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Three Stages of Indirect Evaporative Cooling: Experimental and Theoretical Evaluation Study*

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A B S T R A C T

Economical energy, reduction of cost and utilization of clean energy are required to meet the human needs. Evaporative cooling units are considered as a solution for these require -cements by transforming such systems into technologies that meet these needs. The equipment's cost, installation and oper-acting costs are simple and low compared with refrigeration systems. An effective design is obtained by employing three stages settlement that equipped with a cross flow heat exchan-ger,direct and indirect evaporative coolers. In order to assess the design performance, a program code is developed. Flow and design parameters namely, air flow rate, piping length and diameter are studied. In addition to that the inlet air-dry bulb temperature at several different time duration over day is studied. The study was conducted in Tikrit University, Iraq (34.35N;43.37E).Readings are recorded in June, July and end of August for two days(24hours a day). The results show that, saturation of direct evaporative cooler effectiveness varies in the range,67%-96% and overall effectiveness of the unit varies in the range,80%-120%.It is provided that the system is efficient in dry and hot areas, and an improvement in the performance of the current design is achieved successfully.

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Effect of Climate and Design parameters on the Temperature Distribution of a Room

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Highlights

- The purpose of this paper is to determine the size of the window on the temperature distribution and air velocity of rooms.
- The experimental investigation contained manufacturing four test rooms where the window areas were 25%, 50%, 75%, and 100% from facade area.
- A numerical analysis was carried out using the Fluent software. The Fluent results agreed well with the experimental data obtained.
- The room with 25% of the facade had the best performance in comparison with other designs.

Chemical Engineering Research and Design
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Modeling of an industrial naphtha isomerization reactor and development and assessment of a new isomerization process

Ahmed M. Ahmed [a], Aysar T. Jarullah [a], Fayadh M. Abed [b], Iqbal M. Mujtaba [c]

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Highlights

- Mathematical model of an industrial naphtha isomerization reactor is developed.
- Parameter estimation technique is utilized to find the best kinetic parameters.
- The optimal design of the reactor is validated against industrial experimental data.
- A new isomerization process is proposed and its performance is evaluated.

Abstract

Naphtha isomerization is an important issue in petroleum industries and it has to be a simple and cost effective technology for producing clean fuel with high gasoline octane number. In this work, based on real industrial data, a detailed process model is developed for an existing naphtha isomerization reactor of Baiji North Refinery (BNR) of Iraq which involves estimation of the kinetic parameters of the reactor. The optimal values of the kinetic parameters are estimated via minimizing the sum of squared errors between the predicted and the experimental data of BNR. Finally, a new isomerization process (named as AJAM process) is proposed and using the reactor model developed earlier, the reactor condition is optimized which maximizes the yield and research octane number (RON) of the reactor.

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Assessment of heat transfer and fluid flow characteristics within finned flat tube

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ABSTRACT

In this paper, the heat transfer and flow characteristic of air over flat finned tube with perforated and non-perforated fin have been carried out numerically. The mesh generation and finite volume analyses have been conducted using Ansys 15 with a RNG k–e turbulent model to estimate heat transfer coefficient and pressure drop. The free stream velocity ranging between 3,4,5,6, and 7 m/s have been applied for all cases in the simulation and verified with the available data. A satisfactory agreement was found between the percent results and the references with a maximum deviation of 7% for the finned circular tube with solid fin. The results present a considerable enhancement in Nusselt number with using perforation technique, where the perforation provide 8.5%, 13.6% and 18.4% enhancement using circular, square and triangular perforation respectively. Triangular perforation model offers a considerable finding due to the increment in the Nusselt number comparing to the pressure drop.

1. Introduction

The heat exchangers with finned tube have been widely used in industries and automotive application. The thermal resistance is the most effective factor in the heat exchanger performance. Furthermore, the extended surface geometry plays a vital role in the heat exchanger design. However, the passive methods such as rough and extended surfaces with different geometries like slotted fins, fins with wavy shape and perforated fins considered an effective technique for thermal performance enhancement [1–9].

According to Webb [10], circular heat exchanger and plate fin heat exchanger have been studied and the results suggested to use punched and slotted fins for heat transfer enhancement. Moreover, for the validation process, Webb [10] advised utilizing the correlation of Briggs and Young [11], for heat transfer and the correlation of Robinson and Briggs [12] for pressure drop. Zhukauskas [12], studied a flow in tube bundles with three regimes of laminar flow, turbulent flow, and separated flow and stated that in order to improve the heat exchanger thermal performance, an artificial technique to decrease the boundary layer. Furthermore, another correlation has been proposed by Zhukauskas [12] for the Nusselt number and friction factor for staggered and inline arranged of finned tube.

According to the study of Sahin et al. [13] of heat transfer enhancement using pin fin and the study of Shaeri et al. [14] of rectangular fins, they stated that the perforation technique increases the fluid surface contact area and this lead to enhance the thermal performance. It's noteworthy that the first numerical investigation of the annular finned tube has been established by Jang et al.[15]. Mon et al. [16] reported a numerical simulation of the annular finned tube with a staggered arrangement under wet and dry operating. The stated that the heat transfer coefficient of the isothermal fin overestimates by 5–35%. Additionally, they proposed

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Determination of the effect of oxidation on attenuation coefficient of (X-ray) by Cu, Zn and their alloys

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Abstract

In this paper we study the effect of the oxidation on the values of total attenuation coefficient for the samples (Cu ,Zn and their alloys Brass (70%Cu +30%Zn), (60%Cu+40%Zn)) . The samples thicknesses chosen (0.02-0.1) cm, the Mo-X-ray tube used with the voltages (20-25-30-35) KV, the effect of oxidation on (μ_L , μ_m) were studied by using the graphic relations, where the effect of oxidation at temperature (100 °C) and oxidation time (1.5,6) hours on the linear and mass attenuation coefficients are studied .It is concluded that best results were achieved for (μ_L , μ_m) at (100 °C) after six hours where (μ_L) increased by the ratio (7.14%,5.76%,8.62%3.77%) respectively, while (μ_m) increased by (7.05%, 5.79%,10.05%,3.55%) respectively by comparing with oxidized samples for time (1.5) hours at voltage 20 KV, it is found a linear relation between the linear and mass attenuation coefficient with the oxidation time. While they are inversely related with increasing X-ray voltages. the effect of oxidation on the structural from of the studied materials was also examined using both the scanning electron microscope and the X-ray diffraction examination.

1. Introduction

Since the discovery of (X-ray) by Rotengen [1] many experiments especially that are related to its attenuation were conducted Thomson ,Held several experiments on the attenuation of (X-ray) by different Materials [2] .

The attenuation of (X-ray) occurs through its interaction with matter . Composite material may offer additional benefits in chemical resistance , physical durability ,and portability, the interaction of (X-ray) with matter is via three main processes photoelectric effect, Compton scattering and pair production. Pair production occurs only for very high energy (X-ray > 1022kev) , the sum of (photoelectric effect ,Compton scattering and pair production) per unit path length were the (X-ray) photon is removed from the beam is called linear attenuation coefficient (μ_L)

$$\mu_L = \sigma(\text{photoelectric}) + \sigma\ (\text{Compton}) + \sigma\ (\text{pair}) \quad (1)$$

σ = Area of the interaction .

μ_L can be described by the well known equation [6]:

$$\mu_L = \frac{\log {}^{I_\circ}/_{I}}{X} \quad (2)$$

I = Transmitted intensity , $I_\circ$ = incident intensity and X = thickness of absorbent ,to find the μ_L for any alloy me may use the equation :

$$\mu_L(Alloy) = p_1\,\mu_L(s_1) + p_2\,\mu_L(s_2) \quad (3)$$

Where :P_1 represents the percentage of the first pure sample (s_1)

P_2 =1-P_1 represents the percentage of the second pure sample (s_2)

The fact that linear attenuation coefficient varies with the density of the absorbent limits its use, even if the absorber material is the same. therefore ,the mass attenuation coefficient (μ_m) is much more widely used and is defined as:

$$\mu_m = \frac{\mu_L}{\rho}\ (cm^2 . gm^{-1}) \quad (4)$$

Where (ρ) refer to the density of the absorbing medium.

We can introduce a half –thickness, $x_{1/2}$,as :

$$x_{1/2} = \frac{0.693}{\mu_L} \quad (5)$$

Also the average distance or the mean free path for absorbing medium for a beam of (x-ray) is defined as[3,4,5,6,7]:

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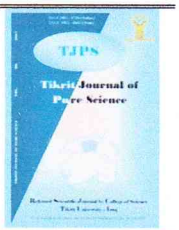

The Physical and Mechanical Properties of a Shape Memory Alloy Reinforced with Carbon Nanotubes (CNTs)

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Abstract

The shape Memory Alloy (SMA) (Copper-Aluminum-Nickel) was prepared in the research by Powder metallurgy (PM) in component percentage (Cu-13% Al-4% Ni), pressure of (500 Mpa) in one direction, and sintering in (800°C) with Nitrogen gas for three hours. (CNTs) was added in percentage (0,0.5,1.0,1.5,2.0,2.5) % as a volumetric ratio at the relatively of the copper ratio to obtain advanced composites for Carbon Nanotubes with a distinct effect on properties.

The elements of the alloy were analyzed using the (EDS) system attached to the Scanning Electron Microscopy (SEM) and study the X-ray Diffraction (XRD) to definition the elements and compounds formed after the process of sintering while imaging the microscopic structure by both Optical Microscopes and (SEM).

The physical characteristics were studied as the results showed that by increasing the content of the Carbon Nanotubes (CNTs), The Bulk Density values of the (Cu-13% Al-4% Ni) decrease by ratio (23.5%) for content of Carbon Nanotubes (0%) to (2.0%) associated with an increase in True Porosity with the increase of the (CNTs) content at the same ratio (27.85%) and the impact is reversed when the content is increased to (2.5%) as it corresponds to the Water Absorption. The decrease in thermal conductivity corresponds to the increase in the True porosity ratio while slightly improving the amount Thermal Conductivity at an add (2.5%) percentage (2.0%) of the (CNTs). Some Mechanical properties, such as Hardness and Compressive Strength, have been reduced by increasing the content of the (CNTs) to (2%) While there has been a slight improvement in these two characteristics at the corresponding ratio.

1-Introduction

The alloy memory of the shape is part of the smart material that has the ability to re-order its dimensions when the thermal stress or mechanical strain external is removed and to be the beginning of the temperature transformation phase. The term alloy memory of the shape (SMAs) is called on the metal materials that has the ability to re Its shape and its initial size were prior to proceeding thermal and mechanical processes, and that property is not limited to metals only but appeared in polymers and ceramics [1,2].

Those Alloys (SMAs) of a unique category of metallic alloys that can be recovered when heated to certain temperatures and the (SMAs) pass to the two phases first a stable phase at the high temperature are called Austanite for the English scientist (William Chandler Austen). The second stage is at low temperatures and is called martinsite for the German scientist (Adolf Martens) [3-5].

Those Alloys(SMAs) are classified into two types controlled by the base material, namely, The Nickel-Titanium alloys and copper-based alloys of their multiplications, their distinctive characteristics and their lesser cost. A copper-based alloys (SMAS) have been developed for high-temperature engineering applications such as remote sensors, engines and because of its ability to work at temperatures close to (200°C) instead of the Ni-Ti alloys that operate at maximum temperature is (100°C). These alloys are

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Review

A comparative analysis on the uniformity enhancement methods of solar thermal drying

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ABSTRACT

The uniformity of solar drying process and the quality of the product are inter-related parameters. Drying uniformity is influenced by the significant process air properties which are temperature, humidity and velocity. Accordingly, solar drying uniformity may be improved by integration with dehumidification system and/or optimizing the dryer design. These concepts were reviewed extensively in this paper by brush up the solar thermal hybrid dryers, the performance of solar assisted desiccant systems for dehumidification of drying air, the effect of geometrical parameters on drying performance, and the drying performance of different products. In the context of desiccant systems, the performance of drying is influenced by desiccant material, dehumidifier design and regeneration technique used. While, the issue of solar dryer design is related to drying chamber geometrical parameters, considering multiple drying chambers, and modeling and optimization of dryer design. Coming out with this comprehensive review may motivate to enhance the quality of product and drying performance in terms of cost and time.

Contents

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Hybrid CFD-ANN Scheme for Air Flow and Heat Transfer Across In-Line Flat Tubes Array

ABSTRACT

Flat tubes are vital components of various technical applications including modern heat exchangers, thermal power plants, and automotive radiators. This paper presents the hybridization of computational fluid dynamic (CFD) and artificial neural network (ANN) approach to predict the thermal-hydraulic characteristics of in-line flat tubes heat exchangers. A 2D steady state and an incompressible laminar flow in a tube configuration are considered for numerical analysis. Finite volume technique and body-fitted coordinate system are used to solve the Navier–Stokes and energy equations. The Reynolds number based on outer hydraulic diameter varies between 10 and 320. Heat transfer coefficient and friction are analyzed for various tube configurations including transverse and longitudinal pitches. The numerical results from CFD analysis are used in the training and testing of the ANN for predicting thermal characteristics and friction factors. The predicted results revealed a satisfactory performance, with the mean relative error ranging from 0.39% to 5.57%, the root-mean-square error ranging from 0.00367 to 0.219, and the correlation coefficient (R^2) ranging from 99.505% to 99.947%. Thus, this study verifies the effectiveness of using ANN in predicting the performance of thermal-hydraulic systems in engineering applications such as heat transfer modeling and fluid flow in tube bank heat exchangers.

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نظام ديناميكا الموائع الحسابية والشبكة العصبية الاصطناعية الهجين لانتقال الحرارة وجريان الهواء عبر حزمة انابيب مسطحة مرتبة بشكل خطي

الخلاصة

الأنابيب المسطحة هي المكونات الحيوية لمختلف التطبيقات التقنية بما في ذلك المبادلات الحرارية الحديثة، ومحطات الطاقة الحرارية، ومشعات السيارات. يعرض هذا البحث استخدم عملية التهجين لديناميك الموائع الحسابية (CFD) والشبكة العصبية الاصطناعية (ANN) للتنبؤ بالخصائص الحرارية والهيدروليكية للمبادلات الحرارية ذات الانابيب المسطحة. اعتبرت حالة الجريان مستقرة وبعدين وطباقي التدفق وغير قابل للانضغاط في التحليل العددي. استخدمت تقنية الحجم المحدود (finite volume technique) ونظام تطابق الاحداثيات (body-fitted coordinate) لحل معادلات نافير- ستوك (Navier–Stokes) ومعادلة الطاقة. حسب عدد رينولدز على أساس القطر الهيدروليكي الخارجي للأنبوب وبمدى 10 الى 320. تم تحليل معامل انتقال الحرارة والاحتكاك لجميع الحالات المدروسة للمسافة بين مركز الانابيب العرضية والطولية. استخدمت النتائج العددية من تحليل الـ (CFD) في تدريب واختبار الشبكة العصبية الاصطناعية للتنبؤ بالخصائص الحرارية وعامل الاحتكاك. أظهرت النتائج المتوقعة من الشبكة العصبية الاصطناعية أداء مرضيا، حيث تراوح متوسط الخطأ النسبي بين 0.39٪ و5.57٪، وكان مدى مربع متوسط جذر الخطأ من 0.00367 إلى 0.219، وتراوح معامل الارتباط (R^2) من 99.505٪ إلى 99.947٪. وبالتالي، فإن هذه الدراسة تتحقق من فعالية استخدام الشبكة العصبية الاصطناعية في التنبؤ في أداء المنظومات الحرارية والهيدروليكية وكذلك في التطبيقات الهندسية المختلفة مثل نمذجة انتقال الحرارة وتدفق الموائع في المبادلات الحرارية ذات حزم الانابيب.

1. INTRODUCTION

The fluid flow and heat transfer in tube banks demonstrate the real-life applications of various industrially significant processes. Tube bundles are widely employed in cross-flow heat exchangers, and their design is based on the empirical correlations of heat transfer and pressure drop. Cross-flow heat exchangers with tube banks are essential to numerous thermal and chemical engineering processes [1–4]. Flat tube designs have been recently introduced for modern heat exchanger applications such as automotive radiators. Unlike circular

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NUMERICAL INVESTIGATION OF THE FLAME LOCATION OF TURBULENT PREMIXED COMBUSTION IN A DIFFUSER BURNER EXPOSED TO VARIOUS TURBULENCE INTENSITIES AND TURBULENCE LENGTH SCALES

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Abstract: This study aims to investigate the response of the flame location of a turbulent premixed flame that has been exposed to various turbulence intensities and turbulence length scales. A diffuser-type burner is used to reveal the influence of turbulence intensity and turbulence length scales on the flame location of premixed propane–air flames without changing the inlet velocity of the fuel. Numerical simulations are performed for the turbulent premixed propane flames by using a coherent flame model under steady-state conditions. Results show that the flame location moves toward the inlet of the diffuser combustor with an increase in turbulence intensity for moderate and high turbulence length scales. The behavior of the flame location is different for the low turbulence length scale. The flame location initially decreases with an increase in turbulence intensity and subsequently stabilizes. Furthermore, the maximum flame area density is shown to increase with an increase in the turbulence intensity and the turbulence length scale, as the flame moves toward the inlet in these cases. It is clearly documented how turbulence intensity and turbulence length scale simultaneously influence the flame area density, flame shape, and flame location in a diffuser-type burner.
Keywords: Premixed turbulent combustion, flame area density, turbulence intensity, turbulence length scale, coherent flame model.

DİFÜZÖR TİPİ YANMA ODASINDA GERÇEKLEŞEN ÖN KARIŞIMLI TÜRBÜLANSLI YANMADA ORTAYA ÇIKAN ALEVİN KONUMUNUN TÜRBÜLANS YOĞUNLUĞU VE TÜRBÜLANS UZUNLUK ÖLÇÜSÜ İLE DEĞİŞİMİNİN SAYISAL OLARAK İNCELENMESİ

Özet: Bu makalenin amacı, ön karışımlı yanma sonucu oluşan alevin, çeşitli türbülans yoğunluklarına ve türbülans uzunluk ölçeğine maruz kalması sonucu oluşan alev yeri değişikliğini incelemektir. Yakıtın yanma odasına giriş hızını değiştirmeden, sadece türbülans yoğunluğunun ve türbülans uzunluk ölçeğinin alev yeri üstüne etkisini görebilmek için araştırmalar difüzör tipi yanma odasında gerçekleştirilmiştir. Propanın türbülanslı ön karışımlı yanma simulasyonları tutarlı alev modeli (coherent flame model) kullanılarak kararlı akış rejiminde gerçekleştirilmiştir. Orta ve yüksek türbülans uzunluk ölçeği kullanıldığında türbülans yoğunluğundaki artış ile alevin difüzörün girişine doğru hareket ettiği gözlemlenmiştir. Düşük uzunluk ölçeği kullanılarak gerçekleştirilen simulasyonlarda, alev türbülans yoğunluğunun artması ile girişe doğru yaklaştığı ancak türbülans yoğunluğunun daha da arttılmasına rağmen alev konumunda kayda değer bir değişiklik olmadığı gözlemlenmiştir. Sonuçlar, türbülans yoğunluğu ve türbülans uzunluk ölçeğindeki artışın, maksimum alev alan yoğunluğunu arttırdığını göstermektedir. Dahası türbülans yoğunluğunun ve uzunluk ölçeğinin alev alan yoğunluğu, alevin şekli ve konumu üzerinde aynı anda etkili olduğu gösterilmiştir.
Anahtar Kelimler : Türbülanslı ön karışımlı yanma, alev alan yoğunluğu, türbülans yoğunluğu, türbülans uzunluk ölçeği, tutarlı alev modeli.

NOMENCLATURE

A	Area [m^2]
b	Progress reaction variable
C_p	Specific heat [kJ/kg-K]
D	Diameter [m]
D_t	Mass diffusivity [m^2/s]
FL	Flame location [m]
FAD_{max}	Maximum flame area density [m2/kg]
IFA	integrated flame area [m^2]
Ka	Karlovitz number [chemical time scale / time time]

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Static and dynamic analyses for the exergetic, exergoeconomic and environmental assessment of a high-performance building

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Abstract: This paper presents an exergetic, exergoeconomic and environmental assessment of an existing high-performance building using both static and dynamic analyses. The IEA ECBCS framework is adopted for exergy analysis, whereas the SPECO method is used to implement the exergoeconomic analysis. The environmental impact is considered in a quantitative fashion. It is noted that a dynamic analysis using average hourly temperatures is preferred over a static analysis. However, if a simpler static analysis is to be used, an annual average temperature needs to be identified for specific climate zone and building type. For Istanbul, an average temperature of 14°C is recommended.

Keywords: exergy; exergoeconomic; environmental; static analysis; dynamic analysis; low-energy buildings; high-performance buildings.

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Viscosity Effect on Stiffness of Non-conventional (Five Tilted Pads) Journal Bearing

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ABSTRACT

In this tribological study, we highlight the effect of lubricating oil viscosity in the Multi-pads hydrodynamic journal bearings generate important improvement in characteristics of stiffness and stability in the high speed turbomachines. Depending on viscosity of oil film (three values) variation for five tilted pads bearing, each pad is pivoted and is facilitated to be tilted with small angles, by using Matlab program, we calculate the oil film thickness for convergence layer. We applied Reynold's equation and solved it's numerically by using finite difference method with 5 nodes technique to find the pressure distributed on each node in the mesh of tilted pad, then calculate stiffness coefficients. Results show that there is clear effect on stiffens with viscosity change. The increase in value of *Krr* (for $n = 0.3$) between viscosity (0.04 Pas. s) and viscosity (0.058 Pas. s) is14.33 MN/m, while the increase in *Krr* value between viscosity (0.058 Pas. s) and viscosity (0.087 Pas. s) is 11.37 MN/m. the increase in value the of *Kss* (for $n = 0.3$) between viscosity (0.04 Pas. s) and viscosity (0.058 Pas. s) is5.921 MN/m, while increase in Kss value between viscosity (0.058 Pas. s) and viscosity (0.087 Pas. s) is9.55 MN/m respectively. the increase in value of *Ksr* (for n = 0.3) between viscosity (0.04 Pas. s) and viscosity (0.058 Pas. s) is 8.95 MN/m, while the increase in *Ksr* value between viscosity (0.058 Pas. s) and viscosity (0.087 Pas. s) is 14.41 MN/m respectively. the increase in value of *Krs* (for $n = 0.3$) between viscosity (0.04 Pas. s) and viscosity (0.058 Pas. s) are 5.08 MN/m, while the increase in *Krs* value between viscosity (0.058 Pas. s) and viscosity (0.087 Pas. s) is8.19 MN/m respectively. The values of the dominate principal coefficients *Krr* is greater than that of *Ksr*, also The values of the principal coefficients *Kss* is greater than that of cross coupling *Krs* for all values of viscosity that studied. From this result, we can conclude the side effect of cross coupling coefficients (*Ksr* ,*Krs*) can be overcome by great values for principal coefficient (Krr, Kss) respectively, so we can get good improvement instability for this bearing by variation the viscosity. After that, we regarded to use high viscosity lubricant in multi-pad journal bearing to improve the performance and stability by controlling the stiffness coefficients.

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تأثير لزوجة الزيت على معامل نابضية المساند الغير تقليدية (ذو خمس وسادات قابلة للإمالة)

الخلاصة

تم في هذه الدراسة التراييولوجية البحث في تأثير لزوجة المزيت المستخدم في المساند الهيدروديناميكية ذات الخمس وسادات القابلة للأمالة والذي سبب تحسن مهم في خصائص نابضيه واستقراريه مساند محركات السرع العالية. بالاعتماد على تغير لزوجة شريحة الزيت (تم أخذ ثلاث قيم) للمسند ذو الخمس وسادات، وحيث أن كل وسادة متمحورة ومثبتة لتكون قابلة للأمالة بزاوية صغيرة، وباستخدام برنامج الماتلاب، تم حساب سمك شريحة الزيت المحصورة. وبتطبيق معادلة رينولدز وحلها عددياً باستخدام طريقة الفروقات ذات الخمس عقد تم أيجاد الضغط الموزع في كل عقدة على شبكة سطح الوسادة، ليتم بعد ذلك حساب معاملات نابضية المسند. أظهرت النتائج تأثير واضح في معاملات النابضية عند تغير لزوجة المزيت. فعند نسبة لامركزية 0.3 للزوجة بين (0.04 Pas. s) و (0.058 Pas. s) كانت قيمة الزيادة في *Krr* هي 14.33 MN/m، بينما عند نسبة لامركزية 0.3 للزوجة بين (0.058 Pas. s) و (0.087 Pas. s) كانت قيمة الزيادة في *Krr* هي 11.37 MN/m. بينما عند نسبة لامركزية 0.3 للزوجة بين (0.04 Pas. s) و (0.058 Pas. s) كانت قيمة الزيادة في *Kss* هي 5.921 MN/m ، بينما عند نسبة لامركزية 0.3 للزوجة بين (0.058 Pas. s) و (0.087 Pas. s) كانت قيمة الزيادة في *Kss* هي 9.55MN/m على التوالي. في حالة نسبة لامركزية 0.3 للزوجة بين (0.04 Pas. s) و (0.058 Pas. s) كانت قيمة الزيادة في *Ksr* هي 8.95 MN/m ، بينما عند نسبة لامركزية 0.3 للزوجة بين (0.058 Pas. s) و (0.087 Pas. s) كانت قيمة الزيادة في *Kss* هي 8.19 MN/mعلى التوالي. قيم المعاملات المسيطرة الرئيسية لـ *Krr* كانت أكبر من *ksr*، كذلك فأن قيم المعاملات المسيطرة الرئيسية لـ *Kss* كانت أكبر من *Krs* لكل قيم اللزوجة التي تم دراستها. نستنتج من هذا أن التأثير السلبي لمعاملات الأزدواج المتقاطع لـ (*Ksr* ,*Krs*) قد تنتج من القيم العالية للمعاملات الرئيسية لـ (*Krr*, *Kss*) على التوالي وبهذا فأنه بالأمكان تحسين قيمة الأستقرارية لهذا المسند بتغيير لزوجة المزيت. وبهذا نوصي بأستخدام مزيتات ذات لزوجة عالية في المساند ذات الوسادات المتعددة لتحسين الأداء والأستقرارية من خلال التحكم بمعاملات النابضية للمسند.

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