Design of Steam Turbine Blade Under Centrifugal Force Effect with Mutation of Rotational Speed and Blade Tongue Length

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ABSTRACT

Steam turbine converts the heat energy of steam into useful work. The steady deals with the structure of turbine type (HP) and the effect of centrifugal force during rotation which is directed outwards, away from center of curvature of the path within range of rotation speed (1800, 2500, 3600rpm). The increasing of rotation speed will cause progressive values of stresses and strains. The paper deals with increase of blade tongue length due to increasing of stresses and strains values especially in the root of blade tongue, also the excessive increase in rotation speed and blade tongue length posing led to increase of stresses and strains to an accepted value.

Keywords: Steam turbine, Blade steam turbine, Design of blade steam turbine, Stresses and strains in steam turbine blade.

1. INTRODUCTION

The steam turbine is a main rotor that diverts kinetic **energy** in steam into rotational mec**hanical** energy thru the impact or reaction of the steam against the blades. The study deals with steam turbine design for small scale steam power plant with aim of outputting electricity. The palm kernel shells are used as renewable energy source to drive turbine by heat energy because it is low cost. The study was focused on elements turbine design and its chumming used computer packages. The micro turbine design was bounded to design, modeling, simulation and analysis of the rotor, blades and nozzle under palm kernel shell fuel for the micro power plant [1, 2, 3].

The wide application of steam turbine is the advance of design technology, this is become lades important research field. The design of turbine blade is important factor to evaluate efficiency of steam turbine. The originality of research deals with structure of steam turbine blade, analysis factor is effect on blade operation, design principle, comparing traditional design of root tooth of steam turbine blade with optimization design after improved of parameters. Finally, was proposed feature design of steam turbine blade [4, 5, 6].

The turbine blade is important part in thermal power generation plants. These blades are exposed to high temperature and pressure in thermal power cycle. The design of blade and its root is important element. The failure always is occurred in root section. The distribution of stress is very important in blade design. The analysis of stress is along of blade turbine in present research. The distribution and analysis of stresses can be done in different rotational velocity (rpm), while the natural velocity for operation is (6728rpm). In research, the velocity is increased 30% for one material, hence, the failure is occurred at 15% increasing of velocity. The other material at 25% increasing of velocity [7, 8, 9,10].

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2. METHODOLOGY:

2.1 1-STEAM TURBINE BLADE STRESSES:

The effective stresses on s**team** turbine blade are static and dynamic stresses. The turbine blade length is considered effective variable on stress value, where the turbine blade in nuclear power plant is longer. The stresses are same on any blade. The machine that the turbine blades are fitted on it, these machines was in tow groups, one from 1500 – 1800 rpm and the second from 3000 – 3600 rpm, these speeds rotation are produce high centrifugal force and led to high centrifugal stress. In present paper takes three speed rotation (1800, 2500 and 3600 rpm) experimental and theoretical.

1-2 The centrifugal force:

The direction of centrifugal force out of blade, mean away anent of path center of curve for blade moving. The general rule of centrifugal force [10,11].

$F \quad = m.r.w^2 \ldots\ldots\ldots\ldots\ldots\ldots (1)$

The small part of mass (δm), in width (δr) and in distance (r) from center, therefore the centrifugal force (δF) on small part of blade mass [12, 13].

$$\delta F \;=\delta m\,.\,r\,.\,w^2 \ldots\ldots\ldots\ldots..(2)$$

$$\delta m \;=\rho\,.\,A\,.\,\delta r \ldots\ldots\ldots\ldots\ldots\ldots..(3)$$

$$dF \;=(\rho.A)r.w^2 dr \ldots\ldots\ldots\ldots\ldots(4)$$

$$F \;=\rho.A.\;w^2\int_{r1}^{r2} rdr \ldots\ldots\ldots\ldots\ldots..(5)$$

$$F \;=\rho.A.\;w^2\left(\frac{r2^2-r1^2}{2}\right)\ldots\ldots\ldots\ldots\ldots.(6)$$

$$w \;=\frac{2\pi N}{60}\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(7)$$

From above equations can be find relationship between centrifugal force and rotational speed, experimental available information from steam turbine in Al-Nasiriya electric generation plant in Iraq (A=175mm, ρ=7850 Kg/mm^2, r_1=225mm, r_2=270mm) was draw the relationship between them in figure 1 , and simulate centrifugal forces which is calculated in Auto desk inventor program to determine stresses produced by these forces in figures 2, 3, 4.

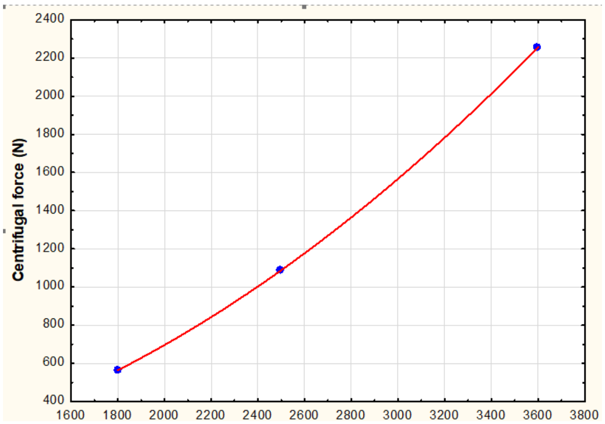

Fig. 1, The relationship between centrifugal force and rotational speed for steam turbine blade.

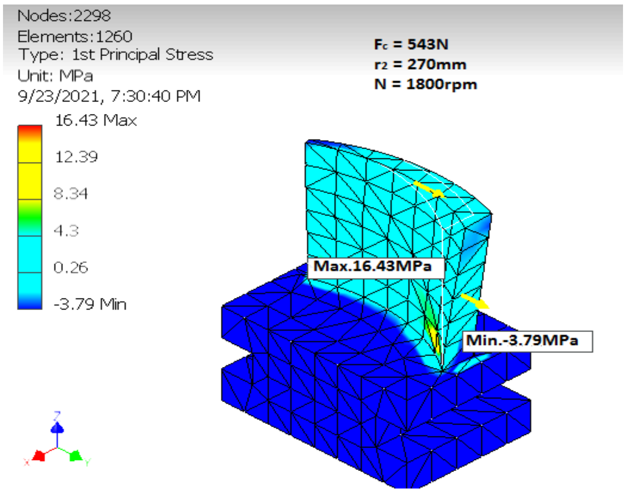

Fig. 2, The centrifugal stress on steam turbine blade with centrifugal force (564N)