.**

***Keywords*: Fabrication, Vegetable cutting machine.**

1. Introduction

Vegetable production has increased over the years. The increase has largely been as a result of a prolonged technological advancement. On a large scale, vegetables are produced to suit the supermarkets and some food industries and mainly for road side eateries. The major problem arises on decreasing the size of the vegetable so that it can be easily consumed by the customer. Several methods have been developed for the size reduction of vegetables. Traditional methods made use of knives and other machines devised for those purposes. These methods have proved to be time-consuming especially in our busy lives. Traditional method is still used in hostels of educational institutions, catering services and even in restaurants. The measure of vegetables to be cut for the dishes consistently stays higher than really what's devoured.

Today, most of the fields have embraced with automation, from manufacturing to food processing, biomedical and pharmaceutical industries. The processes which were manual before are slowly being converted to semi-automated and automated nature. Throughout the industrial era revolution, automated machines have gradually become a vital component of human life daily. Compared to their manual counterparts, automated machines have continuously saved most of the people’s time to carry out a certain task and this enhancement has greatly led to a more and more competitive and faster way of doing things. The associated difficulties like time constraint, contamination, etc. make it more difficult for the person handling the job. There, arose a need to automate the process of vegetable cutting, and here we came up with a machine which can help the people to overcome these issues.

In this machine, initially the motor is connected to the supply and it acts as a primary unit. To press the vegetable against the blade, we have chosen the Slider crank mechanism to convert motor’s rotary motion into linear reciprocating motion of the piston. Here, chain sprocket is used as the crank and piston arrangement is used for slider. The Slider crank mechanism is easy to construct when compared to other mechanisms. Because of various advantages of this mechanism we have used it to develop our prototype.

2. Objective

The main objective of this project is to,

- Provide an alternative to the existing automated system mainly, targeting the financial factor.
- Use simple design and mechanisms, thereby eliminating the difficulties associated with traditional method.
- To eliminate the contamination of vegetables.

3. Literature review

Gunjal A.V.et al. (2016), Robotization was the wrath of the designing scene. The arrangement includes a container game plan and the weight square is impelled by a pneumatic chamber, and has a responding movement along the vertical length of packaging, while the cutting lattice stays fixed. The air supply to the chamber is constrained by a solenoid activated DCV, which is constrained by a Timing circuit. The section of Lemon into the network mechanical assembly is controlled utilizing a pneumatic chamber alongside a Double bar system. Variable weight setting for cutting distinctive Lemon is done by the Timing circuit. The proposed work is profited by pneumatic force, which is abundant.

Tilekar J.S. et al. (2017), The fundamental objective of our gathering is to build up an organic product shaper and shaper system that is physically worked more, which is little in size and can work without the utilization of any electrical worked equipment. Our instrument remarkably structured with a balanced shaft instrument making competent to arrive at an organic product at various statures, the gadget is additionally outfitted with a topped funnel that gets and picked the natural product. Every part of this instrument is structured ergonomically to lessen exhaustion, push and require least measure of strain. For model, a portion of the current cutters and shaper are extremely huge, gauging many pounds and along these lines costly to buy and keep up. Organic product shaper with productively system will create through this venture what's more, will meet client necessity and can help individuals effectively cut and pick neighborhood organic product, for example, mango, coconuts and Drumsticks and so forth.

S. Manjunath et al. (2017) Vegetable cutting is important for readiness of nourishment and it is regular movement in all houses and cafés. The goal is to structure and create a vegetable shaper which worked by utilizing pedal which can be valuable to crippled people too. Huge scale lodgings can utilize numerous kinds of cutting edge programmed machines yet little scale inns can't manage the cost of such high-class hardware. They are not appropriate so well for the medium measured inns and home machines.

BalajiB.a et al. (2017) Cutting vegetables are a risky and tedious assignment in our bustling life. The related troubles like time imperative, tainting, and so on make it really hard for any individual dealing with the job. Manual cutting of vegetables is as yet common, in lodgings, and even in cafés. This framework is predominantly intended to diminish the human exertion and time. This undertaking is planned for taking care of above expressed issues by presenting an uncommon item named computerized vegetable cutting framework.

Tony Thomas.A et al. (2014), The arrangement includes a container course of action and the weight square is activated by a pneumatic chamber, and has a reciprocatory movement along the vertical length of packaging, while the cutting matrix stays fixed. The air supply to the chamber is constrained by a solenoid impelled DCV, which is constrained by a microcontroller. The section of vegetable into the matrix device is controlled utilizing a pneumatic chamber alongside a solitary bar system. The vegetables are fed through slanted cylinder. A plate is put at the base of the contraption to gather the vegetable pieces subsequent to handling. Variable weight setting for cutting various vegetables is done by the microcontroller. The proposed work is profited by pneumatic force, which is inexhaustible.

Thomas Alias et al. (2019), This paper shows the sequential advancement of mechanical stripping and furthermore features on new idea of vegetable peeler which would be the essential prerequisite under breakdown upkeep. The motivation behind our paper is to plan and manufacture the model of stripping and cutting machine. It is planned for giving a base to the business creation of a stripping and cutting machine, utilizing locally accessible crude materials at a moderately minimal effort. The machine establishes a drum, rough based stripping and cutting segment.

Aung KoLatt et al. (2019), The generation of potato is more in the rustic region of Myanmar. The electrically worked gadget is intended to cut the crude potatoes into meager cuts of thickness 3 mm roughly, appropriate for singing and heating as potato chips. From the test, the limit of component is 4.3 kg of potato every moment. Locally and effectively accessible materials like cast iron, mellow steel and tempered steel are utilized for the development of potato cutting machine. This machine permits in its straightforwardness of structure and unobtrusive expense with the capacity to create meager uniform cuts of the potatoes for the chips maker with the assistance of electric force framework.

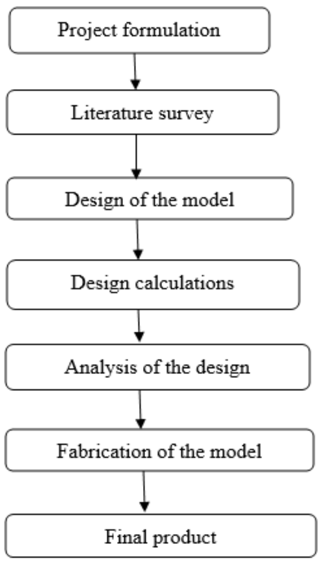
Kamaldeen O. et al. (2016), The improved tomato cutting machine was built and the assessment of both old and new cutting machines were completed. The outcomes from the assessment were looked at utilizing t-test investigation. The outcomes show that there is a huge accomplishment on the recently created tomato cutting machine as

far as cutting productivity while regarding limit, there is no critical contrast. The cutting productivity and yield limit of recently created slicer was 90.10 % and 3.79 kg/hr. separately. While that of old isolating machine 66.07 % and 3.48 kg/hr respectively.

S Ganyaniet al. (2019), Manual cutting and slicing of vegetables has proved to be very time consuming and is prone to the risk of contamination of the food leading to high rates of food borne diseases. The desire to make a design that simplifies, that saves time, that is relatively cheaper and efficient during the process of size reduction of vegetables was the main scope of the whole project. The contaminant free products will be produced through the use of U.V light and this machine will incorporate U.V light as its integral component. The principle of operation of the machine is attached to the theory of rotating hollow discs. Experiments were conducted at the Department Laboratory and a force of 19.5N was obtained for the hardest vegetable. The comparison of newly automated vegetable cutter and manual cutter was made and it was found that the productivity and yield limit of the cutter was increased.

F.H.C.A. Silva et al. (2016) The target of this study was to build up a ginger slicer so as to improve the cutting proficiency of the crisp ginger. The machine has a cutting instrument with a revolving cutting circle and a semi-computerized transport nourishing framework. The transport feeder comprises of a belt and a holding plate to hold the ginger rhizomes while cutting. The slicer circle comprises of an etched (one side angled) treated steel straight sharp edge connected to a SS revolving plate. The machine was assessed at two distinctive turning speeds; 400 rpm and 480 rpm separately for a ginger assortment. Cutting proficiency, material misfortune, machine limit and the mean thickness of the cuts determined.

4. Methodology



5. Components and their functions

A. Motor

The main source of power transmission system is electric motor, one pulley is mounted on motor shaft and another pulley is mounted on driven shaft. Driven shaft supported by two housing block and it is mounted on the frame. Power is transmitted from driving shaft to driven shaft using V-belt. The specifications of the motor are 0.5hp and 1440 rpm.

B. V belt mechanism

Belt transmits the power from one shaft to other shaft. The material of the belt is most important, because the life time of the felt depends on the material quality. The main for choosing V-belt is to avoid slippage and to minimize losses.

C. Shaft

Shaft is rotating part of the machine which is of 470mm length and the diameter of the shaft is about 18mm, in which a driven pulley of 295mm and two chain sprockets of 100mm is fixed. The shaft is driven by the main motor by using a V belt drive.

D. PVC pipe hopper

PVC pipe hopper is designed using creo4.0. The diameter of the hopper is about 3 inch. The cutting blades are inserted inside the hopper and the blades are perpendicular to the piston. The main purpose of this hopper is to feed the vegetables into the blades and to reduce the size of the vegetables.

E. Piston

The piston is the main part of the machine. The piston is connected to the sprocket with the help of a pin the main purpose of the piston is to convert the rotary motion of the sprocket into reciprocating motion which may help to the size reduction of vegetables. The diameter of the piston is about 75mm and the length is about 300mm.

F. Pulley

Pulley is a wheel on a shaft that is used to support movement and used to transmit power, here two V Grooved pulleys made of cast iron are used and the dimensions of the smaller and larger pulley is 292mm and 31.75 mm. The main purpose of using V-grooved pulley instead of flat pulley is to increase the efficiency and to minimize the losses and to prevent slippage.

G. Frame

Frame is stationary part of the machine in which the entire weight or load of the other components is acting on it. At the top of the frame motor and shafts are placed and various other parts are either welded or clamped within the frame. The dimensions of the frame are 1000mm length, 850mm height and 450mm width.

H. Cutting blades

Cutting blades are mounted on a cylindrical PVC pipes use to cut the vegetable into pieces. Blade are mounted on the cylindrical PVC pipe at equal distance at an angle. The material used in cutting blades is stainless steel. The thickness of the blades are about 0.3mm.

Table 1
Material for construction of different parts of the machine

S.No.	Parts	Materials Used
1	Motor	Aluminum
2	V Belt	Rubber
3	Cutting Blades	Stainless Steel
4	Pulley	Cast Iron
5	Shaft	Mild Steel
6	Piston	wood
7	Cylindrical PVC Pipe	Plastic

6. 3D model of the machine

3DModel and Drafting for Automatic- Vegetable Cutting Machine is done using PTC creo 4.0, each and every parts or components in the machine is analyzed using Ansys software.

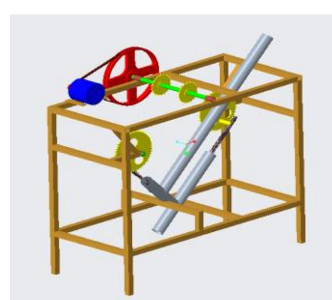


Fig. 1. Design of cutting machine

7. Calculations

Dimensions of frame:
Length (L) =1000mm
Breadth (B) = 450mm
Height (H) =850mm

Motor calculations:
N=1440rpm
P=0.5hp=372.85 watts
P=2∏NT/60
372.85=2×3.14×1440×T/60
T=2.47Nm.
Speed ratio Formula
$=D_2/D_1=N_1/N_2$
$=292.5/31.75=1440/N_2$
N_2=156rpm.
Pulley design
Step 1: Selection of pulley = cast iron v grooved pulley.
Step 2: Various dimensions of pulley:
Diameter of larger pulley =292.5mm
Diameter of smaller pulley=31.75mm
Number of arms =4
Step 3: Thickness of arm from PSGDB
pg no: 7.56
$b=2.94\ (aD/4n)^{1/3}$ where (a=26mm and D=292.5mm)
$b=2.94(26\times292.5/4\times4)^{1/3}$
b=23mm.
Step 4: Radius of cross section of arms:
r=0.75b
r=17.25mm.
Step 5: Minimum length of bore:
l=2/3×a=0.66×26
=17.33mm.
Step 6: Thickness of rim
t=D/200+3mm
=4.4mm
Design of driver shaft:
$T=\prod/16\tau d^3$ (Ʈ=200mpa for mild steel)
$2.47=3.14/16\times200\times10^6\times d^3$
d=4mm (minimum diameter)
Design of driven shaft:
P=2∏NT/60 where N=156rpm and P=0.5hp
Substituting the values we get,
T=23 Nm
$T=(\prod/16)\tau\times d^3$
$23\times16/3.14\times200\times10^6=d^3$
d=9mm (minimum diameter)
Cutting force and cutting torque calculation

As referred from the journal (Experimental Determination of Cutting Force Required for Severing Fruit Stalks Volume 1, Issue 8, January 2015) Cutting Force value for the hardest vegetable is 52.145 N

Cutting Torque = Cutting Force × Length of the Arm on cutting side
= 52.145 × 0.28=14.6 Nm
V-belt design:
Step1: Selection of Belt = Type A (from PSGDB pg no:7.58)
Step 2: Selection of Pulley diameter
d =32 mm and D = 293 mm
Step 3: Selection of center distance
C=360 mm
Step 4: Length of the belt: $L=2C+\prod/2+(D+d)+((D-d)^2/4C)$ PSGDB pg. no:7.61
=1166.3mm.
Step 5: correction factor F_C (from PSGDB pgno:7.59), For type A belt and length 1166 mm, F_C=0.92.
Step 6: Correction factor for arc of contact:(PSGDB pg. no. :7.68)
Arc of contact angle: 180-(D-d/c×60)
=180-(293-32/380×60)=136.5
Correction factor v-v =0.89,
v flat 0.85
Step 7: Calculation of service factor F_a(From PSGDB pg. no 7.69)
For medium duty application F_a=1.1
Step 8: Calculation of maximum power capacity (from PSGDB pg. no:7.62)
(For type A belt), $KW=(0.45s^{-0.09}-19.62/d_e-0.765\times10^{-4}s^2)s$
S= (3.14×d×N)/(60×10000)
S=2.4m/s. and d_e=36.48mm
P=2.28KW
Step 9: Determination of Number of Belts (from PSGDB pg no:7.70)
No. of belts = $(P\times F_a)/(KW\times F_C\times F_d)$
= (0.372×1.1)/ (2.2×0.85×0.92) = 0.8≈1
Step 10: Calculation of actual center distance: (from PSGDB pg. no:7.61)
$C=A+(A^2-B)^{0.5}$
where, A= L/4-3.14 (D+d/8)=164mm
$B=(D-d)^2/8$=8515mm
Substituting the values of A and B
C=300mm.
Design of sprocket
Step 1: Selection of transmission ratio (from PSGDB pg. no 7.74)
$I=z_2/z_1=42/18=2.33\approx2.25$ preferred transmission ratio)
Where, z_2 is the no. of teeth on sprocket wheel and Z_1 is the no. of teeth on sprocket pinion.
Step 2: Calculation of center distance (from PSGDB pg. no:7.74)
a= (30 to 50) P
P=15.875mm (from table for z_1 =18)
a= 30*15.875=476.25mm
Step 3: Selection of type of chain (from table at pg. no:7.72)
Chain 10 A-2 DR 50 is selected.
Step 4: Evaluation of total load
$P_{TOTAL}=P_t+P_C+P_S$
P_t=1020N/V= 1020*0.373/0.74 Where, (v=zpn/60*1000)
P_t=514.13N
$P_C=mv^2$
$=1.78*0.74^2$=0.97N
P_S=K*W*a= 6*1.78*0.476=5.086N
Where, K=6 (coefficient of sag) from table in pg. no 7.78
P_{TOTAL}=520N.

Step 5: Service Factor Evaluation

$KS=K1*K_2*K_3*K_4*K_5*K_6$

$K_S=1*1*1*1.25*1.5*1=1.875$

(Values are taken from table PSGDB pg. no:7.76 and 7.77)

Step 6: Calculation of design load

Design load $=P_T*K_S$

$=520*1.875=975N.$

Step 7: Calculation of Factor of Safety (PSGDB pg. No:7.77)

From table for P=15.875 and speed =156rpm

Factor of safety=7.8

Step 8: Checking of bearing stress (from PSGDB pg. no:7.77)

Bearing stress= $(P_t*K_S)/A$ (Where A=140mm from table in pg. no:7.72)

$= (514.3*1.875)/140=6.88N/mm^{2.}$

Step 9: Pitch circle diameter of sprockets (from PSGDB pg. no:7.78)

Diameter of smaller sprocket $d_1=p/ (Sin(180/Z_1))=91.4mm$

Diameter of smaller sprocket $d_2=p/ (Sin(180/Z_2))=212.3mm$

Where p is the pitch in mm =15.875mm from PSGDB pg. no:7.74

8. Working

Initially, AC motor is connected to the supply and acts as a primary unit, then the vegetables are fed into the hopper, the hopper is made up of PVC pipe. The cutting blades are sealed inside the cylindrical walls of hopper and the cutting blades are placed perpendicular to the reciprocating piston. To press the vegetable against the blade, we have chosen the Slider crank mechanism in which motor's rotary motion is converted into linear reciprocating motion of the piston. This reciprocating motion of piston forces the vegetables over the cutting blades to make into pieces. Again it is forced by another piston against the cutting blade to cut into further smaller pieces. These small pieces can be collected at the end point of hopper using a clean vessel.

9. Conclusion

Thus, we have come up with a low-cost automatic vegetable cutting machine. We have been able to design and develop an automatic vegetable cutting machine for different objectives using simple mechanisms. In this paper the attempt made for designing and manufacturing of semi-automatic paper bag making machine was successful.

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References

[1] Balaji B., Hari Narayanan U., Jagadeesh Shanmugam H., Karthikeyan R. and Selvan T.A. "Automatic Vegetable Cutting System" International Journal of Innovative and Emerging Research in Engineering Volume 4, Special Issue 1, NCIAR2k17.

[2] Kamlesh Pradhan, Amar Dandale, AkshayDhenge, Prof. Ritesh Banpurkar4 "Review Paper on Semi-Automatic Chips Machine" International Research Journal of Engineering and Technology (IRJET), Volume: 04, Issue: 03.

[3] Badadal Raghavendra. R, S. B. Naik "Experimental determination of cutting force required for severing fruit stalks", IJIRST –International Journal for Innovative Research in Science & Technology| Volume 1, Issue 8, January 2015.

[4] Roshan M. Hatwar, Kunal Rahandale, Mohan G. Trivedi, "Concept, Design and Development of Semi- Automated Potato Slicing Machine", International Journal for Scientific Research & Development, vol. 4, Issue 02, 2016.

[5] Gunjal A.V., Shinde K.L., Sonawane R.V., Dike A.P., Gujrathi T.V., Bhane A.B. "Automatic Pneumatic Operated Lemon Cutting Machine" International Journal of Emerging Technology and Advanced Engineering, Volume 6, Issue 4, April 2016.

[6] S. Manjunath, K. Kalyani Radha "Pedal Operated Vegetable Cutter" International Journal of Mechanical and Production Engineering, ISSN: 2320-2092, Volume- 5, Issue-10, Oct.-2017.

[7] Tilekar J.S., Adsul R.S. "Versatile Fruit & Vegetable Cutter" IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), Volume 14, Issue 5 Ver. II (Sep. - Oct. 2017), pp. 01-14.

[8] AungKoLatt, Auntt Min Thaw "Design and Construction of Potato Slicing Machine "Jul 2019 IRE Journals, Volume 3 Issue 1, Iconic Research and Engineering Journals 391.

[9] Kamaldeen O. S, Arowora K.A, Abioye J. S, Awagu E. F "Modification of Manually Operated Tomato Slicing Machine" ISSN 2321 3361 © 2016 IJESC, Volume 6, Issue No. 7.

[10] Kunal Vinod Tundalwar, Aditya Diwedi, Gajanan Jadhav, Rakesh Madankar, "Design & Development of Variable Size Paneer Cutting & Packaging Machine for a Small Scale Industry" International Advanced Research Journal in Science, Engineering and Technology, vol. 4, Special Issue 3, January 2017.

[11] Sukhmeet Singh, Paras Chawla, Ishbir Singh "A Robotic Automated Vegetable Making Machine" International Journal of Engineering and Advanced Technology (IJEAT), Volume-8, Issue-5S3, July 2019.

[12] F.H.C.A. Silva and D. N. Jayatissa "Design and Development of a Ginger Slicer for Small Scale Spice Processors" International Journal of Trend in Research and Development, Volume 4(1).

[13] Thomas Alias, Manu Eldhose, Navneeth Krishnan, V K, "Design And Fabrication of Peeling and Cutting Machine" International Journal of Applied Engineering Research, Volume 14, Number 14, 2019 (Special Issue).

[14] Tony Thomas.A1, Muthu Krishnan. A, Sre Nandha Guhan. K. S, Design and Development of Automated Vegetable Cutting Machine Design and Research Conference (AIMTDR 2014) December 12th–14th, 2014, IIT Guwahati, Assam, India.

[15] R. S. Kumar, J. Alexis & V. S. Thangarasu, (2017). Optimization of high-speed CNC end milling process of BSL 168 Aluminium composite for aeronautical applications. Transactions of the Canadian Society for Mechanical Engineering, 41(4), 609-625.

[16] S. R. Kumar, J. S. Alexis & V. S. Thangarasu, (2017). Experimental Investigation of Influential Parameters in High-Speed Machining of AMS 4205. Asian Journal of Research in Social Sciences and Humanities, 7(2), 508-523.

[17] S. Ganeshkumar, V. Thirunavukkarasu, R. Suresh Kumar, S. Venkatesh & T. Ramakrishnan. Investigation of Wear Behaviour of Silicon Carbide Tool Inserts and Titanium Nitride Coated Tool Inserts in Machining of EN8 Steel.

[18] S. Kumar, J. Alexis & V. S. Thangarasu (2016). Prediction of machining parameters for A91060 in end milling. Advances in Natural and Applied Sciences, 10(6 SE), 157-164.

[19] R. S. Kumar, V. S. Thangarasu & S. J. Alexis (2016). Adaptive control systems in CNC machining processes--a review. Advances in Natural and Applied Sciences, 10(6 SE), 120-130.

[20] S. Kumar, J. Alexis & K. P. Dhanabalakrishnan (2015). Application of GA & ANN for the optimization of cutting parameters for end milling operation- A comparison. International Journal of Applied Engineering Research, 10(20), 18092-18107.
[21] T. Ramakrishnan & P. S. Sampath (2017). Dry Sliding Wear Characteristics of New Short Agave Angustifolia Marginata (AAM) Fiber-Reinforced Polymer Matrix Composite Material. Journal of Biobased Materials and Bioenergy, 11(5), 391-399.
[22] R. Jeyakumar, P.S. Sampath, R. Ramamoorthi & T. Ramakrishnan (2017). Structural, morphological and mechanical behavior of glass fiber reinforced epoxy nanoclay composites. The International Journal of Advanced Manufacturing Technology, 93(1-4), 527-535.
[23] T. Ramakrishnan & P. S. Sampath, (2017). Experimental investigation of mechanical properties of untreated new Agave Angustifolia Marginatafiber-reinforced epoxy polymer matrix composite material. Journal of Advances in Chemistry, 13(4), 6120-6126.
[24] R. Ramamoorthi, R. Jeyakumar & T. Ramakrishnan (2017). Effect of Nanoparticles on the Improvement of Mechanical Properties of Epoxy Based Fiber – Reinforced Composites - A Review. International Journal for Science and Advance Research in Technology, 3(11), 1251-1256.
[25] T. Ramakrishnan, P. S. Sampath & R. Ramamoorthi (2016). Investigation of Mechanical Properties and Morphological Study of the Alkali Treated Agave Angustifolia Marginata Fiber Reinforced Epoxy Polymer Composites. Asian Journal of Research in Social Sciences and Humanities, 6(9), 461-472.
[26] T. Ramakrishnan& P. S. Sampath (2016). Thermogravimetric Analysis (TGA) and the Effect of Moisture Absorption on the Mechanical Properties of New Agave Angustifolia Marginata 3 Fiber (AAMF) Reinforced Epoxy Polymer Composite Material, International Journal of Printing, Packaging & Allied Sciences, 4(5), 3245-3256.
[27] T. Ramakrishnan, K. Sathish, P. S. Sampath &S. Anandkumar (2016). Experimental investigation and optimization of surface roughness of AISI 52100 alloy steel material by using the Taguchi method. Advances in Natural and Applied Sciences, 10(6 SE), 130-138.
[28] K. Sathish, T. Ramakrishnan & S. Sathishkumar (2016). Optimization of turning parameters to improve the surface finish of 16 Mn Cr 5 material. Advances in Natural and Applied Sciences, 10(6 SE), 151-157.
[29] S. Karthik Raja, S. Balasubramani, S. Venkatesh, T. Ramakrishnan (2015). Effect of Cryogenic Tempering on Steel, International Journal of Mechanical and Civil Engineering, 2 (6), 98-113.
[30] Yaser H. Alahmadi, Andrzej F. Nowakowski (2016). 'Modified shear stress transport model with curvature correction for the prediction of swirling flow in a cyclone separator' - Chemical Engineering Science 147 (2016) 150–165.
[31] Sakura Ganegama Bogodage, A.Y.T. Leung (2016). 'Improvements of the cyclone separator performance by down-comer tubes', Journal of Hazardous Materials311 (2016) 100–114.
[32] Xiaofeng Gu, Jianfei Song, YaodongWei (2016). 'Experimental study of pressure fluctuation in a gas-solid cyclone separator' - Powder Technology PII: S0032-5910(16)30261-3.
[33] MounaLazragDeisy Lizeth Mejia-Mendez C´ecile Lemaitre Philippe Hugh Emmanuel Stafford Rainier Hreiz Romain Privat Ahmed Hannachi Danielle Barth (2016). 'Thermodynamic and hydrodynamics study of gas-liquid flow in a cyclone separator downstream supercritical drying' J. of Supercritical Fluids PII: S0896-8446(16)30223-6.
[34] S. Venkatesh & M. Sakthivel (2017). 'Numerical Investigation and Optimization for Performance Analysis in Venturi Inlet Cyclone Separator', Desalination and Water Treatment, Vol. 90, No. 9, pp. 168-179.
[35] S. Venkatesh, M. Sakthivel, S. Sudhagar & S. Ajith Arul Daniel (2018). 'Modification of the cyclone separator geometry for improving the performance using Taguchi and CFD approach', Particulate Science and Technology.
[36] S. Venkatesh, I. Bruno Clement, M. Avinasilingam, & E. Arulkumar (2017). "Design of Experiment Technique for Improving the Performance of Stirling Engine", International Research Journal of Engineering and Technology, Vol. 4, No. 5, pp. 62-65.
[37] S. Venkatesh, S. Balasubramani, S. Venkatramanan & L. Gokulraj. "Standardization of hpx spool for lead time reduction of string test", Journal of Mechanical and Civil Engineering, Vol. 2, No. 6, pp. 62-79.
[38] S. Kousalya Devi, S. Venkatesh & P. Chandrasekaran. (2015). "Performance Improvement of Venturi Wet Scrubber, "Journal of Mechanical and Civil Engineering, Vol. 2, No. 4, pp. 1-9.