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Improving Performance of the Poultry Eggs Incubator using the Pulse Repetition Frequency

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ABSTRACT

In recent years, research on a poultry egg incubator has become very interesting, especially quail eggs. The main objective of this study is applied to Pulse Repetition Frequency (PRF) as an innovative technique used to control the power supply for the pulse's generator. The experiments were carried out to apply the PRF technique during an incubation process through design and build an electronic circuit for producing a pulse repetition frequency signal to control the pulses generated using PRF circuit. This circuit was used to generate PRF waves so that the frequency pulses of the generator can be adjusted as required level during the integrated circuit. The incubator performance was evaluated under the following parameters: four different pulse intensities (48, 60, 72 and 84 W.m^{-2}) and frequency durations (10, 15, 20 and 25 minute per hour), taking into consideration the following indicators: hatchability, mortality, and incubator efficiency. The obtained results reveal that the highest hatchability percentage of 89% and a mortality of 17% with incubator efficiency of 83%. It was observed that the consumed energy value of 529 W.h **.**The quail egg incubator is recommended to be used under a pulse intensity of 72 W.m^{-2} with a frequency duration of 25 minutes per hour. The results of this research are difficult to compare with other studies because there is no data on this subject in the available literature.

Keywords: incubator, pulse repetition frequency, poultry eggs, Incubator efficiency, Energy consumption.

INTRODUCTION

Population growth globally leads to an increase in poultry egg demand. Poultry farming supports with the agricultural production of quail eggs that commonly starts from egg incubation and hatching (Ajiwiguna *et al.*, 2018).

In the Egg incubation process, the quail egg exposed to hatch and development the embryo within the egg. Egg incubators are machines, which simulate the quail's role of providing the optimum environmental conditions as (temperature, relative humidity, turning and ventilation) to the fertilized eggs to activate embryonic development until the hatching process. Low incubator efficiency is one of the problems and obstacles preventing expansion in this field, which does not exceed 75% (Aru 2017). Various types of small-scale egg incubators with several heat sources have been developed. These incubators were operated a temperature range of 37◦C to 39.5◦C and with relative humidity from 55 to 75% throughout the incubation period. Hatchability percentage of the incubated eggs were recorded 78.5% (Ahiaba *et al.*, 2015).Modern incubators can control the temperature, turn and humidity automatically based on recent technology nowadays. These incubators are distinguished with ease of monitoring and controlling as well as efficiency in saving the energy consumed. Accordingly, these systems are preferable to other conventional egg incubators (Pallavi *et al.*, 2018). Nowadays, the advantages of pulse repetition frequency (PRF) and its biological effects are subject to so many studies on humans and animals. Poultry eggs can be incubated under standard conditions such as frequent rotation, expose eggs to electromagnetic fields as well as the exposure to the repetition frequency may have beneficial improvement on the nervous system (Batellier *et al.*, 2008). Many factors as the type of pulse repetition frequency (PRF), the intensity of PRF and duration of exposure that impact the performance of chicken embryos and consequently hatchability (Shafey *et al.*, 2011). The impact of pulse repetition frequency on human beings can be described as completely useful as well as, it has been used in the medical field since old times and their effectiveness for both bone wound and bone fracture healing has been proven (Shckorbatov *et al.*, 2010). A low-frequency intensity was studied on the proliferation and productivity of cells by changing frequency levels. The experimental results show that pulses intensity from 0.4 to 0.8 W.cm^{-2} and pulse repetition frequency can facilitate cell proliferation. In other words, the extent of reproduction closely correlated with pulse repetition frequency. An appropriate parameter setting for pulse repetition frequency is vital to its accurate use. These findings will be providing valuable information for the application of low pulse repetition frequency in tissue engineering (Yang *et al.*, 2016). There are four main factors that influence embryo development such as Humidity, temperature, ventilation, and eggs turning during egg incubation. Maintain the level of humidity and distribute hot air is vital to avoid dry atmosphere which makes hatching more difficult (Ramli *et al.*, 2015). The heat transfer inside the incubator done primarily by the difference between eggs and the plate setter environment temperature plus the airflow through eggs, which can be affected by the fan flow rate at forced incubators. The optimal temperature for Japanese quail is 37.5±0.5 °C with an incubator period around 17 to 19 days (Nowaczewski *et al.*, 2012). The oxygen availability and get rid of carbon dioxide are necessary, so ventilation is

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required to ensure an adequate supply of oxygen and the proper removal of carbon dioxide during embryo development. Accordingly, provision of the incubation system with fresh-air is necessary (Benjamin and Oye, 2012). Undoubtedly, the regular air velocity is essential to preserve uniform embryo temperatures. Obviously, if the air movement across the eggs is slow, more time needs to absorb heat from the eggs. It could also be said that lower air velocity related to more variation in temperatures of the embryo, so the optimal air velocity is 2 m/s to control the temperature of the embryo to acceptable levels (Lourens, 2001).

This study presents a modern method based on pulse repetition frequency PRF technique as well as study the effect of different pulse intensity and frequency duration on quail egg hatching under low levels. Therefore, the objectives of this study include the design of an electronic circuit for producing a pulse repetition frequency signal to control the pulses generated using the PRF circuit as well as optimize some operating parameters affecting the performance of the incubation system. The results of our research are difficult to compare with other studies because there is no data on this subject in the available literature. So, research efforts that combine innovation and development are still requested to whole advantage potential as regards the egg incubation systems.

MATERIALS AND METHOD

The experiments were carried out at Electrical Engineering Laboratory, Agricultural Engineering Department, Faculty of Agriculture, Zagazig University to improve the performance of an egg incubator using pulse repetition frequency through design and construct an electronic circuit for producing a pulse repetition frequency (PRF) signal to control the pulses generated using PRF generator. This development was targeted ensuring increment of hatchability percentage and low mortality ratio.

Description of the egg incubator

In this study, a new modulation method based on the pulse width modulation technique is proposed to control the pulses generator to improve the performance of a quail egg incubator via a new technique to reach an optimum incubation conditions. The essential components of the incubator are an electric heater, fans, circuit of pulse repetition frequency, PRF controller, thermometer, hygrometer and turning device as shown in Fig. (1).

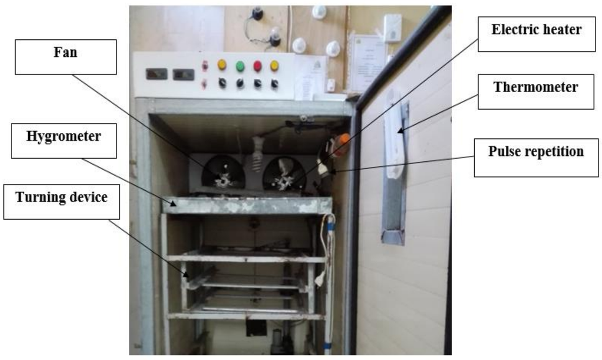

Fig. 1. Front view of the developed egg incubator.

Pulse repetition frequency enhances the performance efficiency of this incubation machine, which could be improve the hatchery eggs.

PRF essentially controls the amount of power, in the perspective of the voltage component that is given to a device by cycling the on-and-off phases of a signal quickly and varying the width of the "on" duty cycle. A very powerful benefit of PRF is that power loss is very minimal compared to regulating power levels using an analog potentiometer to limit the power output by essentially choking the electrical pathway, thereby resulting in power loss as heat, while pulse repetition frequency turns off the power output rather than limits it. Fig. 2 illustrates the generating circuit of pulse repetition frequency with the control unit connected to an egg incubator.

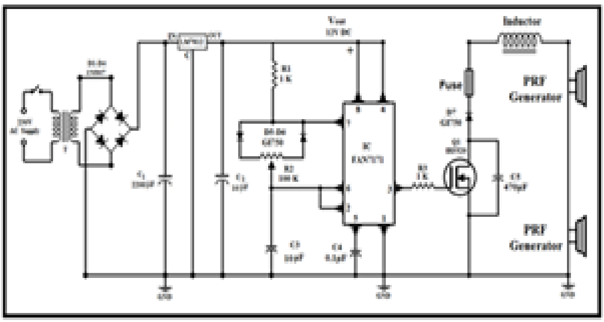

Fig. 2. Diagram of generating circuit of pulse repetition frequency.

Design considerations and analysis

Design considerations included both circuit of pulse repetition frequency, ventilation holes and required speed of air inside the incubation cabinet.

Design of PRF circuit

The power supply is an electronic device that supplies electric energy to an electrical load. The power supply circuit can be designed using different techniques for converting the high voltage into low voltage. Basic components related to the power supply transformer, bridge rectifier, a filter circuit, voltage regulator and control switch, which is employed for installation electronic circuit of a power supply. Switching power supply is designed and installed down-up AC converter for supplying power (12-35VDC) to the pulse repetition frequency generator and other electrical appliances in the egg incubator from 230 VAC and then produce different levels of the required voltage.

The voltage regulator needs to 2 volts more than confirmed voltage as well as, diodes are dropped about 0.7V for each one when operated in forwarding bias. So, in bridge rectification will drop around 1.4V. To determined output voltage step down transformer, V_o is be through the following equations, (Onuorah and Nwozor 2014).

$$\mathbf{V_t = V_d + V_r + V_b}$$

Where:

V_d is desired output voltage, V_r is stored voltage in regulator and V_b is voltage dropped in bridge rectifier.

$$\mathbf{V_t = 30 + 2 + 1.4 = 33.4 \approx 35V}$$

So, must be use a 230 to 35 Volt step down transformer for that. On the other hand, the resistance value, R_r is calculated as follows:

$$R_r = \frac{V_d - 3}{0.01} = 2700\Omega \approx 2.7k\Omega$$

To determined output power, P_o is be through the following equation.

$$P_o = I_o \times V_a = 60W$$

Where:

I_o is current strength = 2A and V_a is voltage applied across the circuit.

In this application, 230VAC power is converted into 30VAC power using a selected step-down transformer for operating a pulse repetition frequency generator and other devices. Where the AC is fed to the transformer, the bridge rectifier follows the transformer thus converting AC voltage into a DC output and through a filtering capacitor (C_1) which feeds it directly into the input (Pin_{IN}) of the voltage regulator, the common pin (C) of the voltage regulator is grounded, the output (Pin_{OUT}) of the voltage regulator is filtered by a second capacitor (C_2) and then the output is taken 30VDC power.

Controller circuit in voltage and frequency

A modern technique to control the power of a pulse repetition frequency PRF generator was fixed inside the incubator to regulate the amount of voltage and frequency across its terminals and this can be achieved using pulse width modulation.The power applied to the pulse repetition frequency generator can be controlled by varying the width of these applied pulses and thereby varying the average voltage applied to the generator terminals from (12 to 30VDC).

The circuit of pulse repetition frequency is designed and installed with a quail egg incubator to provide an automatic controller as well as ease of monitoring and control of the operating system. It was done by employing the integrated circuit (FAN7171-F085 IC). This circuit was used to generate PRF waves so that, the frequency pulses of the generator can be adjusted as a required level.

The integrated circuit, IC was wired as a stable multivibrator which produces a series of square wave pulses. The output frequency of the stable multivibrator depends on the utilization of the resistors, capacitors, and diodes in order to make IC FAN7171 produce PRF output signal modification in the stable circuit.The duty cycle of the output was governed by the variable resistor R2 connected between pin 6 and pin 7 of IC. This resistor holds the key for generating the PRF waves from the IC output so by varying the resistance in the R2 the output width of the pulse can be varied as desired resulting in the generation of PRF waves, thus the R2 can be used as a switch in order to control the pulse repetition frequency generator in this way. The IC output is connected to transistor Q1 which drives the generator by the signal coming from FAN7171 IC output. The output frequency of the generator will be high if the signal from the duty cycle of the PRF is high.

Hence, the operating theory can be summarized as follows: when the power switch is changed in the operation mode, the current starts flowing from the voltage source through the power supply circuit for converting 230V AC into (12-30VDC) power using a step-down transformer. Accordingly, the DC current flows from the power supply to pulse width modulation than to an inductor and PRF generator. A repetition frequency is generated due to this continuous make and break of the circuit which induced repetition frequency in the generator inside the eggs incubator to the extent required.

Ventilation holes and required air inside incubation cabinet

The main dimensions of the incubator are 0.96×0.72×1.10 m, hence this incubator capacity was 1000 quail eggs. The density of air can be calculated using the following equation (Gbabo *et al.*, 2014):

$$\rho_a = \frac{P}{RT} = 1.137\ \mathrm{kg.m^{-3}}$$

Where:

ρ_a is density of air inside incubator, P is atmospheric pressure = 101.325 kPa, R is specific gas constant = 287.058 J/kg·K° and T is incubation temperature = 37.5°C Weight of required air inside the incubation cabinet can be calculated using the following equation:

$$m_a = \rho_a \times V = 1.137 \times 0.76 = 0.86\ \mathrm{kg}$$

Where:

ma is weight of required air inside incubation and V is volume of incubation cabinet. The ventilation of the incubator chamber has a strong influence on the efficient operation of the incubator and on subsequent hatchability and incubator efficiency. For optimum performance, incubators need to be enclosed in a room where there is plenty of fresh air that has been preconditioned with temperature and humidity.During the embryo develops it obtains oxygen and gives off carbon dioxide. Hence, adequate ventilation inside the incubator is required to achieve an appropriate supply of oxygen and the removal of carbon dioxide. Best results are achieved during the incubation process in the normal oxygen level of ambient air. The embryo can undergo a limited level of carbon dioxide since the normal carbon dioxide and oxygen concentration existent in the air appears to represent an optimum gaseous environment for incubated eggs.

A ventilation system should be designed to achieve the appropriate circulation of fresh air at a favorable temperature and humidity. Based on the following equation can be calculated the heat required to raise the temperature of the air within the incubator.

$$Q_a = m_a\, C_a\, \Delta T = 10.80\ \mathrm{kJ}$$

Where:

Q_a is heat required to raise temperature of air, m_a is weight of required air, C_a is specific heat capacity, kJ/kg.K and ΔT is temperature change.

To calculate air flow rate, q_a can be used the power required to heat an air flow as shown in the following equation.

$$q_a = \frac{P_o}{C_a \times \rho_a \times \Delta T} = 0.035\ m^3.s^{-1}$$

Where:

q_a is air flow rate $m^3.s^{-1}$, P_o is power required to heat an air = 500W, C_a is specific heat capacity, ρ_a is density of air inside incubator and ΔT is temperature change. Through relationship, q_a=A×v can be calculated diameter of hole is 1.5 cm with 10 ventilation holes. Where, A is area of holes and v is air velocity = 2 $m.s^{-1}$.

Air flow inside the incubation chamber

Laminar flow ensures uniformity of airflow in the incubator making it guarantees the optimal combination of air temperature, airspeed, and relative humidity reaches every egg inside the incubation chamber. This makes it possible to maintain optimal hatchability percentage and chick quality. Laminar flow occurs when the Reynolds number is below a critical value of approximately 2000. So, the Reynolds Number can be determined as follows (Reynolds, 1883).

$$R_e = \frac{\rho_a v d_h}{\mu_d} = 1791$$

Where:

ρ_a is air density, μ_d is dynamic viscosity = 1.904×10^{-5} $kg.m^{-1}.s^{-1}$, v is air velocity and d_h is hydraulic diameter.

Hatchability and Mortality

The Percentage of hatchability and chick vitality rate must be calculated for evaluating the developed incubator. Hatchability and mortality on hatching day were calculated as follows (Dalangin and Ancheta, 2018).

$$HP = \frac{N_h}{N_{in}} \times 100$$

Where:

HP is percentage of hatchability, N_h is number of chicks hatched and N_{in} is number of eggs incubated.

$$MP = \frac{N_d}{N_{in}} \times 100$$

Where:

MP is percentage of mortality, N_d is number of dead embryo and N_{in} is number of eggs incubated.

Incubator efficiency

Incubator efficiency can be calculated by using the following equation **(Dalangin and Ancheta, 2018)**:

$$\eta_{in} = \frac{N_{hc}}{N_h} \times 100$$

Where:

η_{in} is incubator efficiency, N_{hc} is number of healthy chicks and N_h is number of eggs hatched.

4. Energy consumption

The energy consumption, EC (kWh) is given by using the following equation **(Harb *et al.*, 2010).**

$$EC = P_h + P_g$$

Where:

EC is energy consumption, kWh.
P_h is power required for operating electric heater.
P_g is power required for pulse repetition frequency generator.

RESULTS AND DISCUSSION

This results of this study will be discussed under two key points namely the effect of both pulse intensity and frequency duration during the incubation process. The experimental results were discussed under the following items:

1. Percentage of hatchability and mortality:

The obtained results of hatchability and mortality versus pulse intensity at different frequency duration are given in Fig. 3. It is noticed that hatchability was increased by increasing pulse intensity up to 72 W.m^{-2}, any further increase in pulse intensity up to 84 W.m^{-2} hatchability will decrease.

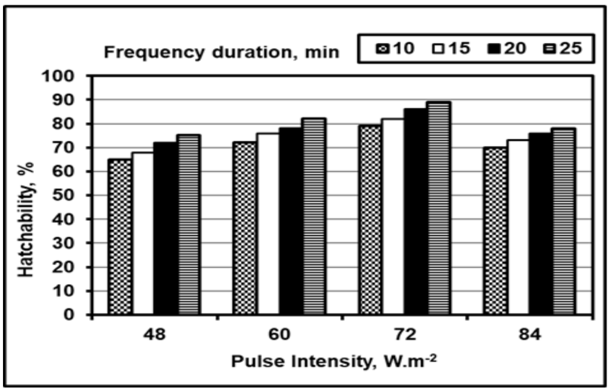

Fig. 3. Effect of pulse intensity and frequency duration on hatchability.

The experimental results show that increasing pulse intensity from 48 to 72 W.m^{-2} measured at different frequency duration of 10, 15, 20 and 25 minute per hour, increased hatchability from 65 to 79, 68 to 82, 72 to 86 and 75 to 89 % respectively. Any further increase in pulse intensity more than 72 up to 84 W.m^{-2} measured at the same previous frequency duration decreased hatchability from 79 to 70, 82 to 73, 86 to 76 and 89 to 78 % respectively.

PRF is affecting the soft tissue for the embryo cells, thus metabolism process will start working really well. Apply PRF lead to improve activates of blood circulation very well. As well as, it gives a positive impact on the growth and development of the embryo in the hatching stage. As, egg incubator is equipped with automatic controls to maintain the proper levels of temperature, humidity, turn and in addition to controlling repetition frequency.

The obtained values of mortality as a function of frequency duration and pulse intensity are shown in Fig. 4. It was evident that mortality values were 40, 37, 35 and 29 % under frequency duration of 10, 15, 20 and 25 min, respectively at pulse intensity of 48 W.m^{-2}. It was noticed that mortality values were 27, 24, 20 and 17 % measured under the same previous frequency duration respectively and at pulse intensity of 72 W.m^{-2}.

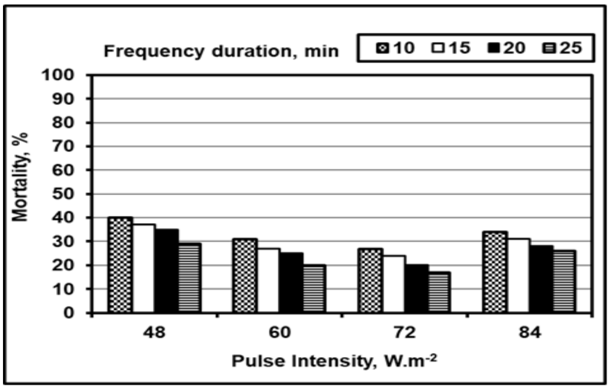

Fig. 4. Effect of pulse intensity and frequency duration on mortality.

The obtained results indicated that the hatchability was reached 89% under frequency duration 25 min per hour and pulse intensity of 72 W.m^{-2}. The pulse intensity and frequency duration are bringing vibration inside the soft tissue and thus will prevent embryos deformity as well as stimulate the chicks and increase their activity, which had a great impact on the percentage of hatchability.

2. Incubator efficiency:

The influence of pulse intensity on incubator efficiency at different frequency duration is given in Fig. 5. The obtained results show that increasing pulse intensity from 48 to 72 W.m^{-2} measured at different frequency duration of 10, 15, 20 and 25 min per hour, increased incubator efficiency from 60 to 73, 63 to 76, 65 to 80 and 71 to 83 % respectively.

Any further increase in pulse intensity more than 72 up to 84 W.m^{-2} measured at the same previous frequency duration decreased incubator efficiency from 73 to 66, 76 to 69, 80 to 72 and 83 to 74 % respectively. Poor results are revealed with improper control of pulse intensity and frequency duration. i.e. that the frequency level or rated voltage is too high or too low for a sufficient length of time that it interferes with the normal growth and development of the embryo, which had a great impact on incubator efficiency. Pulse repetition frequency was affecting the soft tissue for the embryo cells and the metabolism will start working really well. It also stimulates blood circulation very well. Furthermore, it gives a positive effect on the growth and development of the embryo.

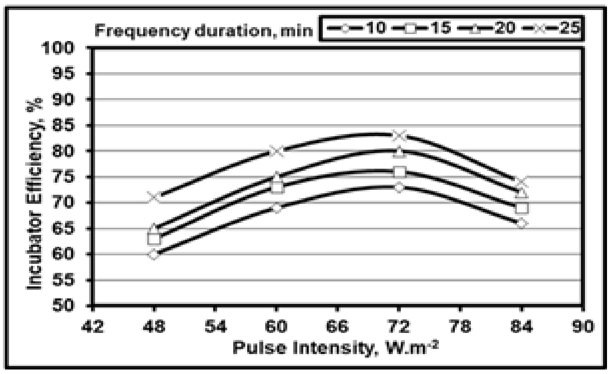

Fig. 5. incubator efficiency as a function of pulse intensity.

3. Energy consumption:

Results show that increasing pulse intensity from 48 to 84 W.m^{-2} measured at different frequency duration of 10, 15, 20 and 25 min per hour, increased energy consumption from 508 to 514, 512 to 521, 516 to 528 and 520 to 535 W.h, respectively as shown in the Fig. 6.

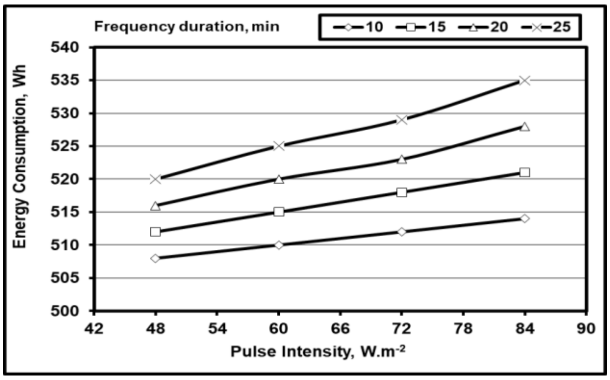

Fig. 6. Effect of pulse intensity on energy consumption.

The energy consumption increased by increasing the pulse intensity because of the increase of power consumed and frequency duration at the same time during the incubation process.

CONCLUSION

In the last few years, there has been a growing interest in egg incubation, for several years a great effort has been devoted to the study of different factors in the incubation technique.

The paper presents a new approach to the new modulation method based on the Pulse Repetition Frequency (PRF) technique to control of pulses generator. PRF is a technique in which the ON time or OFF time of a pulse was varied with respect to the amplitude of the input signal, which keeps the period of pulses constant but varying its duty cycle.

The essential concept of the innovator technique is to control duty cycles for the pulses generator by regulating the amount of voltage across its terminals. The proposed technique can regulate the rated voltage from 12 to 30VDC using the power supply circuit to control the pulses generator in an egg incubator. Using the suggested control technique, it is possible producing the required voltage for operating the pulses generator during the egg incubation at low levels of PRF. Pulse intensity and its duration are creating a low vibration inside the soft tissue and thus stimulate the chicks and increase their activity. Which had a great impact on the percentage of hatchability in a safe manner that would not impact negatively the incubation process. This development would provide a good perspective for hatching results and incubation process efficiency.

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تحسين أداء ماكينة تفريخ بيض الدواجن باستخدام تردد تكرار النبضات

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شهدت الآونة الأخيرة تحولات جذرية على مستوى كافة مراحل عمليات إنتاج وصناعة الدواجن، بناءاً على متطلبات العصر. فلقد كان للتقدم التكنولوجى تأثيراً هائلاً على تلك المراحل؛ ففى ظل البيئة التكنولوجية الحديثة ظهرت العديد من الطرق والتقنيات المستحدثة فيما يتعلق بأنظمة التفريخ الصناعى، والتى تراجعت معها الأنماط التقليدية إلى نمط يقوم على البعد التكنولوجى، حيث أخذت نصيباً وافراً سواءً على المستوى النظرى أو التطبيقى. التفريخ الصناعى لبيض الدواجن هو عملية حضن البيض ورعايته وتأمين أنسب الظروف البيئية اللازمة لتحقيق أعلى نسبة فقس وأقل معدل وفيات. ويعتبر التفريخ الصناعى من أهم حلقات إنتاج الدواجن المكثف الذي يتطلب أمور عديدة لزيادة كفاءة ماكينات التفريخ لبيض الدواجن بصفة عامة ولاسيما بيض السمان بصفة خاصة لدعم التنمية المستدامة طويلة الأجل. ماكينة تفريخ البيض هي الآلة التي تحاكي دور السمان في توفير البيض المخصب مع توفير الظروف البيئية المثلى من (درجة الحرارة - الرطوبة النسبية - التقليب والتهوية) لتنشيط التطور الجنيني حتى عملية الفقس، ويعتبر انخفاض كل من نسبة الفقس وكفاءة الآلة لبيض السمان والتي لا تتجاوز 75٪ إحدى المشكلات والعقبات التي تحول دون التوسع في هذا المجال. ومن ثم، تناولت هذه الدراسة تطوير ماكينة تفريخ بيض الدواجن باستخدام تردد تكرار النبض بهدف تحسين بعض عوامل التشغيل التي تؤثر على أداء الماكينة. تضمنت الاعتبارات التصميمية كل من تصميم دائرة توليد تكرار تردد النبضات (PRF) مزودة بمتحكم فى مستويات التردد، بالإضافة لتحديد أقطار ثقوب عملية التهوية وكمية الهواء المطلوبة داخل غرفة التحضين لضمان معدل السريان الرقائقى. تم تصميم وتركيب هذه الدائرة بماكينة التفريخ لتوليد موجات PRF بحيث يمكن ضبط نبضات تردد المولد بمستويات منخفضة الشدة حسب المستوى المطلوب خلال الدائرة المتكاملة ، IC ذات الثمانية أطراف، التى تنتج سلسلة من نبضات الموجة المربعة. يعتمد تردد خرج الهزاز متعدد النبضات (IC FAN7171) على استخدام المقاومات والمكثفات والموحدات لإنتاج تعديل إشارة خرج PRF في الدائرة المستقرة من خلال تنظيم مقدار الجهد والتردد المطبق عبر أطرافه من (12-30VDC)، فكلما زاد متوسط الجهد المطبق على أطراف مولد النبضات، زاد مستوى التردد داخله ومن ثم زيادة توليد النبضات التكرارية. كما تم توفير متحكم تلقائي لسهولة التحكم ومراقبة نظام التشغيل عن طريق استخدام الدوائر المتكاملة فمن خلال تغيير المقاومة في R2 المتصلة بأطراف الدائرة المتكاملة رقم (6-7)، يمكن أن يتغير عرض خرج النبضة حسب المستوى المطلوب وتم توصيل خرج IC رقم (3) بالترانزستور Q1 الذي يدفع النبضات إلى مولد PRF بواسطة الإشارة القادمة من خرج IC. تم تقييم أداء ماكينة التفريخ وفقًا لأربعة مستويات مختلفة لشدة النبضات (48، 60، 72 و84 واط/م٢) بشكل تجريبى مع فترات تردد (10، 15، 20 و25 دقيقة فى الساعة) بأخذ القياسات التالية: نسبة الفقس، معدل الوفيات، كفاءة ماكينة التفريخ و استهلاك الطاقة . أوضحت النتائج التي تم الحصول عليها 1- زيادة نسبة الفقس بزيادة شدة النبض حتى 72 واط / /م٢ ، وأي زيادة أخرى في شدة النبض تؤدى الى انخفاض النسبة. 2- أن أعلى نسبة فقس بلغت 89٪ تحت مدة التردد 25 دقيقة للساعة وكثافة النبض 72 وات / م٢ بطاقة مستهلكة 529 واط بكفاءة كلية بلغت 83٪ لماكينة التفريخ. 3- زاد استهلاك الطاقة مع زيادة شدة النبض بسبب زيادة الطاقة المستهلكة ومدة التردد في نفس الوقت أثناء عملية الحضانة من ثم يوصى باستخدام ماكينة التفريخ بيض السمان تحت شدة نبض يصل إلى 72 واط/م٢ بمعدل 25 دقيقة في الساعة من تردد النبضات التكرارية. إن محدودية الدراسات والأبحاث المتعلقة بتطبيق هذه التقنية أثناء عملية التفريخ تفتح أمام المهتمين بهذا المجال مزيداً من التحديث والتطوير فى محاولة لإثراء هذه التقنية لتحقيق أقصى استفادة ممكنة فى الجوانب النظرية والتطبيقية.