to accompany the solar system. Latent heat energy storage in a solar water heater can occur in a phase-change material. These materials are generally encapsulated in a container and positioned in the water container. Shape, material type, and size of the encapsulating container have direct effect on the efficiency of the storage system. In this paper, effort has been made to investigate experimentally the encapsulation diameter effect on the storage system efficiency. Industrial paraffin with 5-7% fat was used as a phase-change material. They were encapsulated in aluminum tubes of 6, 10, and 12 mm diameter. The thicknesses of the capsules in all diameters are 1mm. For each tube size, a set of tests was carried out. For each test, 88 capsules with 280 mm height containing the paraffin were used. As a result, for capsules with 6, 10, and 12mm diameter, 281.6gr, 1126.4gr, and 1760gr of paraffin were used, respectively. The results show that the rate of energy storage using aluminum tubes of 6, 10, and 12 mm with phase-change material in comparison to when using no phase-change material, improved energy storage efficiency by 4.4, 15.3, and 11.2%, respectively. With regard to the fact that by reduction of capsule diameter, the rate of surface area to the volume increases; hence, heat transferring surface area increases. Therefore, it is expected that by reducing the capsule diameter, density of energy storage will increase. Consequently, by reducing the capsule diameter, total paraffin mass will decrease. Hence, by considering these two factors, maximum rate of energy storage occurs when the capsule diameter is 10mm.

Key Words: Solar energy; solar water heater; thermal energy storage; phase change materials; encapsulation.

THERMODYNAMIC MODELING AND INVESTIGATION OF THE REFRIGERANT EFFECT ON THE PERFORMANCE OF VARIABLE REFRIGERANT FLOW (VRF) SYSTEMS

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Abstract

A significant part of the total annual energy consumption is used in buildings. The most part of the energy consumption in buildings is due to the HVAC systems. As a result, the efficiency of air conditioning systems plays an important role in energy saving. In the recent years, variable refrigerant flow (VRF) systems have become popular, especially for commercial buildings, due to their high efficiency and their ability in simultaneous heating and cooling. In this research, VRF systems are investigated from the second law of thermodynamic point of view; the effect of design parameters and the refrigerant type on the system performance is studied. At first, the thermodynamic cycle of VRF systems is modeled. Comparison of the numerical results with the available experimental data shows that the developed model can predict the system behavior with reasonable good accuracy. Based on the results, the coefficient of performance (COP), the exergy destruction, and the exergy efficiency of the VRF system are evaluated to investigate the system effectiveness. The results indicate that the compressor and the condenser are responsible for the most exergy destruction in the system, while the exergy destruction in the sub-cooling heat exchanger and the expansion valve is the least. In addition, the refrigerant type is an important parameter which may affect the system performance. Considering the importance of the sub-cooling heat exchanger, the effect of the heat exchanger on system performance has also been investigated. It has been found that the effect of the sub-cooling heat exchanger depends on the refrigerant type. In the systems using R-134a and R-407c, the heat exchanger improves the system effectiveness; if R-22 and R-410a are used as a refrigerant, the system performance decreases. The results of this paper are useful in getting a better understanding of the VRF systems and in designing more efficient ones.

Key Words: Variable refrigerant flow (vrf); thermodynamic modeling; exergy analyses; exergy efficiency; exergy destruction.

to the change of the mixture state from sub-critical to super-critical space, and vice versa.
The performance of the proposed approach is assessed using a number of homogeneous one-dimensional multi-component problems. Numerical results show that the proposed method has acceptable accuracy and significantly reduces the total number of flash calculations needed in a compositional simulator.

Key Words: Compositional simulation; equation of state; compositional space parameterization; tie-line; delaunay triangulation.

ESTIMATION OF NEAR WELL-BORE DAMAGED ZONE PARAMETERS FROM PRESSURE TRANSIENT DATA

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Abstract
Estimation of properties of near-wellbore damaged zone made by drilling, completion, injection, and other operations is a challenging issue in reservoir engineering. Researchers have proposed different methods to predict reduction in damaged zone permeability; however, few studies have focused on the prediction of the damaged zone radius and its permeability. In this study, a simple and practical method is proposed to predict the damaged zone properties, i.e., radius and permeability, based on pressure drawdown test data.
In this approach, pressure derivative curves for a homogenous reservoir as a base case and a reservoir with spatial permeability variation based on Composite Reservoir model are compared. Eventually, the pressure data points were used for comparison from a drawdown test in a synthetic reservoir model. This spatial permeability variation represents a permeability anomaly. Permeability anomaly makes pressure derivative curve deviate from base curve for corresponding homogenous reservoirs. The parameters of permeability anomaly such as size, orientation, and location have different effects on pressure derivative curve. In reservoir with simple permeability heterogeneity that has a single permeability anomaly, originating location and end location of an anomaly can be predicted by pressure derivative curve. In this study, damaged area radius of a damaged homogeneous reservoir, causing a single anomaly in permeability, is calculated by means of pressure derivative curve, known correlations, and the result from pressure wave propagation concept in reservoir. Short-term pressure data is used to measure the damaged permeability. The method has been validated in a synthetic cylindrical reservoir generated by numerical simulation, as well as in an actual reservoir. For the actual reservoir example, validation is made by comparing the results with Skin Factor model. The proposed method is suggestive of its ability to predict the damaged radius and permeability very well.

Key Words: Damaged zone; permeability anomaly; damaged radius; location; composite reservoir.

EXPERIMENTAL INVESTIGATION OF CAPSULE'S DIAMETER SIZE EFFECT ON THE PERFORMANCE OF ENERGY STORAGE SYSTEM OF A SOLAR WATER HEATER USING PCM

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Abstract
Regarding the variability nature of the solar ray in a day, application of a thermal storage system seems necessary

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Abstract

Cold roll forming is one of the most complex forming processes in which quality of products is highly dependent on the process parameters. Estimation of forming torque and power in the cold roll forming process is one of the most important parameters. Effective parameters on the forming torque and forming power are investigated in the present study. These parameters are rolls geometry, sheet thickness, sheet width, strength of sheet, and forming angle. So, the forming process is simulated in the finite element software Abaqus for both flat and angled geometry of the top roll. Simulation results show that with yield strength, sheet thickness, and increase of roll angle, forming torque and power will increase. Also, the rolls force increase and the forming torque decrease with sheet width increasing. The results of this study show that the forming torque and power for the top roll with flat geometry is lesser than the top roll with angled top roll. Due to easier process of manufacturing of flat rolls, this type of rolls geometry can be used for channel sections. The effect of thickness and width of sheet is investigated experimentally on the forming torque and power. Numerical results are verified by experimental results of the present study. Results show that forming torque and power increase with yield strength, then forming angle and sheet thickness increase as well. Therefore, engineers can consider the effects of these parameters on the forming torque, forming power, and selecting proper type of motors. Edge longitudinal strain of numerical simulations of the present study is verified by numerical results of Lindgeren, 2007 [8]. This comparison shows that numerical results of the present study is near to the results of Lindgeren, 2007. Results show that edge longitudinal strain decreases with the increase of yield strength. These results also show that the increase of edge longitudinal with the increase of roll forming angle.

Key Words: Cold roll forming; forming torque; roll geometry; longitudinal strain; fem simulation.

EXPLICIT-IMPLICIT COMPOSITIONAL HYDROCARBON RESERVOIR SIMULATION USING ADAPTIVE COMPOSITIONAL SPACE PARAMETERIZATION

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Abstract

In recent decades, there have been great efforts to simulate flow in hydrocarbon reservoirs and oil recovery processes. Compositional model is one of the most advanced models for this purpose. In this model, nonlinear mass conservation equations for multicomponent flow have to be solved along with thermodynamic equilibrium constraints. In most compositional simulators, an equation of state is used to determine phase behavior of hydrocarbon mixtures.

In this article, an efficient two-phase compositional model for both immiscible and miscible fluid flows in porous media is presented. In this model, the mass conservation equations are discretized using a cell-centered control volume method. The solution algorithm employs the so-called Implicit Pressure Explicit Saturation (IMPES) method. To determine the thermodynamic state of the mixture, the equation of state must be solved at each time step for each computational cell. These computations consume considerable time in a compositional simulation. Compositional space is parameterized with tie-line variables, and this parameterized space is used to reduce the number of times the equation of state must be solved. To parameterize compositional space, a few supporting tie-lines are needed, which were obtained adaptively during simulation process. The tie-line space is discretized using these supporting tie-lines and a Delaunay triangulation procedure. In the rest of discretized tie-line space, thermodynamic properties are calculated using linear interpolation. It is important to note that the equation of state is solved only at the supporting points used to discretize the tie-line space. Since tie-lines do not exist in the super-critical region, the space is represented based on overall compositions and equation of state. In this work, the used method keeps continuity of tie-line variables and overall compositions with respect

ties of corrugated cylindrical structure were achieved by the mechanical properties of equivalent orthotropic circular cylinder. Then, critical buckling load was obtained for both simple circular and corrugated cylinders. The present analytical results are validated by the finite element models. These validations report very good agreement between the present results and those obtained by the finite element analysis. Effect of different parameters including number of corrugations, cylinder thickness, cylinder length, cylinder radius, corrugation angle, and shape factor was investigated numerically on buckling behavior of corrugated cylindrical structure. The results of finite element reveal that buckling mode shapes can be divided into two types as local and global buckling modes. Graphical shapes of local and global modes are presented to make the better physical sense. In this article, the present analytical method can solve the global buckling problem of a corrugated cylinder. According to the comparison between present modeling results and those obtained by finite element analysis, increasing the corrugation angle and cylinder radius and decreasing the number of corrugations, the cylinder thickness, the cylinder length, and shape factor led to an increase in the buckling load of corrugated cylinder with respect to circular cylinder on the condition that local buckling had not been occurred. The present results and procedure can help engineers and designers to achieve a best performance for their structures, especially related to aerospace structures.

Key Words: Corrugated cylinder; buckling strength; finite element model; trapezoidal corrugation.

INVESTIGATION OF MECHANICAL PROPERTIES AND FATIGUE LIFE OF AL-5083 SHEETS PROCESSED BY EQUAL CHANNEL ANGULAR ROLLING

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Abstract

Equal Channel Angular Rolling (ECAR) is a continuous severe plastic deformation process. In this process, severe shear strains are applied to the sheet. This strain increases the yield or ultimate strength of sheet without significant change in sheet dimension. In this article, the effect of ECAR process on mechanical properties and fatigue life of manufactured sheets will be studied. Four Al-5083 samples have been prepared and annealed for obtaining stress-free samples. Three samples have been rolled by ECAR process with 1, 2, and 3 pass of rolling, respectively. Mechanical tests including tensile test, hardness, and axial fatigue tests have been carried out on prepared samples. Fatigue tests have been implemented according to strain-based approach with constant strain ratio and 0.5 Hz frequency of loading. Strain ratio (ratio of minimum strain to maximum strain in each cycle) is selected which equals 0.75. All of the tests have been carried out in a controlled laboratory condition. Fatigue life of samples is defined as the total of cycles before complete rupture of samples. Results show that the ultimate tensile strength (UTS) of samples increases with increasing the pass of rolling. Also, the maximum elongation of samples decreases. Maximum elongation was 17% in annealed sample, while it decreases to 10% in sample with three pass of rolling. The hardness of samples has been measured by Vickers micro harness test. The hardness of samples increases at higher pass of rolling. Fatigue test results show that fatigue life of Al-5083 samples decreases in manufactured sheets of equal channel angular rolling process.

Key Words: Equal channel angular rolling; tensile strength; fatigue life; mechanical properties.

NUMERICAL AND EXPERIMENTAL STUDY OF EFFECTIVE PARAMETERS ON THE LOAD AND FORMING TORQUE OF ROLLS IN THE COLD ROLL FORMING OF SYMMETRIC CHANNEL SECTION

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pensated. To demonstrate the validity and performance of the proposed method, navigation of a LEO launch vehicle has been simulated. Results admit great compensations in velocity and position errors.

Key Words: Strapdown inertial navigation system; celestial navigation system; unscented kalman filter; smoothing; back-propagation.

INVESTIGATION OF ACCURACY OF INTEGRATED INERTIAL-RADAR NAVIGATION SYSTEMS IN AUTOLANDING OF UNMANNED AIR VEHICLES

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Abstract

In this paper, the accuracy of integrated inertial-radar navigation systems used for autonomous landing of unmanned air vehicles is studied. These navigation systems use the inertial instruments as the main navigation and the radar data as the navigation aids. The radar system provides the position and velocity measurements with respect to the runway coordinate system.

Navigation of aircrafts is classified to "terminal" and "non-terminal" phases. The terminal phase involves the parts of flight which are related to arrival and departure from a runway. The requirements of the navigation system in the terminal phase are more complicated than the non-terminal phase. The final condition of the non-terminal phase will be set as the initial condition of the terminal phase. Thus, the designer of the navigation system should consider the interaction of these two phases. In this study, the accuracy of an integrated navigation system with velocity matching algorithm is analyzed during the landing phase of a fixed wing aircraft. The relation between accuracy of inertial instruments, flight parameters, and accuracy of integrated navigation are extracted in the form of differential equations. The initial conditions of these equations are calculated from the terminal phase parameters.

The mentioned differential equations can not be solved analytically. Thus, based on the nominal behavior of an aircraft in the landing phase, some reasonable assumptions are made and the equations are solved in a closed form. The analytical solutions are used to express the accuracy of the integrated navigation in the terminal phase. The designer of the navigation system of an aircraft can use the analytical results obtained in this study to select the accuracy of the aircraft inertial instruments.

In order to verify the analytical results, landing phase of a famous unmanned air vehicle, Shadow-200, which uses a system named "TALS" as the navigation aids, is simulated numerically. It is shown that the analytical results are well matched with the numerical ones.

Key Words: Autolanding; unmanned air vehicle; inertial navigation; integrated navigation; velocity matching algorithm.

BUCKLING ANALYSIS OF CORRUGATED CYLINDRICAL STRUCTURES TO ACHIEVE THE HIGHEST STRENGTH-TO-WEIGHT RATIO

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Abstract

Increasing the buckling strength-to-weight ratio is of particular importance in aerospace, mechanical, nuclear, and civil engineering. Corrugated structures with trapezoidal geometric pattern have higher amount of the buckling strength-to-weight ratio with respect to other similar structures; hence, these generations of structures are widely used in several industries. Static stability of corrugated cylindrical structures with trapezoidal geometric pattern was investigated here under axial loading for simply supported boundary condition. Using first-order shear deformation theory of Mindlin, equilibrium equations of the problem were derived. Mechanical proper-

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Abstract

Boundary layer profile on the upper surface of a supercritical airfoil in pitching motion has been experimentally investigated. Measurements were performed using a boundary layer having total pressure slim tubes positioned at 25% of the chord from the leading edge on the upper surface. In the static mode, the effect of the angle of attack ranging from -3 to 14 degrees and for free-stream velocities of 40 m/s to 70 m/s were investigated, where for the dynamic case effects of oscillation amplitude varied between ±3 and ±10 degrees, reduced frequencies from 0.007 to 0.0313, and mean angles of attack between -3 and 6 degrees, on the boundary layer profile were studied for one oscillation cycle. Time series of each pressure signals acquired from the pressure sensors were processed after filtering and corrections. To study the amplitude of the dominated frequency in the velocity profile, Fast Fourier Transformation on the pressure signals acquired from each rake was used. The results indicate hysteresis loops for boundary layer thickness during upstroke and downstroke states and extension of width of hysteresis loops at higher reduced frequency. In addition, boundary layer thickness is decreased as the angle of attack is increased in the upstroke portion of the motion.

Key Words: Unsteady boundary layer, pitching motion, supercritical airfoil.

VELOCITY AND POSITION COMPENSATION IN AN INTEGRATED INERTIAL/-CELESTIAL NAVIGATION SYSTEM BY IMPLEMENTING, SMOOTHING AND UNSCENTED KALMAN FILTER

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Abstract

In this paper, the purpose is to compensate the errors of velocity and position, existing at the starting time of star sensor work in an integrated inertial/celestial navigation system. In an inertial navigation system, there exists attitude error at launch moment. Moreover, while integrating gyros and accelerometers outputs, errors grow in estimation of attitude, velocity, and position on vehicle. On the other hand, because of earth's atmosphere effects, celestial navigation cannot be implemented for a while after launch moment. Then, pure inertial navigation is carried out at this interval. Consequently, large errors of velocity and position exist at starting time of integration. The estimation and integration are carried out using unscented Kalman filter through which current attitude and the gyros fixed bias can be estimated accurately. To precise integration, nonlinear navigation equations have been used and propagated implementing an accurate discretization method. Moreover, in all sequences of navigation and estimation, quaternions have been used to deal with attitude. This will reduce computation costs and immunize integrated system from singularity. Since quaternions have their own vector space, some considerations are applied to estimation procedure which includes sigma point's calculation, propagation, and calculating mean and covariance. On the other hand, velocity and position errors are not observable in an integrated inertial/celestial navigation system. Then, in this paper, using nonlinear navigation equations and implementing back-propagation and smoothing, initial attitude and accelerometers fixed bias are estimated accurately. In addition, the vehicles attitude is acquired at prior time steps while back-propagating. By carrying out a new parallel navigation based on vehicles attitude at prior moments and taking out gyros and accelerometers fixed biases, velocity and position errors are com-

surface has been measured with type K thermocouples, which is used to estimate the heater heat flux. There has been low pass Butterworth filter applied to the collected data before the usage in inverse algorithm. These kinds of problems with measurement at the inactive surface are common in inverse heat conduction fields due to the measurement and construction complexities. Second experiment is a bit more sophisticated and designed in order to find the free convection heat transfer coefficient of air adjacent to stainless steel plate. It consists of the previous heater and steel plate, in addition to wood, fiber glass, and elastomer insulation layers. The temperatures inside the steel and wood plates are measured, in addition to the ambient air and the last insulation layer temperatures. The calculation is started from the bottom surface and the heat flux lost into environment is calculated, then heat transfer in each layer is estimated one by one until we reach the steel plate on the top, adjacent to air. Sequential function estimation method, due to its online and fast solution, has been used as an inverse heat conduction technique to solve the problems. The results show that inverse heat conduction algorithm has an acceptable accuracy in situations, in which temperature measurement on active surface comes with difficulties such as high temperatures, harsh environment, construction problems, etc.

Key Words: inverse heat conduction; sequential method; heat flux estimation; convection heat transfer coefficient estimation.

DYNAMIC MODEL IDENTIFICATION OF AN UNDERWATER VEHICLE IN PLANAR MOTION USING FREQUENCY RESPONSE METHOD

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Abstract

The current study aims to identify the equivalent linear dynamics of an autonomous underwater vehicle in the horizontal plane to be able to design an appropriate linear controller. Autonomous underwater vehicles are increasingly being used to provide researchers with a simple, low-cost, and rapid response capability to collect pertinent environmental data. They are fairly stable platforms with little roll and pitch. Nevertheless, dynamic coupling and non-linearities make it a challenging task to perform identification process, stability analysis, and control design. Here, for the first time, the frequency response analysis and the CIFER software, which utilizes strong mathematical algorithms, are employed to solve this problem. Advanced features such as the Chirp-z transform and composite window optimization are also used to extract high-quality frequency responses and best fit equivalent transfer functions. After formulating the problem, a frequency sweep input is designed and applied to the rudder controller in the nonlinear simulation and transfer functions for the heading angle and the rate of turn are derived. In addition, these transfer functions are obtained by perturbed equations of motion to be compared with the transfer functions from CIFER. To evaluate the accuracy of the identified models, time domain responses from a zig-zag test are compared with the responses predicated by the identified model and the linearized model. The results show that this model is in good agreement with the analytical linear model and performs significantly better in presence of noise, thanks to the precise spectral functions and windowing technique. The robustness of the proposed method and transfer functions are also assessed by evaluation of the coherence function and altering the window size, frequency bandwidth, and input commands. The results also show that in a specific frequency range, nonlinear terms are negligible, and the turn rate could be easily predicted by the time derivative of the heading angle.

Key Words: Frequency domain identification; autonomous underwater vehicle; equivalent linear model; CIFER software.

EXPERIMENTAL INVESTIGATION OF UNSTEADY BOUNDARY LAYER OVER A SUPERCRITICAL AIRFOIL

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proposed modeling in capturing all nonlinear behavior phenomenon reported in literature. It is simple to extend the proposed modeling for different boundary conditions.

Key Words: Modeling pipe; flutter; fluid conveying pipe; 3d analysis; nonlinear vibration.

INVESTIGATION ON THE INFLUENCE OF EXHAUST GAS RECIRCULATION ON PERFORMANCE OF HOMOGENEOUS CHARGE COMPRESSION IGNITION (HCCI) ENGINE

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Abstract

Environmental pollution and energy constraints have made engineers research a new method of ignition in the internal combustion engines. Also, the automotive industries are searching to replace SI and CI engines due to the strict regulations of international organizations actives in the field of environment. (HCCI) is a suitable method for combustion in SI and CI engines. The HCCI engine uses a premixed air/fuel mixture that is pressed with high compression ratio. In the research, a CFD model has been used for the analysis of HCCI engine. In order to validate the model, we used the experimental results obtained from Dutez engines with Methane fuel and a secondary fuel injection diesel in 270oCAD position. Investigation showed that concordance between the model and experimental results is acceptable. Maximum cylinder pressure decreases with the increase of EGR. With an increase in EGR percentage, the rate of carbon black increases which it results from the incomplete combustion. Therefore, performance of EGR is acceptable within a certain range. Also, an increase of EGR reduces cylinder temperatures. Incomplete combustion causes a part of the air/fuel mixtures to leave the cylinder without participating in the combustion process. As a result, those parts of the air/fuel mixtures leave the cylinder without producing thermal energy.
Increase of EGR rate reduces the amount of heat release due to incomplete combustion, but heat release increases even despite non-combustion. This performance is due to the increase of temperature which, in turn, causes the increase of cylinder density. As a result, heat release is produced even despite non-combustion. It is noteworthy that maximum heat releases occur under non-EGR condition.
Change in the heat release rate regarding different EGR rates shows that the combustion occurs in different positions. The increase of EGR greatly reduces NOX emissions.
So, EGR system can provide adequate effect on reducing NO_X emissions.

Key Words: Homogeneous charge compression ignition engine; egr; cylinder pressure; ignition delay.

EXPERIMENTAL EVALUATION OF INVERSE HEAT CONDUCTION METHODS

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Abstract

In this paper, we investigate the inverse heat conduction method by a set of data extracted from experimental applications has been studied. Two heat transfer classic problems are designed for this purpose and the measured data are utilized as an input to the inverse heat conduction algorithm. In the first experiment, a stainless steel plate (AISI-304 with length, width, and thickness of 250, 70, and 5 millimeters, respectively) is in proximity to a heater from one surface. Other faces are completely insulated, and the temperature from the bottom insulated

Abstracts of Papers in English

THREE-DIMENSIONAL FLUTTER AND NONLINEAR DYNAMICAL BEHAVIOR ANALYSIS OF FLUID CONVEYING PIPES

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Abstract

In this work, the modeling and flutter and nonlinear dynamical behaviors of fluid-conveying pipes in three dimensions are undertaken. All equations of motion are derived assuming an appropriate displacement in nonlinear form using Lagrange principle to circumvent the complex modeling approach given in mentioned references. In previous works on modeling three-dimensional motion of pipe, a complex approach based on inextensibility of pipe was used for derivation of equation of motion. This assumption resulted in nonlinear complex equation of motion and boundary condition. But, here, a simple method is used to obtain equation of motion. Due to three-dimensional motions of pipe, double bending and in-plane displacement field are assumed. Governing partial differential equations are discretized by Rayleigh-Ritz's method, and dimensionless form of equation is derived with defining appropriate parameters. The nonlinear equations are solved numerically and its vibration behavior is examined. Due to fluid flow, detrimental flutter phenomenon occurs, which make system unstable. Different types of bifurcations are observed, and the effect of varying parameters on flutter is accurately examined. Discussion of how flutter occurs and different modes of flutter are presented. Finally, the effect of design parameters on the system instability and its type is presented. With varying flow velocity, different types of nonlinear vibrations are occurred. These behaviors include simple limit cycle oscillations, period doubling, intermittency, and chaos. Also, in some flow velocities, locking motion in a special plane is occurred. The effects of different parameters on these nonlinear behaviors are examined. Some new results are presented, which are not previously reported. Obtained results and their comparison with appropriate references show the accuracy of modeling according to the assumed field displacement. Obtained results show the efficacy of the