



DESIGN OF SMALL BULB TURBINES WITH UNEQUAL SPECIFIC WORK DISTRIBUTION OF THE RUNNER'S ELEMENTARY STAGES

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ABSTRACT

Regarding this state of information within the field of the turbomachinery style, the strategy for coming up with tiny bulb rotary engines with unequal specific work distribution of the turbine runner's elementary stages close to the hub is given within the paper. The distribution operate of specific work of all the elementary stages is obtained, consistent with that the averaged axisymmetric flow surfaces of the rotary engine runner have a negligibly tiny deviation from the cylindrical flow surfaces. The precise work of the near-the-hub elementary stages, within the given distribution operate, are often reduced up to hr of the specified (design) specific work, still achieving nearly cylindrical flow surfaces.

1. INTRODUCTION

Both the hydraulic turbines style and their in operation performance analysis need the utilization of less complicated methodologies in preliminary style phases, particularly once the pure mathematics of the rotary engine runner isn't utterly outlined. within the field of the turbomachinery style, such tries ar unceasingly created so providing United States of America with completely different methodologies and procedures for the look method improvement [10, 11]. With the pc technology development, a major breakthrough of numerical strategies and numerical simulation of the fluid flow has been created, encouraging the numerical techniques incorporation into the look procedure and performance analysis of the turbomachinery [12, 13].

A number of assumptions and simplifications, empirical equations still because the designer's expertise continuously accompany the coming up with method [1, 2, 5, 7, 9]. the fundamental assumption within the hydraulic rotary engine coming up with procedure is axisymmetric flow surfaces. Associate in Nursing elementary stage may be a flow area between 2 elementary immediate axisymmetric flow surfaces. The intersection of keep vane (SV), or rotary engine runner (TR), and axisymmetric flow surfaces, defines the vane or blade profiles within the rotary engine elementary stages. keep vanes and blades ar shaped by the keep vane profiles and therefore the runner blade profiles within the turbine's elementary stages. The vane and blade profiles within the rotary engine elementary stages are often outlined mistreatment appropriate hydraulic calculations for a twodimensional fluid flow through the profile cascade of axisymmetric flow surfaces. within the cases once the flow surfaces ar cylindrical, the idea of fluid flow through the straight plane profile cascade are often utilized in calculations [6]. so as to attain cylindrical or virtually cylindrical flow surfaces within the bulb rotary engine runners, these runners ar typically designed to get Associate in Nursing equal specific work of all the elementary stages. The rotary engine runners designed consistent with such a principle ar product of blade profiles with a considerably larger inclination angle close to the hub than close to the shroud. so as to attenuate the blades' spacial curvature and to scale back the axial length of the runner, it's eligible to style the runner with smaller specific work of the elementary stage nearer the hub than the blade outer boundary [3, 4]. during this approach, the spacial curvature of the keep vanes is additionally reduced. the likelihood to style such keep vanes and rotary engine runners is analyzed within the paper. solely tiny bulb turbines, which may be utilized in tiny hydropower plants or as models of huge water turbines (for the model testing purpose) ar thought-about during this study.

2. BASIC FORMULAS

The theme of a bulb rotary engine meridional cross-sectional, with traces of 2 elementary immediate axisymmetric flow surfaces, wherever one (below) is marked as S_m , is given in Fig. 1. A flow area between 2 elementary immediate axisymmetric flow surfaces represents Associate in Nursing elementary stage of the runner. to see the form of keep vanes and runner blades, it's spare (for tiny turbines) to outline profiles in seven to twelve elementary stages, roughly equally distributed on the blade height.

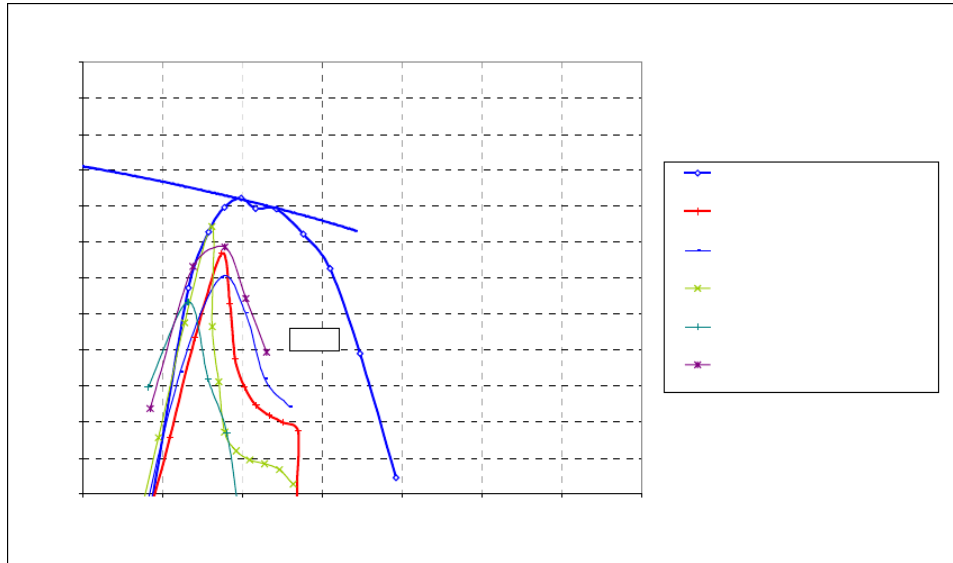


Fig:-1 Scheme of a bulb turbine meridional cross-section

3. CONDITIONS FOR GETTING CYLINDRICAL FLOW SURFACES WITHIN THE MANAGEMENT CROSSECTIONS AHEAD OF AND BEHIND THE ROTARY ENGINE RUNNER

The necessary condition is that the management cross-sections are placed within the area that is physically finite by cylindrical surface of the hub (turbine hub radius $R_{hub} = \text{const.}$) and therefore the shroud (turbine shroud radius $r_e = \text{const.}$), as shown in Fig. 1. The equation of steady fluid flow of the inviscid fluid, irrespective gravity acceleration, are often written within the form:

4. SUGGESTION FOR OPERATE

In order to scale back specific work of elementary stages close to the hub, and to attain flow surfaces within the runner that don't deviate a lot of from the cylindrical surfaces, the distribution operate of elementary stages specific work is usually recommended as follows:

The values of repetitive steps and outlined relative errors of specific work and volume rate of flow are often selected within the program for determination of $y_k(r)$ and $cz_1(r)$ [4]. However, the values applied within the on top of mentioned example of the bulb rotary engine offer the results that are correct enough for the technical follow.

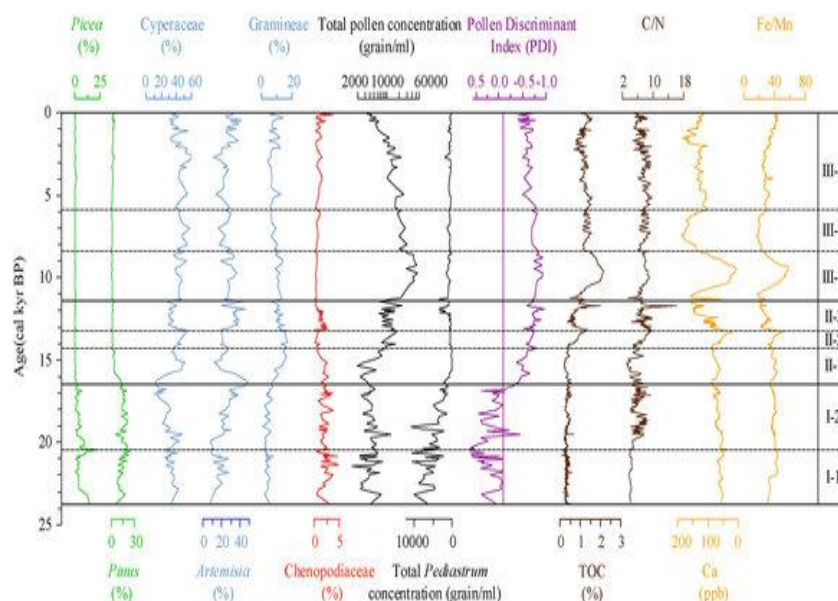


Fig:-2 Diagrams of $y_k(r)$ $c_{21}(r)$



5.CONCLUSION

The distribution operate of specific add rotary engine elementary stages ($y_k(r)$) ar planned within the paper. additionally, operate $1/2 r(r)$ is outlined, consistent with that the flow surfaces deviation compared to the cylindrical shapes are often determined. mistreatment the planned purposeful distribution of specific work of the rotary engine elementary stages, with the consummated condition that the flow surfaces negligibly deviate from the cylindrical surfaces, the designed bulb rotary engine blades ar less twisted. This style methodology is applicable to remain vanes, getting less twisted keep vanes still.

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