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DESIGN, MODELLING AND SIMULATION OF A PALM KERNEL OIL EXTRACTION MACHINE MANAGEMENT APROACH

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abstract

vegetable oils and fats have gained popularity in food, cosmetic, soap, pharmaceutical and medical industries for the production of cooking oil and margarine, pomade, toilet soaps, drugs and medical ointments respectively. recently,they have found their uses in energy and automotive industries as biodiesel and engineering industry as cooling fluid in machining process and lubricants for machine components. the scope of this work are: to design a small scale screw press oil expeller for palm kernel oil extraction; to model and simulate the machine before production, to fabricate the components of the expeller based on the design specifications and; to test the expeller afterfabrication and assembly of the components.while in designing and in material selection,consideration was given to the techno-economic status of the micro and small scale vegetable oil processors who are the intended users of the machine.the functional parts of the machine included barrel, worm shaft, gear reduction, prime, oil outlet, cake outlet, hopper, and bearings. the worm shaft is at an increasing diameter while the screw system is at a decreasing pitch a combination that is essential for obtaining maximum pressure for oil extraction and cake extrusion process. in operation, the gradually built-up pressure along the worm shaft travel conveys, crushes, grinds, presses and squeezes oil out of the seeds into the oil outlet via the oil channel. the residual cake from where the oil is extracted is extruded out of the cake outlet in form of flakes. the expeller was tested and results showed a high oil yield and extraction efficiency with low extraction loss. powered by a 20 hp three-phase electric motor.

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introduction

palm kernel oil is rich in protein and is therefore used in food industry as good sources of cooking oil.the residual cakes from which the oil is extracted are also used as ingredients in livestock feed pr oduction. these products, in developing countries,have a lot of potential for export and therefore serv e as a foreign exchang earner. in addition, palm kernel oil is used in chemical industries for the produ ction of fatty acids andother product the traditional method of oil extraction in nigeria is known as h eat rendering process. in this method,the kernels are fried and roasted in a pot placed over firewood and the oil is expelled by dripping. this method is time consuming, drudgery-prone, involves heat hazar ds, and grossly inefficient. apart from this, the oil extracted by this method is very poor in quality and i s, in most cases, not used for consumption. akinoso (2006) studied the effects of storage on quality of palm kernel and sesame oils while the effect of postharvest and pre-extraction treatments on nige rseed processing in a small expeller were investigated byayenew (2000).oil expression from palm ker nel was modeled by akinoso et al. (2006) while alonge etal. (2003) investigated the effects of some proc essing factors on groundnut oil extraction.they discovered that heating temperature, moisture conten t of seeds, and other forms of postharvest pretreatments and extraction conditions had effects on yie ld, efficiency of extraction and quality attributes of oil. vegetable oil expellers are of different types an d forms based on design, construction and the raw materials they are to process. while a mechanical expression rig was developed by olaniyan and oje (2007) for shea butter extraction. olaniyan (2010) dev eloped a manually-operated expeller for groundnut oil extraction and the performance of a pko extrac ting machine was evaluated olawepo-olayiwole and balogun (2004). in most pko extraction mills, raw materials are squeezed under high pressure in a single step. when used for the extraction of food oils, typical raw materials are nuts, seeds and algae, which are supplied to the press in a continuous feed. a s the raw material is pressed, friction causes it to heat up; in the case of harder nuts (which require hi gher pressures) the material can exceed temperatures of 120 0F (49 0c).

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The cost of machine of this type could be high when produced under small scale production. But the other advantages are that it does not require any specialist skill for its operation and it does not call for any elaborate production environment before it becomes operational and so many others.

The advantages of this design outweigh the disadvantages. In fact it can be used where mass production is necessary with high efficiency. Also by using software to determine the strength and simulation in our research is added advantage in which involve the following

- Long product development,
- Countless trial and error,
- Accountability

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- Limited Profitability

it is general knowledged that those who are enggaged in agriculture are the poor in comparison with t hose who engaged in other sector of economy in nigeria ,that is to say their standard of living is low t hat shortage of funds to enable them purchase moderm facilities has been a major handicap in the dev elpment of agriculture.

raw material preparation

all raw materials should be sorted to remove stones and mouldy nuts. when storage is needed, this sh ould be in weatherproof, ventilated rooms which are protected against birds, insects and rodents. so me raw materials (for example groundnuts, sunflower seeds) need dehusking (or decorticating). a se parate heat source is necessary. all oil-bearing materials need to have the correct moisture content to maximize the oil yield. using small-scale expellers, oilseeds and nuts are usually processed ⊗ cold⊗ (ie without additional heating).

objectives of the project

the objectives of this project is centered on the following

to design, modelling, simulating , develop an efficient of a screw press expeller for palm kernel oil extr action machine for rural communities.

to enuring food security and aleviating poverty by creating employment for the teaming youth.

to empower the farmers and other agro-allied stake holders through stimulation of economic develo pment and generation of employment opportunities especially to farmers in the rural communities.th e ability to creat something out of nothing makes design one of the most exciting aspects of engineerin g.to be sucessful design engineer require a broad set of talents include knowledge,creativity people s kill and planning ability.

design considerations

materials selection:this was the first design feature considered.all the component parts of the machin e in contact with the oil were made of stainless steel materials because of its anti-rust property.

cylindrical barrel accommodate the require quantity of raw materials (palm kernel).

worm shaft ensure maximum conveyance, crushing, grinding and pressing of the palm kernel.

main frame ensure structural stability and strong support for the machine

pair of gear for speed reduction fig the choice of gear was made to transmit power generated fro m the prime mover to the rotating worm shaft because it requires small amount of installation work, absorbs shock and operates at low bearing pressure as well as being used widely in power transmis sion.

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vibration control: considering the operation of the machine, an attached base stand helps to withstand the vibrations generated during the operation of the machine and for support also.
maintenance: maintenance was not neglected during the design considerations and as such the design was made in such a way that the machine could be detached into its various component parts to allow for maintenance in case of breakdown.fig 2– illustrate modelling of machine components
cost: the screw oil expeller was designed to stand better substitutes to existing ones in terms of cos t without compromising quality and safety.

principles of operation of the oil expeller machine

the machine component parts include speed reduction gear, drain collector, the feeding hopper,cake o utlet.cake tray,oil outlet. cylindrical barrel and the main frame. the expeller is driven by a 20hp electri c motor(fig;5) via a reduction gear. the expelling unit consists of a screw expellant shaft (fig).the he ating of oil seeds is achieved by generated heat, which heats the surrounding of seeds (toaster.)
an expeller consists of a helical thread (worm assembly) which revolves within a perforated cylinder (t he cage or barrel). the barrel is usually formed by a series of axially–placed lining bars contained withi n a robust frame. heated oilseeds enter one end of the barrel through the feed inlet and are conveyed b y the rotating worm assembly to the discharge end. with any power–driven equipment, it is important to consider how the equipment will be repaired as it becomes worn. local refurbishment is normally c heaper than importing spare parts.the cylindrical barrel was made from 16mm mild steel square rod o f length 750 mm(lower and upper casing fig5), form inside diameter of 100 mm .the worm shaft was m ade from a mild steel solid rod of diameter130 mm and length 730 mm, which was machined on th e lathe at a decreasing screw pitch and decreasing screw depth. the worm shaft is housed in the c ylindrical barrel at a clearance of 1.5 mm between the screw diameter and inside diameter of the bar rel. in operation, the oilseed is introduced into the machine through the feeding hopper; the machine co nveys, crushes, grinds and presses the oilseed inside the cylindrical barrel with the aid of the worm sh aft until oil is squeezed out of the seed. the oil extracted is drained though the oil channel into the oil tr ay where it is collected; the residual cake is discharged at the cake outlet and collected at the cake

COMPONENT AND MATERIAL SELECTION

Most machine and tools are constructed from metallic and non-metallic materials. The metals are divided into two groups' ferrous metals: are those which have the iron as their main constituent such as cast iron, wrought iron and steel. Non-ferrous metals: are those which have a metal other than iron as their main constituent such as copper, aluminium, brass, tin, zinc etc.

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The selection of a proper material, for engineering purposes, is one of the most difficult problems for the designer. The best material is one which serves the desired objective at the minimum cost. The following factors are considered while selecting the material:

- Availability of the materials.
- Suitability of the materials for the working conditions in service.
- The cost of the materials.

The machine (Oil expeller) which has been produced from the assembly of various components were designed based on the properties of materials, including the frame, shaft, knuckle bearing, **barrel** , collector, hopper , , **tapered screw conveyor** electric motor. The design considerations for each component are discussed below:-

FRAME: This component is the primary made up of mild steel fig; 3. the reason for this is that the material possessed the required properties as ductility, plasticity and also considerable strength which are capable of being fabricated to the required degree of functional tolerance. Also the selection factors are being cheap and most abundant in the market in case of replacement, machine ability or workable are other consideration.

SHAFT: this is also made of mild steel besides the considerations mentioned above, we consider its toughness properties which can be improved through heat treatment.Fig:10 shows blue region which indicate safe

BEARING: It exists as a standard component, it is of various types- cone bearing, roller, knuckle bearing and from steels-chromium steel. Among these types mention above, some are sealed while some are not. For our design, we opt for the knuckle bearing with sealed ball bearing to avoid grease contamination on the feed fig.14. The selection of knuckle bearing is that it balances itself and possesses the required

gear a gear is a mechanical device often used in transmission system that allows rotional force to b e transferred to another gear or device in fig12

HOPPER

the hopper was designed based on the principle of self delivery which is aided bythe energy absorbed by the vibration of the working machine.fig 13. it is aimed to avoid clogging that will impend delivery and cracking.the vibration aid slow movement of the kernel rnel into the delivery channel

elecric motor has been introduced to drive the shaft mechanisms through gear reduction system fig 6

oil collector is under the barrel collecting oil that squeezes out fig 11

oil out let after crush,grind press and squeezes oil the cake run out from this unit in fig 7a

web is supporting plate weld together with upper and lower casing for rigidity fig 5

computer aided design

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CAD began as an electronic drafting board, a replacement of the traditional paper and pencil drafting method. Over the years it has evolved into a sophisticated surface and solid modeling tool. Not only can products be represented precisely as solid models, factory shop floors can also be modeled and simulated in 3D. It is an indispensable tool to modern engineers. Engineers use CAD to create two− and three− dimensional drawings, such as those for automobile and airplane parts, floor plans, and maps and machine assembly

While it may be faster for an engineer to create an initial drawing by hand, it is much more efficient to change and adjust drawings by computer. In the design stage, drafting and computer graphics techniques are combined to produce models of different parts. i. Using a computer to perform the six−step 'art−to−part' process: The first two steps in this process are the use of sketching software to capture the initial design ideas and to produce accurate engineering drawings. Next, engineers use analysis software to ensure that the part is strong enough. Step five is the production of a prototype, or model.

In the final step the CAM software controls the machine that produces the part, during the design of the machine and the drafting, software was used to draw the orthogonal views, Isometric views, exploded drawings fig 4 shows the detailed drawing of the machine, modeling and simulation was done before the commencement of the fabrication processes.

Wire frame model is a skeletal description of a three-dimensional object. It consists only of points, lines, and curves that describe the boundaries of the object. There are no surfaces in a wire frame model. Three-dimensional wireframe representations can cause the viewer some confusion because all of the lines defining the object appear on the two-dimensional display screen. This makes it hard for the viewer to tell whether the model is being viewed from above or below, inside or outside. (See fIg.2)

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modeling

Modeling is the process of producing a model; a model is a representation of the construction and working of some system of interest fig2-8,11-14 illustrate the idea.A model is similar to but simpler than the system it represents. One purpose of a model is to enable the analyst to predict the effect of changes to the system. On the one hand, a model should be a close approximation to the real system and incorporate most of its salient features. On the other hand, it should not be so complex that it is impossible to understand and experiment with it. A good model is a judicious tradeoff between realism and simplicity. Simulation practitioners recommend increasing the complexity of a model iteratively. An important issue in modeling is model validity. Model validation techniques include simulating the model under known input conditions and comparing model output with system output. Generally, a model intended for a simulation study is a mathematical model developed with the help of simulation software. Mathematical model classifications include deterministic (input and output variables are fixed values) or stochastic (at least one of the input or output variables is

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probabilistic); static (time is not taken into account) or dynamic (time-varying interactions among variables are taken into account). Typically, simulation models are stochastic and dynamic

SIMULATION

A simulation of a system is the operation of a model of the system. The model can be reconfigured and experimented with; usually, this is impossible, too expensive or impractical to do in the system it represents. The operation of the model can be studied, and hence, properties concerning the behavior of the actual system or its subsystem can be inferred. In its broadest sense, simulation is a tool to evaluate the performance of a system, existing or proposed, under different configurations of interest and over long periods of real time. Simulation is used before an existing system is altered or a new system built, to reduce the chances of failure to meet specifications, to eliminate unforeseen bottlenecks, to prevent under or over-utilization of resources, and to optimize system performance. For instance, simulation can be used to answer questions like:What is the best design for a new network? What are the associated resource requirements? How will a telecommunication network perform when the traffic load increases by 50%? How will a new routing algorithm affect its performance? Which network protocol optimizes network performance? What will be the impact of a link failure? The subject of this tutorial is discrete event simulation in which the central assumption is that the system changes instantaneously in response to certain discrete events. For instance, in an M/M/1 queue - a single server queuing process in which time between arrivals and service time are exponential - an arrival causes the system to change instantaneously. On the other hand, continuous simulators, like flight simulators and weather simulators, attempt to quantify the changes in a system continuously over time in response to controls. Discrete event simulation is less detailed (coarser in its smallest time unit) than continuous simulation but it is much simpler to implement, and hence, is used in a wide variety of situations.

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Figure 1, 8-10 is a schematic of a simulation study. The iterative nature of the process is indicated by the system under study becoming the altered system which then becomes the system under study and the cycle repeats. In a simulation study, human decision making is required at all stages, namely, model development, experiment design, output analysis, conclusion formulation, and making decisions to alter the system under study. The only stage where human intervention is not required is the running of the simulations, which most simulation software packages perform efficiently as show in fig;8 and 9 below. The important point is

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that powerful simulation software is merely a hygiene factor - its absence can hurt a simulation study but its presence will not ensure success. Experienced problem formulators and simulation modelers and analysts are indispensable for a successful simulation study.

The steps involved in developing a simulation model, designing a simulation experiment, and performing simulation analysis are:

- Step 1. Identify the problem.
- Step 2. Formulate the problem.
- Step 3. Collect and process real system data.
- Step 4. Formulate and develop a model.
- Step 5. Validate the model.
- Step 6. Document model for future use.
- Step 7. Select appropriate experimental design. Step 8. Establish experimental conditions for.
- Step 9. Perform simulation runs.
- Step 10. Interpret and present results.
- Step 11. Recommend further course of action. Although this is a logical ordering of steps in a simulation study, many iterations at various sub-stages may be required before the objectives of a simulation study are achieved. Not all the steps may be possible and/or required. On the other hand, additional steps may have to be performed. The next three sections describe these steps in detail.

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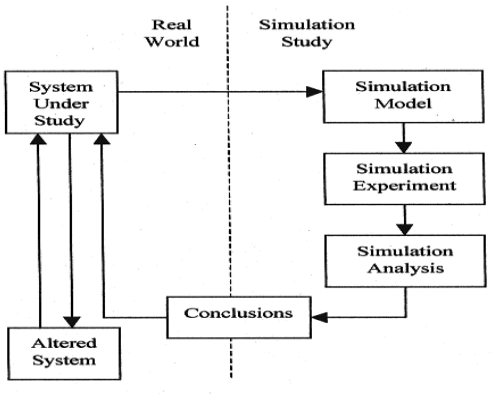
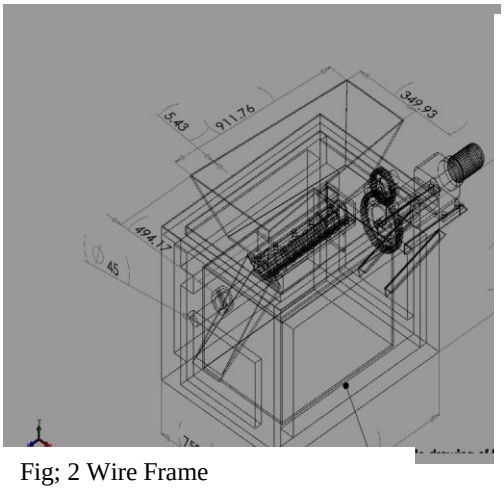


Fig 1: Simulation Study Schematic

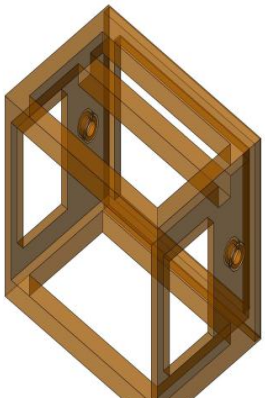
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MODELLING AND SIMULATION OF THE MACHINE / THE COMPONENTS

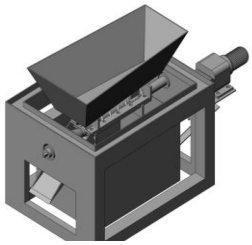


Fig; 2 Wire Frame



Fig,3 Frame

ITEM NO.	PART NUMBER	QTY.
1	spiral gear 1	1
2	spiral gear	1
3	warm	1
4	shaft	1
5	stand 4 expeller	1
6	hopper expeller	1
7	upper basket 1	1
8	web	4
9	upper basket	1
10	collector	1
11	outlet expeller	1
12	geared motor	1
13	bracing	4



Fig,4. Detailed Drawing



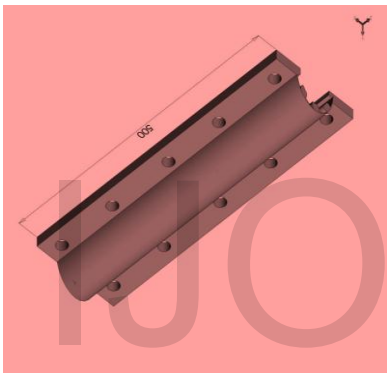
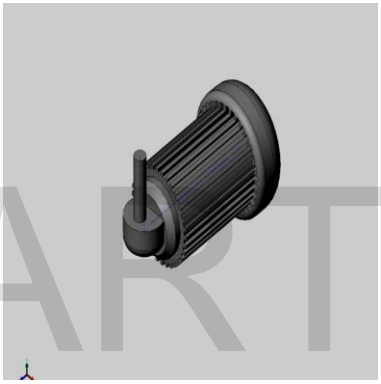


Fig 5;Lower and Upper Casing



Fig;6 Electric motor



Fig;7A outlet casing



Fig.7B. Web

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Fig.8 CAD; Model

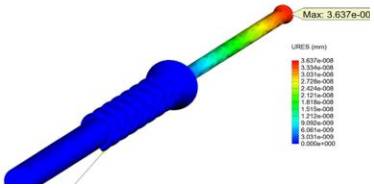


Fig ;9 Region with factor of Safety value less than 1 shown in Red



Fig :10 Blue Region Indicate safe

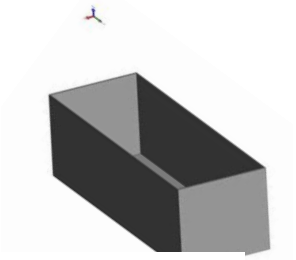


Figure11;Collector



Fig;12 Gears



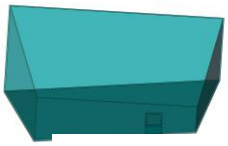


Figure 13; Hopper

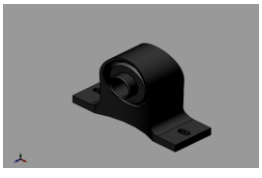


Fig 14 Bearing

the average oi efficiency and extraction loss were 13.48, 22.13 and 7.41% respecti

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vely. For improvement. an improvement in the design of the worm shaft of the expeller is expected to improve the oil yield and extraction efficiency; hence, this is highly recommended.oil is a valuable product with universal demand, and the possible income from oil extraction is therefore often eno ugh to justify the relatively

the average oil yield, extraction efficiency and extraction loss were 13.48, 22.79 and 7.41% respec tively for palm kernel while those of soybean were 9.47, 36.55 and 7.95% respectively. olaniyan a nd oje (2007), olaniyan (2010) and olaniyan and oje (2011) used these criteria for shea butter and cast or oil extraction respectively. the data obtained from the tests shows that the expeller was able t o extract some of the oil from the seeds but there is still plenty of scope for improvement.an imp rovement in the design of the worm shaft of the expeller is expected to improve the oil yield and e xtraction efficiency; hence, this is highly recommended. high cost of setting up and running a small scale oil milling business.the cell walls of oil seeds encapsulating the oil are characterized by cellul osic and non-cellulosic materials like hemicelluloses, pectin etc. they in general protect the c onstituents of the cell. in the extraction process the cell wall is ruptured by grinding in order to release oil. incomplete rupture due to process constraints results in reduced yield.

the testing result suggests that the performance of the machine is highly depended on the speed of the electric motor and the quantity of material passing through the machine with expelling opera tion probably better at around 18 revolutions per minute.

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preliminary test carried out on the machine without heating of the oil gave no oil yield and only paste was observed passing through the cake outlets. this implies that for oil to be extracted from oil heati ng is necessary. however, when the oil was roasted before extracting oil from it, oil was produced b ecause of the breaking of oil bearing cells during heating.

conclusion

a screw press expeller was designed, constructed and tested for palm kernel . the expeller was si mple enough for local fabrication, operation, repair and maintenance. powered by a 20 hp three-p hase electric motor, the expeller has average oil yield and extraction efficiency of 13.48 and 22.79 % respectively from palm kernel . an oil expeller was developed. preliminary evaluation of the m achine gave a better performance at the speed of 18 revolutions per minute. without heating of the groundnut no oil yield was observed with only paste observed through the cake outlet.the expeller can be used for small scale palm oil extraction in the rural and urban communities. a cottage palm kernel oil processing plant based on this technology can provide employment for at least two pers ons at the same time providing palm kernel oil at affordable costs for rural dwellers and palm ke rne cake for livestock feed mill. when the oil seeds were roasted before extraction of oil, reasonab le oil was extracted. however, improvement in the design by incorporation a heating chamber along the expeller barrel is expected to greatly improve the performance efficiency of the machine. also

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an improvement in the design of the worm shaft of the expeller is expected to improve the oil yield and extraction efficiency; hence, this is highly recommended.above all simulation reduce cost and time-to-market by testing your designs on the computer rather than in the field."Simulation tools enable us to be creative and to quickly test new ideas that would be much more difficult, time-consuming, and expensive to test in the lab."—JEFFREY D. WILSON, NASA GLENN RESEARCH CENTER

The computer is well suited to design in four areas, which correspond to the latter four stages of the general design process. Computers function in the design process through geometric modeling capabilities, engineering analysis calculations, testing procedures, and automated drafting, which means that software design should be encouraged in our institution of higher learning base on the following facts, long product development, countless trial and error, and accountability and limited profitability

Reference

[1] Fishwick, P. A. (1995). Simulation Model Design and Execution: Building Digital Worlds, −Hall.Freund, J. E. 1992. Mathematical Statistics, Fifth Edition

[2] Spectrum Expeller Pressed vs. Cold Pressed (http://www.spectrumorganics.com/?id=32)

[3]http://en.wikipedia.org/w/index.php?title=Expeller_pressing &oldid=572753297

[4]Ajao, K.R, Ajimotokan, H.A and Olaomi, J. Development and Performance Evaluation of a Groundnut oil Machine

[5]Adesoji M. Olaniyan1*, Kamaldeen A. Yusuf2, Adebayo L. Wahab3 and Kunle O. Afolayan4 Design, Development and Testing of a Screw Press Expeller for Palm Kernel and Soybean Oil Extraction

[6] Akinoso, R. (2006). Effects of moisture content, roasting duration and temperature on oil yield and quality of palm kernel (Elaeis guineensis) and sesame (Sesamium indicum) oils. PhD Thesis, Department of Agricultural and Environ mental Engineering, University of Ibadan, Ibadan, Nigeria

[8] Sivakumaran, K., Goodrum, J. W., & Bradley, R. A. (1985). Expeller optimization of peanut oil production. Transactions of the American Society of Agricultural Engineers, 316−320

[9] Koya O.A and Faborode M.O(2005) Mathematic al modeling of palm fruit cracking based on Hertzs Theory˜Biosyst ems Engineering, Vol.91 No.4 pp 471− 7

[10] Law, A. M., and M. G. McComas. 1991. Secrets of Successful Simulation Studies, Proceedings of the1991 Winter Simulation Conference, ed. J. M.Charnes, D. M. Morrice, D. T. Brunner, and J. J.Swain, 21−27. Institute of Electrical and Electronics Engineers, Piscataway, New Jersey

IJOART

Copyright © 2015 SciResPub.

ISSN 2278-7763

[11] Onwualu, A. P., Akubuo, C. O., & Ahaneku, I. E. (2006). Fundamentals of Engineering in agriculture. (1st ed.). Lagos: Immaculate Publications Ltd., (Chapter 9)

[13] Mechanical Engineers' Handbook, 2nd ed., Edited By Myer Kutz.

[14]Ashok Kumar Gupta Dr.Vandana Somkuwar (2014) Spiral Gevel Gear and Development Generation and Simulation of Meshing and Tooth Contact Analysis (TCA)

[15] Mark T.Holtzapple W.Dan Reece "Fundamental of Engineering"Taxas A&M University

[16] industrial engineering handbook fifth edition edited by kjell b. zandian co-sponsores by jma consultants,inc.

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