Tuijin Jishu/Journal of Propulsion Technology
ISSN: 1001-4055
Vol. 45 No. 4 (2024)

Impacts of Vibrations in Olive Oil Presses Components

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Abstract. Vibrations have bad effects on machines and systems if they are repeated and occurred frequently with a frequency close to the natural frequency of that machine or component. Any machine having rotating parts, will have vibrations, oil presses have a sequence machine, which have rotating parts and oscillators. Such vibrations have different frequencies which may reach to some values closes to the natural frequency of the components which may effect on the performance of the stations' machine and then on the production line or cycle and hence on quality of olive oil produced. In this study, the sources of vibrations in such olive oil presses will be investigated, measured, and analyzed and a mechanical solution will be proposed to reduce such vibrations and hence improving such presses performance and increase production of oil and its quality. A SIMIO model is implemented in the study to show the effects of vibrations on productivity of a given press (mill) olive oil after adjusted to overcome the vibration effects. The main sources of vibration in rotating machines are misalignment, imbalance and bearings wear, in the current study shaft misalignment and bearings wear are taken as the main sources of vibration. A comparisons between the current study results and findings found in some same condition case in literature is performed and a good agreement is noticed under the same conditions. it was found that by performing some maintenance operations like shaft alignment, mechanical balancing, and improve bearings lubrication, the values of vibration velocity of crushing and extractor components of olive presses can be reduced and hence improving productivity of such olive oil plants (also this is proved using SIMIO results).

Keywords: production, olive oil, vibrations, Simio, quality, management.

1. Introduction

The extraction of olive oil is divided into many phases. The olive is first put in a big jar. The motor is then used to wash the olives by dragging them into a traveling bag. After that, it goes into a special container where the olives are ground, and the process takes about 40-60 minutes such process is called milling. After passing the oil mixture to another piston and working through the central pressure to isolate oil from impurities at a certain temperature and pressure, it is passed to the piston to separate the oil from the crushed seeds at a certain pressure. Fig.1 shows the mills used in olive oil production. Modern olive mills are partially or fully automated and have replaced granite crushers with metal crushers. They consist of a stainless steel body and a stainless steel crusher that rotates at high speed. The olives are typically thrown against a hammer-shaped metal grating, thus the name hammer mill. Alternatives include toothed disc, cylinder, and roller mills. Modern milling is very gentle in order to avoid overheating of the paste. Cold pressed (extra virgin) oils must not exceed27˚C at any step in the processing of the oil [1].

Fig.1.A Single olive mill [1]

The second process is to separate oil from olive oil pasta using Separators machine as shown in Fig. 2.

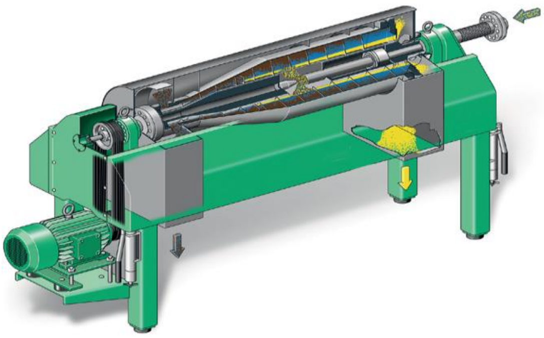

Fig. 2. Separator machine [1]

The effect of vibrations on mechanical machines (like mills and separators of olive pasta) operating on flaws in the manufacturing process reduces the life of the devices and, over time, increases the stress, which leads to equipment failure and, in some cases, human injury. Fig. 3 shows the continuous low-scale plan used for olive oil extraction stages.

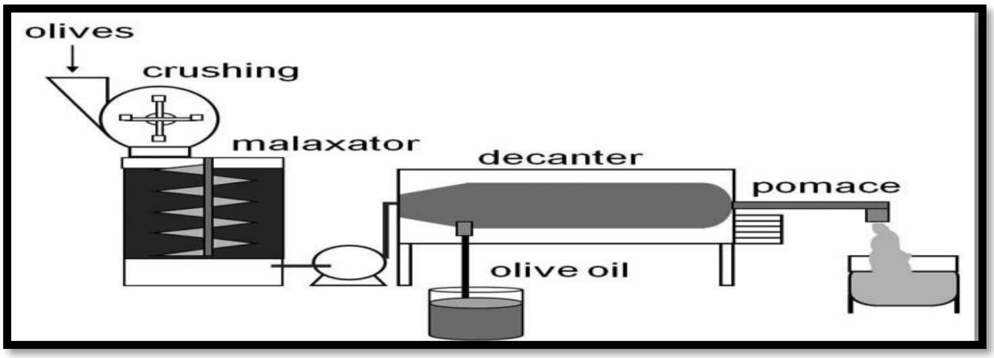

Fig.3.The continuous low-scale plan used for olive oil extraction [2]

-Misalignment and Imbalance in Olive presses

Misalignment in shafts causes vibration in all rotating machines in the industry, this misalignment appeared as the main source of vibrations in the case of olive presses or other components in the station, and it is adequate to simply illustrate the different types of misalignment, which are shown in Fig. 4 and 5. Fig. 4 shows the axial misalignment, while Fig. 5 shows the angular shaft misalignment.

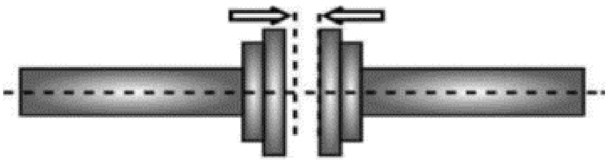

Fig. 4. Axial misalignment

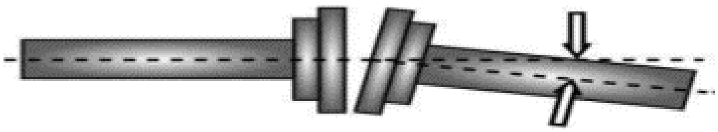

Fig.5. Angular Misalignment

Industrial case studies demonstrated that vibration spectrum analysis (VSA) may detect shaft misalignment issues in induction motor drives. In the following case histories, vibration spectrum analysis was employed with no phase measurements, and just the important vibration features were studied, as VSA alone cannot accurately establish the true kind of shaft misalignment. There is still some controversy about whether vibration components are genuinely influenced or created by each form of shaft misalignment, but it is undeniable that misalignment causes observable changes in vibration spectra. This is proven in each case history in this study, where subsequent re-alignment created a normal vibration spectrum at the bearings. The centrifugal force (C.F.) produced by intrinsic rotor imbalance in an induction motor and other spinning devices is constant if the rotor's mechanical imbalance and speed remain constant. The C.F. rotates at the rotor's speed, producing the basic 1X vibration component. Shaft alignment can vary in several directions. There might be offset misalignment in the vertical and horizontal directions, angular misalignment in these directions, or any combination of these misalignment instances. Figure 4 depicted parallel offset or axial misalignment, in which the shafts of the two machines are on two different but parallel centerlines; and Figure 5 depicted angular misalignment, in which the shafts' centerlines connect at their coupling point and are at an angle to each other. The extent to which these misalignments must be addressed has a significant influence on the length of time required to complete a precise alignment. Alignment is an iterative procedure that involves numerous phases of measuring and correcting the location of machines. An initial move may result in an alignment near to the necessary tolerance, and the move may be completed in a couple of minutes. Many more iterations may be required to obtain perfect alignment or something very near, which might take hours of labor. This extra time diverts resources away from other plant maintenance tasks and may result in higher machinery downtime. Inevitably, a judgment must be made on how well a certain piece of spinning machinery should be aligned in order to be judged good enough. The concerns posed include how good is 'good enough' and how important is 'perfection' [3].

-Problem Definition

Vibration can accelerate machine wear, consume excess power, and cause equipment to be taken out of service, resulting in unplanned downtime. Other effects of vibration include safety issues and diminished working conditions. When measured and analyzed properly, however, vibration can play an important role in preventive maintenance programs. It can serve as an indicator of machine condition and allow plant maintenance professionals to act before damage or disaster strikes. The effects of vibration of olive oil presses (mills) components on olive oil production and quality need to be investigated and analyzed, the study also includes an investigation about the sources and causes of such vibrations and mechanical solutions to reduce or eliminate such vibrations frequency in some olive presses (mills) and separators in stations. The misalignment and imbalance of rotating components are also studied and analyzed because they represent the main source and causes of such vibrations. Misalignment of the machinery shafts generates reaction forces and moments at coupling location, which significantly affect the vibration behavior of machines, shafts and rotors.

-Literature Review

Many research discussed the effects of vibrations on rotating machines and presses, Tiboni et al. (2022) [4] conducted a thorough review of the literature on the issue of monitoring vibrations in rotating equipment, which enabled successful diagnostics since aberrant operating states are associated with certain patterns that can be derived from vibration signals. Extensive research has been conducted on the many approaches used to carry out the major phases of a malfunction automatic diagnosis (signal measurements, pre-processing and processing, feature selection, and fault detection). Furthermore, vibration-based condition monitoring was performed on a variety of mechanical systems or components. A preliminary phase included an analysis of the publication distribution to determine the level of interest in studying the application of the method to various rotating machines, the level of interest in investigating the main phases of the diagnostic process, and the techniques most commonly used for each phase of the process. Subsequently, the various signal processing, feature selection, and diagnostic procedures are thoroughly examined, emphasizing their usefulness in relation to the researched aspects and the findings of the numerous investigations. The study reveals the most important research trends and breakthroughs linked to the various phases of vibration-based condition monitoring.

Chouaib (2023) [5] developed a novel contribution to problem diagnosis in an industrial process, especially in bearings, using signal processing and pattern recognition algorithms. The work described in this paper focused on detecting and diagnosing bearing faults using vibration analysis and machine learning. In the first step, data is collected from a system or test rig and analyzed to determine the various sorts of problems. In this study, two separate datasets including vibration signals are utilized to diagnose bearing faults. The second step involves condition categorization using machine learning methods. This step will investigate and evaluate a variety of supervised learning algorithms, including Support Vector Machines, Random Forests, Artificial Neural Networks, and Extreme Learning Machines, to discover the best strategy for bearing failure classification. Finally, the built machine learning models will be rigorously tested and validated on real-world industrial machinery to confirm their efficacy and usability in a production context. This work used Independent Vector Analysis (IVA), feature selection, and Extreme Learning Machine (ELM) to build a unique bearing defect detection technique. The IVA was initially used to separate distinct sources from the mixed signals acquired from a three-axis accelerometer, and statistical parameters were then extracted from each component that resulted. The recovered characteristics were optimized with three binary optimization algorithms: the binary bat method, the binary Particle Swarm Optimization (PSO), and the binary grey wolf algorithm. This stage aims to choose the appropriate feature subset, reduce the high dimensionality of the gathered data, and improve classification accuracy even further. The best feature subset is then utilized to train the ELM, ANN, and RF classifiers. This stage aims to choose the appropriate feature subset, reduce the high dimensionality of the gathered data, and improve classification accuracy even further. The most effective feature subset is then utilized to train the ELM, ANNs, and RF classifiers. The data indicate that combining IVA, binary grey wolves, and harsh learning produces the best classification results. Additionally, this combination allows for the diagnosis of bearing defects.

Desouki et al. (2020)-[6] this study examined the combined effects of imbalance and misalignment (parallel or angular) on the vibration spectra of rotating equipment. A numerical model is created and utilized to calculate the temporal and frequency responses of the rotor-coupling-bearing system to the simultaneous effects of these defects. The numerical model revealed that the imbalance was mostly associated to the peak around 1X, whereas misalignment was linked to the peak around 2X. Furthermore, the parallel misalignment fault increases the displacement response by two times, whilst the reaction to angular misalignment is caught at two and four times the amplitudes. This study also looked at the impacts of adjusting the model's rotational speed, misalignment level, and coupling type on angular and parallel misalignments.

In [7] simplified the rubber bearing into parallel-distributed springs, but the water and oil layers were ignored. The dynamic model of the propulsion shafting system was created using the finite element approach and reduced using mode truncation. The combined impact of bearing misalignment and friction was then investigated using this simplified model and the fourth-order Runge-Kutta technique. Finally, the whole system's lateral and torsional vibration characteristics were obtained under varied bearing misalignment, which may be employed in the detection or diagnosis of improper vibration caused by friction.

A mathematics vibration model of a high-speed punching press was created and applied by [8] when working the punching press's vibration modes. A multi-domain model of the punching press was designed to predict the kinematic state of the press beneath totally different circumstances, likewise because of the effects of load fluctuation on the motor speed. In associate experimental setting, the punching press's acceleration was calculated. In step with the findings comparison, the multi-domain model is compatible with the vibration model and also the experimental measurements. A modal analysis and structural modification were done on the punching press. The inspiration at the bottom of the punching press was improved to reduce excessive vibration. The influence of the bottom measurements on vibration were investigated exploitation the multi domain model. Finally, an appropriate base structure capable of minimizing vibration was discovered.

In [9]three-phase extraction technique for the assembly of virgin vegetable oil was wont to examine the content balance of olive fruit materials like oil, water, carbohydrates, proteins, minerals, and polyphenols. The calculable overall olive content balance supported mass flow indicated a final oil extraction yield of concerning 83.3 % with AN initial olive fruit mass flow of five hundred kg/h. the excess oil was principally discharged as waste within the type of olive cake (8.9%) and olive mill water (7.8%). in line with the fabric balance of carbohydrates, the bulk of carbohydrates is discharged in olive cake (73.3 kg/h) and olive mill water (27.7 kg/h). The content balance of polyphenols, the foremost voluminous purposeful compounds in olives, resolve as a result of their importance to the chemical stability of vegetable oil. Throughout the malaxation method, the content of polyphenols increased (17.6%), thanks to variety of protein reactions that were directly reflected within the composition of virgin vegetable oil.

In study [10] and after perceptive the number of vibrations on the bearing house of a turning shaping machine that had been chosen before by varied the revolutions per minute and therefore the thickness of the fabric extracted in frontal kind shaping machine producing. Supported the importance of nominal splinter thickness, dynamic technological specifications of the drilling method as a results of motor rotating speed resulted in a rise in mechanical vibration values. The vibration acceleration amplitude direction varies counting on the frequencies for four hundred, 800, and 1200 motor r/min. An electricity device from the Bruel&Kjaer cluster, model 4507B-004, was hooked up to the bearing house of the shaping machine TOS SV 18RB to watch the frequency analysis of the vibration. The vibration signal computed throughout the synthesis and time cycle is remodeled to a frequency scale within range of 3.0–10.0 kHz employing a quick Fourier transformation. The measured values of vibration acceleration amplitude were processed and evaluated exploitation the Signal specific program.

The study in[11] investigated the influence of three crushing machines on the viscosity of olive paste: a hammer crusher, a disk crusher, and a de-stoner were all evaluated. The tests were repeated on both the paste exiting each machine and the paste to which water was added, with the goal of taking into account the various dilutions of the paste as it entered the decanter. The results also demonstrate that the pastes produced by the two traditional crushing methods (hammers and disks) are nearly equal, with packing factors of about 17.9% and 18.6%, respectively. The paste produced by the de-stoner, on the other hand, has greater viscosity values and a lower solid packing factor of roughly 2.8%. At 30% dilution with water, the volume of the solid concentration reduced to around 11.6% for the hammer and disc crushers, but only 1.8% for the de-stoner. This tendency is reflected in the yield evaluation, which was 6% lower with the de-stoner. There were no significant changes in the legal parameters of oil quality between the three crushing technologies.

-Aim and Objectives

The main objective is to reduce vibrations in olive press components. This olive press consists of three production line stages. In the first stage of this study the vibration ratio of multiple parts of the press is measured using the vibrometer device. Then work on dismantling all the pieces in the production lines to make the alignment required, according to the manufacturer and then run the press and read the vibrations again and if the vibration readings still not matching the allowable range and still a proportion of vibrations work on the second stage and create a buffer between the production lines and the floor of the compressor and it will be the insulation by a rubber and then the vibrations are measured again and if the vibration still exist the next step in the third stage, is to check construction and how to handle the construction of vibrations. The main sources of vibration in rotating machines are analyzed which included misalignment, imbalance and bearings wear, in the current study shaft misalignment and bearings wear are taken as the main sources of vibration and a comparisons between the current study results and findings found in some same condition case in literature is performed.

2. Methodology

The study is executed experimentally at some selected olive press stations. To measure the values of vibration using a wt63a high quality portable vibration meter in different locations in the olive press. The vibration meter is used to measure variable data of vibration such as velocity, acceleration, and displacement, the vibration meter shown in Fig. 6.

Fig. 6. Wt63a vibration meter was used in the study.

-Conditions of the Study

All readings in the current study are taken at the same conditions of temperature, pressure and angular velocity or RPM of the rotating machines. Also, the same device is used for all readings with the same error (0.05) for displacement, velocity and acceleration.

Vibration Sensors and meters play a crucial role in protecting and monitoring plant machinery or a structure. These measurements help in controlling the process control systems and making adjustments in a process environment. These sensors can be found everywhere including aerospace labs and automotive test bays, to smart structures providing condition monitoring systems and active control. But, how to ensure that the actual process value is measured by the sensor and passed along for processing? While these sensors or meters continue to improve the performance of processes, machinery, and structures, they also tend to grow a calibration liability with time. Calibration involves finding out the deviation between the true reading and the displayed reading. It is the procedure of comparing the output from the sensor to a reference or standard value of high accuracy. To provide accurate data, accelerometers are calibrated to ensure they cover the correct frequency range and their sensitivity to acceleration is correctly rated. To perform calibration, a vibration sensor is exposed to a precisely defined excitation quantity and the measurements are recorded during this time. In order to measure something, the exact properties of the measuring equipment must be known [12].

To ensure that, the measurement results are comparable with the measurements of third parties. The measuring instrument must be traced back to a national standard, wherein this traceability is regulated and secured by the calibration hierarchy. The calibration of this meter produced an error of 5% and this error is applied for all taken readings. Traceability showed that an instrument has been calibrated or certified by a higher-order standard which is then calibrated by its higher-order, and so on. A vibration sensor is generally calibrated and traced through a comparison method.

In this study, the ISO 10816-3 chart (Fig. 7) is used for “advised” levels of vibration quality. Some common sense must be used as well. As an example, a machine tool would need to operate at a lower level of vibration, to maintain machining finish quality. A hammer mill might operate at a higher vibration level while in use. The chart divided the levels of vibrations into three areas: Unrestricted Operation – this assumes a motor/pump or any rotating part or machine that has been in operation beyond original commissioning. An acceptable vibration level would be below 0.16 in/sec (pk) or 2.8 mm/sec (root mean square (rms)). Restricted Operation – the same motor/pump operating a vibration levels between 0.16-0.25 in/sec (pk) and 2.8-4.5 mm/sec (rms) should be considered to have a problem causing excessive vibration, such as unbalance or misalignment. This machine could be run as needed however it should be scheduled for maintenance to reduce the vibration. Damage Occurs – vibration levels on the motor/pump above 0.25 in/sec (pk), or 4.5 mm/sec (rms) could cause additional damage to machine components, such as bearings. This machine should be taken out of service as soon as possible, and corrective actions taken to reduce the vibration [12-16].

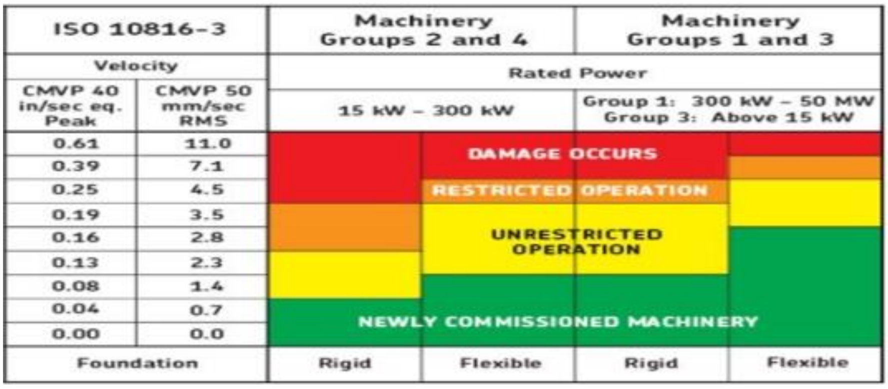

Fig. 7. ISO 10816-3 Vibration severity chart [12].

3. Results and Discussion

The values of vibration in all the sections in the olive press are measured, such as the decanter centrifuge (the extraction section), bravo separator, malaxing section, and leaf removal, rushing machine, presses or mills and washing section. The highest values of vibration were in the presses –Crushing component, extraction and separation sections because that these three sections are located in an area where there is an empty storage of 10 meters high under the olive press. The values of vibration parameters for the olive press in multiple locations were not matching the ISO 10816-3 (Fig. 7), as shown in Table 1 below. The data measured showed that crushing, extraction and ground pass components have high vibration velocity values and depending on ISO chart shown in Fig. 7, such components may exposed damage status, while other components are in safe side.

Table 1. Vibration Readings

Location name	Acceleration (m/s^2)	Velocity (mm/s)	Displacement (mm)	Class/Depend on ISO-Standards
Crushing	10.0	10.0	0.10	DamageOccur
Washing machine	3.6	3.6	0.036	Unrestricted Operation
Malaxing	0.3	0.3	0.003	No Danger
Separation	5.0	0.5	0.05	No Danger
Extraction	14.0	14.0	0.14	DamageOccur
Ground Pass	6.0	6.0	0.06	Restricted Operation

Reading with multiple olive oil presses were measured for 3 different olive presses as shown below.

-Press A:

Table 2 shows the vibration parameters readings for press A on 8/11/2022 while Figures 8, 9 and 10 show such vibrations of this press. The data measured for press A showed that crushing and extraction components have high vibration velocity values and depending on ISO chart shown in Fig. 7, such components may be exposed to damage status, while other components are in safe status.

Table 2. Vibration parameters readings for press (A) on 8/11/2022.

Location name	Acceleration m/s²	Velocity mm/s	Displacement mm
Crushing	8.0	8.0	0.08
Washing Machine	3.7	3.7	0.037
Malaxing	0.3	0.3	0.003
Separation	3.5	3.5	0.035
Extraction	12.5	12.7	0.127
Ground Pass	1.7	1.7	0.017

Fig. 9, 10 and 11 show the displacement, velocity and acceleration of the components of press A, it can be noticed that the crushing and extraction components have maximum displacement, velocity and acceleration values, which means that such component need to be maintained or adjusted to decrease such values by making alignment or balancing or replacing the assisted bearings.

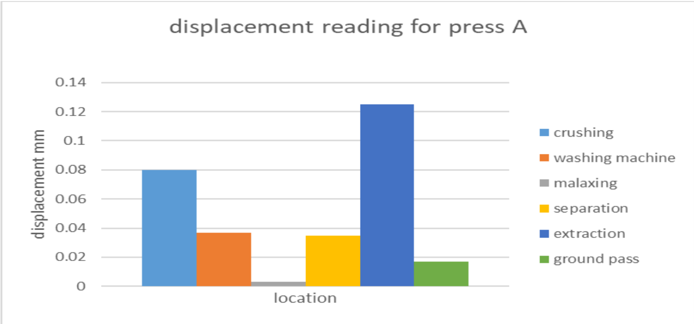

Fig. 8. The displacement readings for press A at 8/11/2022.

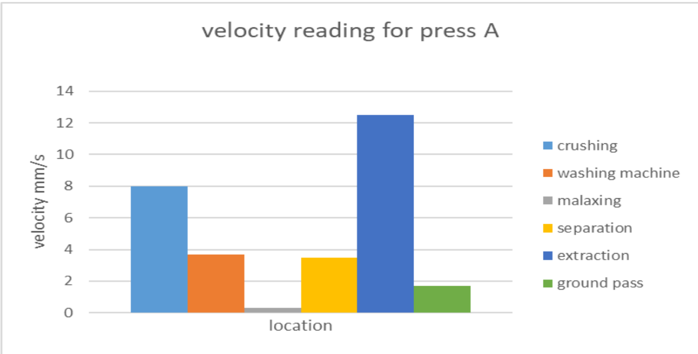

Fig. 9. Velocity readings for press A at 8/11/2022.

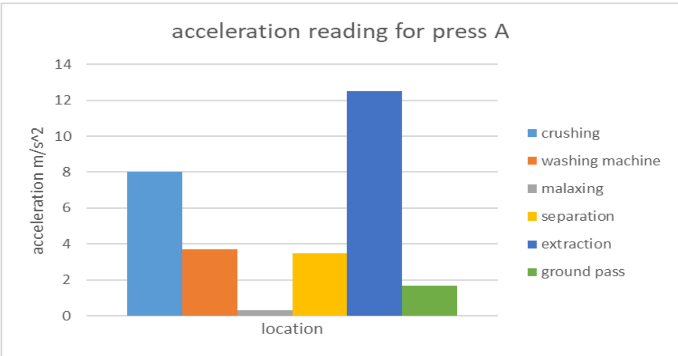

Fig.10. Acceleration reading for press A on 8/11/2022.

After maintained Press A: crushing machine, and extraction component, the values of vibration displacement, velocity and acceleration are modified for extraction component and becomes in satisfaction values, while the crushing component is still need to be adjusted or maintained as shown in Table 3.

Table 3. Vibration parameters readings for press A on 30/11/2022.

Location name	Acceleration m/s²	Velocity mm/s	Displacement mm
Crushing	8.0	8.0	0.080
Washing Machine	3.7	3.7	0.037
Malaxing	0.4	0.4	0.004
Separation	4.0	4.0	0.04
Extraction	2.5	2.5	0.025
Ground pass	1.7	1.7	0.017

-Press B

Table 6 shows the vibration parameter readings for press B on 8/11/2022. It can be noticed that all components of press B are in good status depending on ISO standards except the extraction and crushing parts which have velocities of 8.8 mm/sec and 4.8 mm/s respectively which need to be fixed.

Table 6. Vibration values of Press B taken in 8/11/2022.

Location name	Acceleration m/s²	Velocity mm/s	Displacement mm
Crushing	8.8	8.8	0.088
Washing Machine	1.7	1.7	0.017
Malaxing	0.3	0.3	0.003
Separation	2.6	2.6	0.026
Extraction	4.8	4.8	0.048
Ground pass	0.7	0.7	0.007

Fig. 11, 12, and 13 show such vibration values as bar chart.

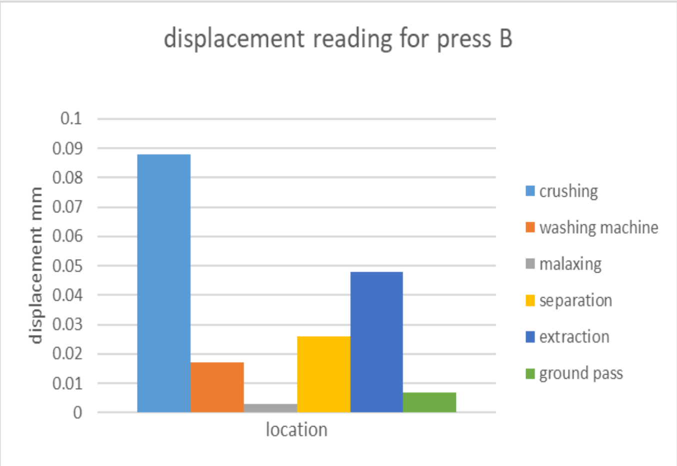

Fig.11. The displacement readings for press B at 8/11/2022.

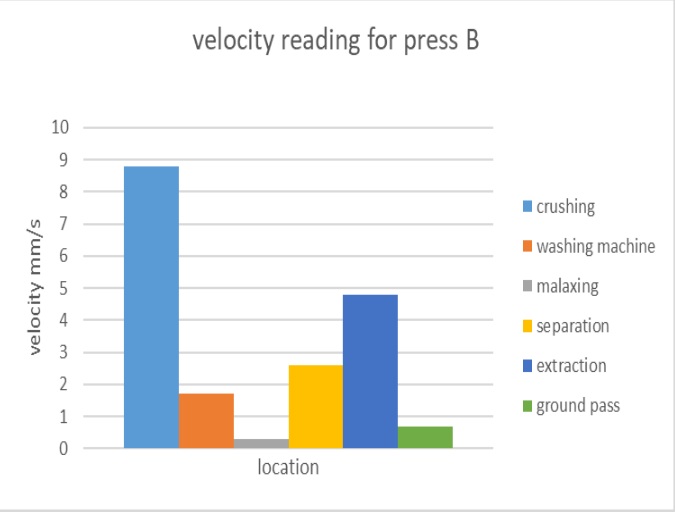

Fig.12. Velocity readings for press B at 8/11/2022.

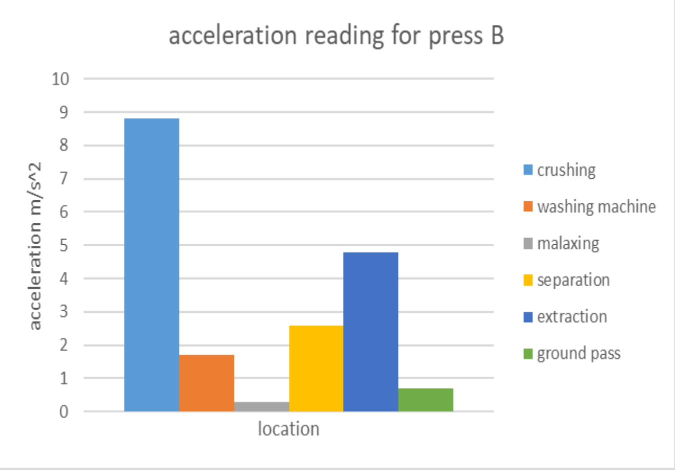

Fig.13. Acceleration reading for press B at 8/11/2022

High separation readings were (found that a fracture inside one plate in separation) of Press B in Table 7: Vibration parameters reading for press B at 30/11/2022. It can be noticed that after re adjusting the extraction component by making some operations of balancing, alignment and changing some required bearings and lubrication, the velocity value decreased to 2.5 mm/sec which indicated that the component is in satisfaction ranges.

Table 7. Vibration values of Press B taken on 30/11/2022

Location Name	Acceleration m/s²	Velocity mm/s	Displacement mm
Crushing	8.8	8.8	0.088
Washing Machine	1.7	1.7	0.017
Malaxing	0.3	0.3	0.003
Separation	2.6	2.6	0.026
Extraction	2.5	2.2	0.025
Ground Pass	0.9	0.9	0.009

-Solving Problem of crushing component of Press A

In the first stage of the process of reduction the vibrations of the press, the rate of vibrations in the press was measured and the following values were (acceleration 12.5 m/s², Velocity 12.5 mm/s, Displacement 0.125 mm). After studying and verifying the reasons that led to the presence of vibrations, there was a weakness in the quantity of production and the wear of a large number of pieces and the appearance of a loud sound from the machines. On the place of the production line and study the building plan, which in the first stage shows that the production line was part of it, such as the piston over an empty warehouse large area. After that, all parts of the production line were unscrewed and inspected from all the moving parts in the production line. It was found that there was wear in the endurance and the springs were examined bearing and was found by wear and rust because of the entry of water to some parts and exposed to excess heat led to the lubricant out of tolerance. (Fig. 17).

Fig.17. Examined bearing

The piston, which is more susceptible to vibration problems, was examined for weak tolerance bearings as well as weak damping and spring under the piston for vibration absorption. After that, the production line is shifted and back by four meters and calibrated and balanced all parts of the press, change all springs and endurance, which has some problems and put some parts of the rubber under the piston and mixer and operated the presses to make sure that they are ready to work and found that all parts of the press work properly and some vibration readings were measured of the presses in four stages as shown in Table 10.

Table 10. Vibration parameters readings on 2/12/2022 after maintenance

Location name	Acceleration m/s²	Velocity mm/s	Displacement mm
Crushing	2.9	2.9	0.029
Washing Machine	3.6	3.6	0.036
Malaxing	0.3	0.3	0.003
Separation	2.3	2.3	0.023
Extraction	6	6	0.075
Ground pass	1.4	1.4	0.014

The crushing readings in press A were high (about 8 mm for displacement, 8.0 mm/s for velocity, and 8 m/s^2 for acceleration) because it was found that the bearing in the pump suffering of mechanical wear and friction. The bearing was changed and the pump was rechecked then the crushing section had the following readings: (acceleration 4.4 m/s², Velocity 4.4 mm/s, Displacement 0.044 mm) and the maintenance cost equals (300$). Fig. 18 shows a comparison of such values before and after maintenance of the crushing element of press A.

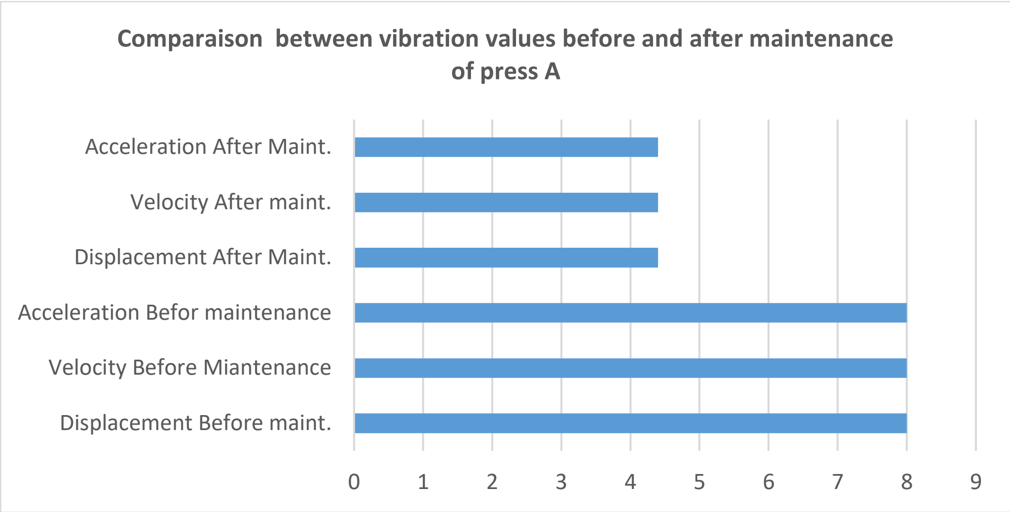

Fig.18. Comparing of vibration values before and after maintenance operations on press A.

Another olive press crushing readings were: (acceleration 29.4 m/s², Velocity 29.4 mm/s, Displacement 0. 294 mm). The other olive press was waiting for the annual maintenance led to a cost of 8000$ to fix the crushing damage and in the decanter centrifuge.

One of the readings had the separation reading 12.8 m/s² (found that there was a plate damaged in the separator, that affects the centrifugal force also), after changing the plate, the vibration reading became (acceleration 2.4 m/s², Velocity 2.4 mm/s, Displacement 0.024 mm), and the cost of maintenance is equal (600$). By apply the reading of all the olive press vibration parameters on graph can easily comparing the effectiveness of the vibration reduction process. All of this results in a perfect production process, faster process and high quality products. Also the noise is gone but the natural noise from the mechanical machines.

Effects of Vibration on Olive Oil Productivity-SIMIO Model

To prove the effectiveness of the decreasing of the vibration values on olive oil production, one press is simulated using SIMIO software, Fig. 19 shows the simulation of olive oil extraction plant-Press A. Fig. 20 shows the model while running.

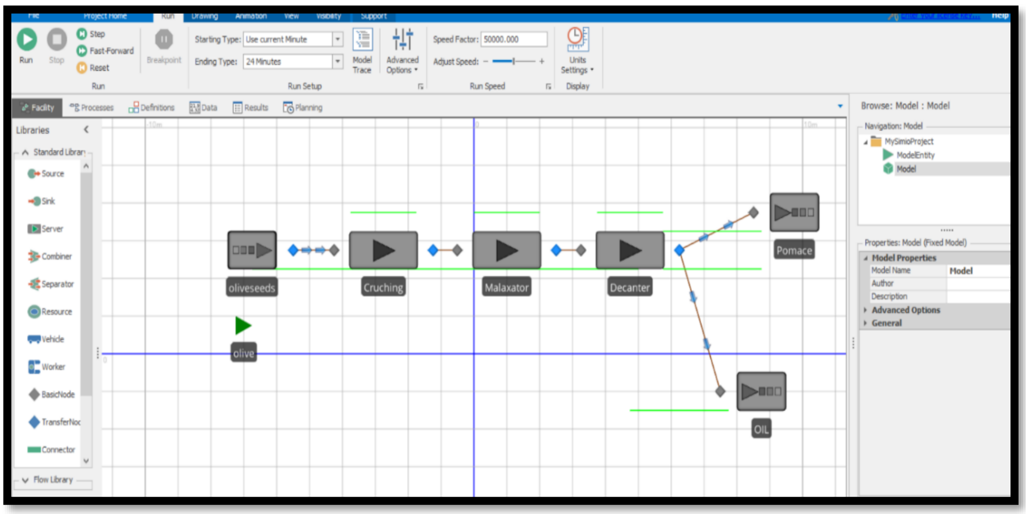

Fig.19. SIMIO model of press A

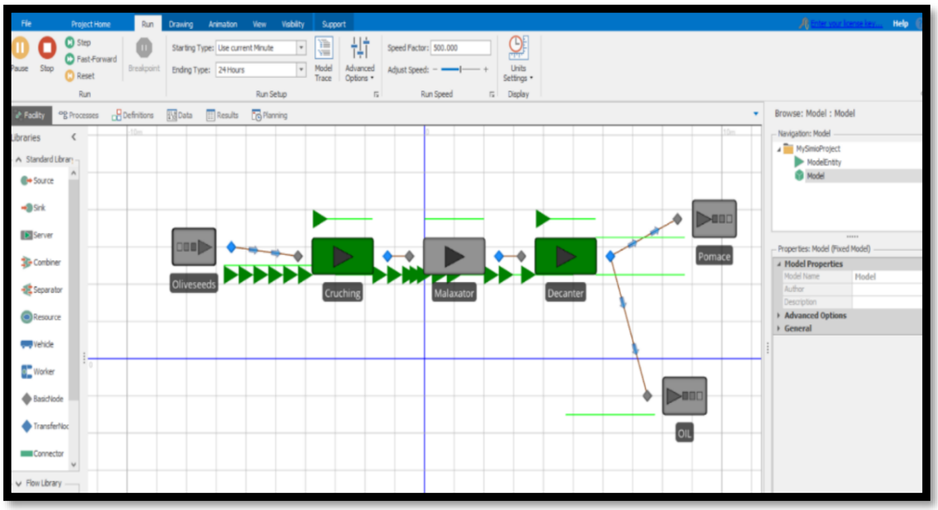

Fig. 20. Running the SIMIO model

The results of the simulated model for crushing part of press A are shown in appendix 1 (Table A.1 and Table A.2), by comparing the results before and after maintaining (by decreasing vibration) the press-Crushing machine, it can be noticed that the productivity of the press A is increased from 687 to 778 units which means that decreasing vibration of the system enhance productivity of the olive oil and decreasing Pomace from 172 to 84 units.

-Comparison with other studies (misalignment and imbalance) of Press A.

The comparison operation with the same condition for a rotating machine (Crushing machine) is very hard, since there is no studies dealt with the specific problem of the present study, but after some effort a similar study performed by [7] is presented. Table 11 shows the values of acceleration of measured by both the present study and by [7]. The data are measured continuously by the vibrometer under the same conditions after making alignment and valancing for press A.

Table 11. The values of acceleration of measured by both the present study and by [7]

Time (seconds)	Acceleration m/s^2 (Present Study)	Acceleration m/s^2 (From Literature-[7])
0	2.9	2.5
1	1.8	1
2	0.56	0.5
3	0.48	0.4
4	0.45	0.3
5	0.2	0.1

Fig. 21 shows a comparison between the present study reading and values determined by [7]

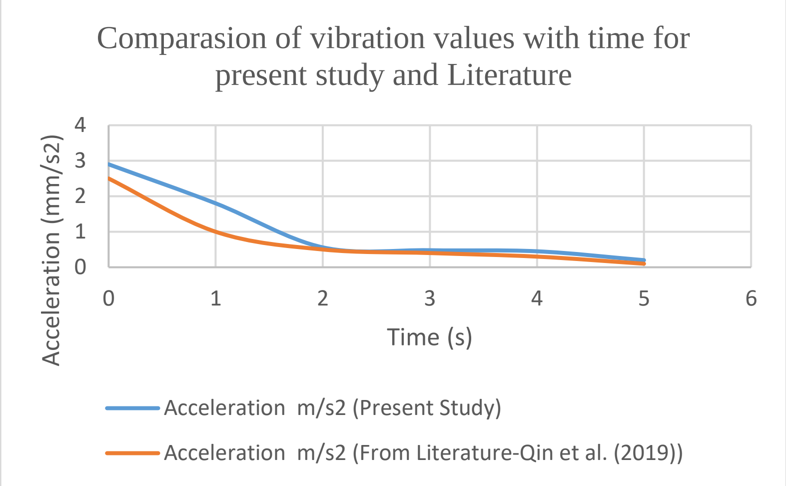

Fig. 21. Comparison between the present study reading and values determined by [7]

From Fig. 21, and by comparing values of acceleration for the same conditions of a rotating machine (crushing machine in the present study and propulsion shafting system by [7] a good agreement between the results can be noticed.

4. Conclusion

The highest vibration parameters reading were in the extraction and separation process due to 10 meters high empty storage under them and due to the high rotational speed and heave weight they had, some of the readings were above the ISO range after the alignment and location shifting were done and that was because of mechanical wear in the bearing, the crushed plate in the separation and the exhausted plates in the crushing with high noise, this high vibration values were eliminated in the mechanical check. High vibration values reduce the speed of the production process because the mechanical system inside each section in the press will not work efficiently when the vibration occurs and leads to misalignment over time which leads to mechanical wear and damage to machines. Any production process has to be maintained maintenance cycle and has to be mechanically monitored to work efficiently. Alignment has to be done periodically to avoid mechanical wear and to avoid high maintenance costs if the alignment is not made. As a result of the vibration reduction process the solid mixture from the extraction process is an accurate indicator of the efficiency of the reduction process where high weight values mean that there is a lot of oil stored in the mixture and the decanter centrifuge is not working properly, as a result of our reduction process the weight values were the minimum in comparison with the other olive presses. A comparison between the current study results and findings found in some same condition cases in literature is performed and a good agreement is noticed under the same conditions. It was found that by performing some maintenance operations like shaft alignment, mechanical balancing, and improving bearings lubrication, the values of vibration velocity of crushing and extractor components of olive presses can be reduced hence improving the productivity of such olive oil plants (also this is proved using SIMIO results).

Conflict of interest

The authors declare that they have no conflict of interest.

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AppendixA1. Interactive Detail Report: Project: Simio Project

Table A1. Before maintenance

Object Name	Data Source	Category	Value
olive	[Population]	Throughput	5671
Number Destroyed - Total			
Object Name	Data Source	Category	Value
olive	[Population]	Throughput	859
NumberEntered - Total			
Object Name	Data Source	Category	Value
Cruching	InputBuffer	Throughput	5671
Cruching	OutputBuffer	Throughput	1498
Cruching	Processing	Throughput	1499
Decanter	InputBuffer	Throughput	861

Decanter	OutputBuffer	Throughput	859
Decanter	Processing	Throughput	860
Malaxator	InputBuffer	Throughput	864
Malaxator	OutputBuffer	Throughput	862
Malaxator	Processing	Throughput	863
OIL	InputBuffer	Throughput	687
Pomace	InputBuffer	Throughput	172
Oliveseeds	OutputBuffer	Throughput	5671
Oliveseeds	Processing	Throughput	5671

Table A2. After maintenance

Model: Model (Evalution Only)

Scenario: [Interactive Run]

NumberCreated - Total

Object Name	Data Source	Category	Value
olive	[Population]	Throughput	5676

NumberDestroyed - Total

Object Name	Data Source	Category	Value
olive	[Population]	Throughput	862

NumberEntered - Total

Object Name	Data Source	Category	Value
Conveyor1	[Travelers]	Throughput	84
Conveyor2	[Travelers]	Throughput	778
Cruching	InputBuffer	Throughput	5676
Cruching	OutputBuffer	Throughput	5675
Cruching	Processing	Throughput	5676
Decanter	InputBuffer	Throughput	863
Decanter	OutputBuffer	Throughput	862
Decanter	Processing	Throughput	863
Malaxator	InputBuffer	Throughput	864
Malaxator	OutputBuffer	Throughput	863
Malaxator	Processing	Throughput	863
OIL	InputBuffer	Throughput	778
Pomace	InputBuffer	Throughput	84
Oliveseeds	OutputBuffer	Throughput	5676
Oliveseeds	Processing	Throughput	5676

Biographies

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