DESIGN B-SERIES PROPELLER OF TRADITIONAL FISHING VESSEL

ZULHILMI BIN SHAFIE

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Faculty of Mechanical Engineering
UNIVERSITI MALAYSIA PAHANG

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ABSTRACT

This thesis presents a study on determination of an optimum parameter in designing fishing vessel propeller. The right combination between the propeller design and the engine is required to give better performance and fuel economy. The objective of this project is to find the diameter pitch of the propeller and the blade dimensional characteristic. By referring to the 'Wageningen B-series' tables and data collection, the study has been carried out. From the data, the optimum diameter pitches of the propeller are calculated. As a result, an optimum designed of the propeller which could give high efficiency, high performance and reduced the fuel consumption of the fishing vessel is produce.

ABSTRAK

Tesis ini membentangkan kajian mengenai penentuan parameter optimum dalam mereka-bentuk kipas kapal menangkap ikan. Gabungan yang tepat antara reka bentuk kipas dan enjin diperlukan untuk memberikan prestasi yang lebih baik dan ekonomi bahan api. Objektif projek ini adalah untuk mencari diameter '*pitch*' kipas dan ciri dimensi bilah kipas. Dengan merujuk kepada jadual 'Wageningen B-siri' dan pengumpulan data, kajian telah dijalankan. Daripada data, diameter optimum kipas dikira. Hasilnya, kipas yang direka dapat memberikan kecekapan tinggi, berprestasi tinggi dan mengurangkan penggunaan bahan api kapal penangkapan ikan.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOL

η	Propeller Efficiency
ω	Angular Velocity
ρ	Density Of Water
β(r)	Pitch Angle Of Blade Section

LIST OF ABBREVIATION

SYMBOL	SPECIFICATION
C(r)	Chord Length Along Blade
D	Propeller Diameter
Z	Number of Blades
K*T*	Thrust Coefficient
K*Q*	Torque Coefficient
M	Number of Radial Vortex Lattice Elements
n	Propeller Rotational Speed
p	Pressure
P	Pitch of Blade Section
R*h*	Radius Of Hub
R	Radius Of Propeller
t	Thickness Parameter For Blade Sections
tmax	Maximum Thickness of Each Blade Section
T	Propeller Thrust

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

Fishing vessels is very important for fishermen to go fishing at the sea. Every day, the fishermen will go out to fishing with start the boat engine and pushing the throttle lever so hard without achieve the maximum speed. This is the fact what is the fisherman doing every day. However, the consideration of propeller and the engine of the boat are important to give maximum output power to the boat.

Designed of propeller will increase the boat performance including the handling, comfort of ride, engine life, economy of fuel, safety and all the important element about the boat resistant and propulsion.

Various types of propulsion units exist, as well as different types of propellers. The two main types of propellers are fixed pitch propellers (FPP) and controllable pitch propellers (CPP). FPP can only be controlled by the propeller speed, whereas CPP can be controlled by both the propeller speed and the angle of the propeller blades (pitch). Both propeller types can be open or ducted. On a ducted propeller, the propeller is situated inside a duct, or nozzle. This increases the efficiency of the propeller at low vessel speeds (Kort, 1934).

1.2 PROBLEM STATEMENT

The propeller is depending on the engine and the boat size. If the choosing of propeller did not matching with the engine boat, this problem will affect the speed and power performance of the boat. In order to achieve the best performance of the boat including handling, comfort of ride, engine life, economy of fuel, safety and all the important element about the boat resistant and propulsion, the propeller must be designed match with the engine and boat size especially for the fishing vessel at Kuala Pahang bay.

1.2 OBJECTIVE

i. To find the optimum diameter and pitch of the propeller.
ii. To find the blade propeller characteristic.

1.4 PROJECT SCOPE

i. Find the design condition and blade characteristic.
ii. The design will be based on the 'standard open water series data and 'Wageningen B-series table'.
iii. Design the propeller on computer by using SOLIDWORK software.

1.5 PROCESS FLOW CHART

Figure 1.1 shows the process flow of how this project done. This makes useful tools how processes work done throughout the project.

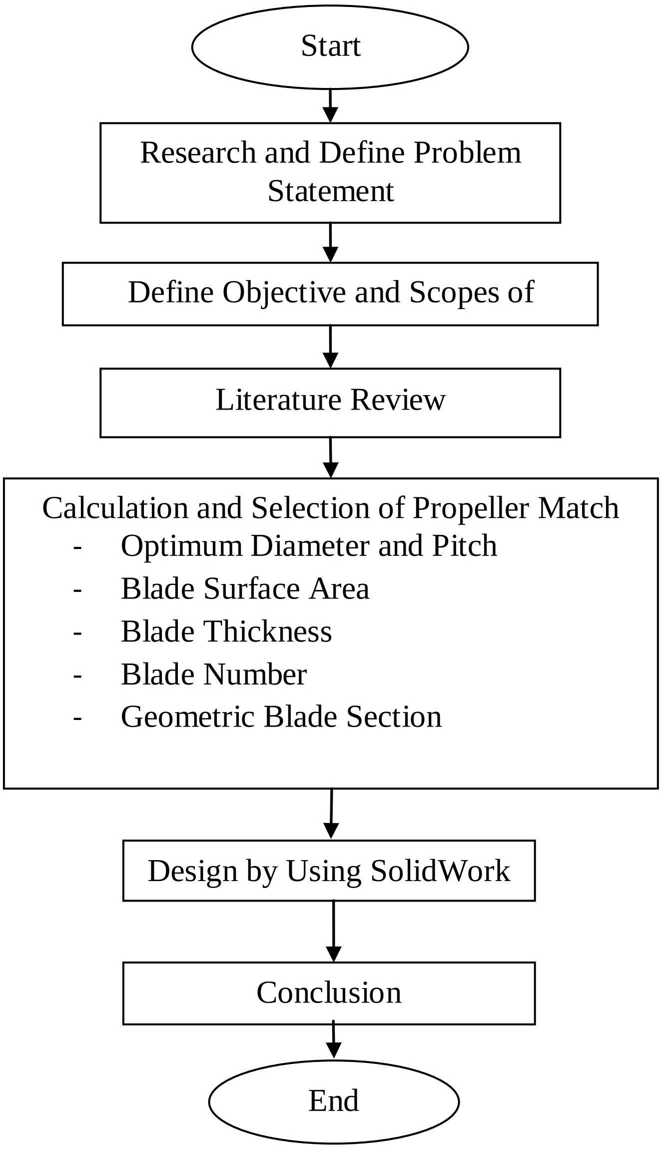

Figure 1.1: Process Flow Chart

1.6 THESIS OVERVIEW

This thesis consist five chapters which is chapter 1, chapter 2, chapter 3, chapter 4 and chapter 5. In chapter 1 there is an introduction and flow chart for this project. Flow chart is consisting for PSM 1 and PSM 2. For chapter 2 it describe about the literature review for this project. Actually, in this chapter there is related research based on the title of this project. This related research takes from the previous journal that has a related experiment for this project also as a guideline to do this research. In chapter 3 this thesis describe about the procedure of this project. It also consist the list of all method that use to finish this research. Result and discussion is including in chapter 4. This chapter describe about the calculation and analysis of this project. Lastly, for conclusion and recommendation it is under chapter 5. This chapter describe about the result of the experiment in this project.

CHAPTER 2

LITERATURE REVIEW

2.1 PROPELLER TYPES

a) Fixed pitch propeller

This propeller are cast in one block and normally made of a copper alloy. The position of the blades, and thereby the propeller pitch, is once and for all fixed, with a given pitch that cannot be changed in operation.

b) Controllable pitch propeller

This type of propeller designed to give the highest propulsive efficiency for any speed and load condition. When the ship is fully loaded with cargo the propulsion required at a given ship speed is much higher than when the ship is empty. By adjusting the blade pitch, the optimum efficiency can be obtained and fuel can be saved. Also, the controllable pitch propeller has a “vane"-stance, which is useful with combined sailing or motor vessels as this stance gives the least water resistance when not using the propeller.

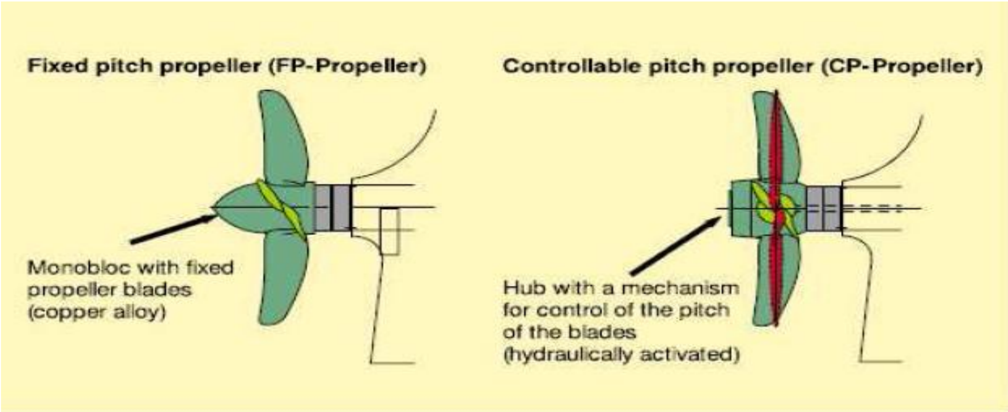

Figure 2.1: Propeller Types

Source: Harvald and Guldhammer (1974)

2.2 PROPELLER GEOMETRY

2.2.1 FRAMES OF REFERENCE

10th International Towing Tank Committee (ITTC) initiated the preparation of a dictionary and nomenclature of ship hydrodynamic terms and this work was completed in 1975.

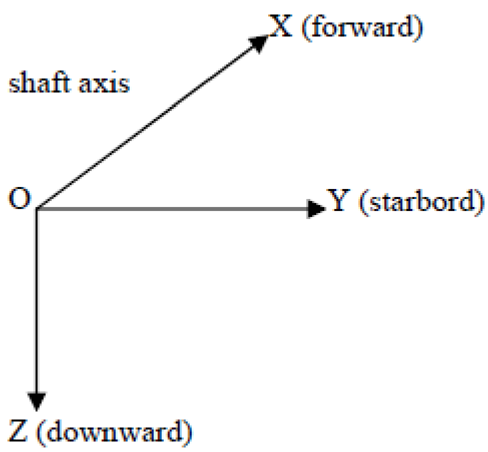

Figure 2.2: Global Reference Frame

Source: Carlton (2007)

The global reference frame proposed by the ITTC is a right-handed rectangular Cartesian system. For propeller geometry it is convenient to define a local reference frame having a common axis such that OX and Ox are coincident but Oy and Oz rotate relative to the OY and OZ fixed global frame.

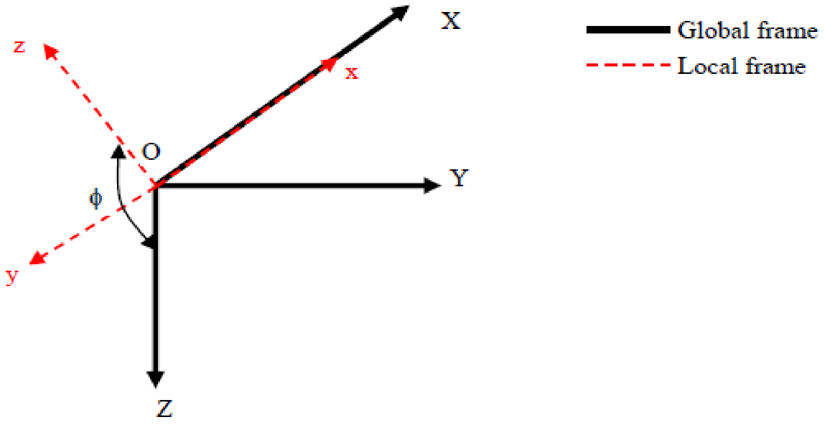

Figure 2.3: Local Reference Frame

Source: Carlton (2007)

2.2.2 PROPELLER REFERENCE LINES

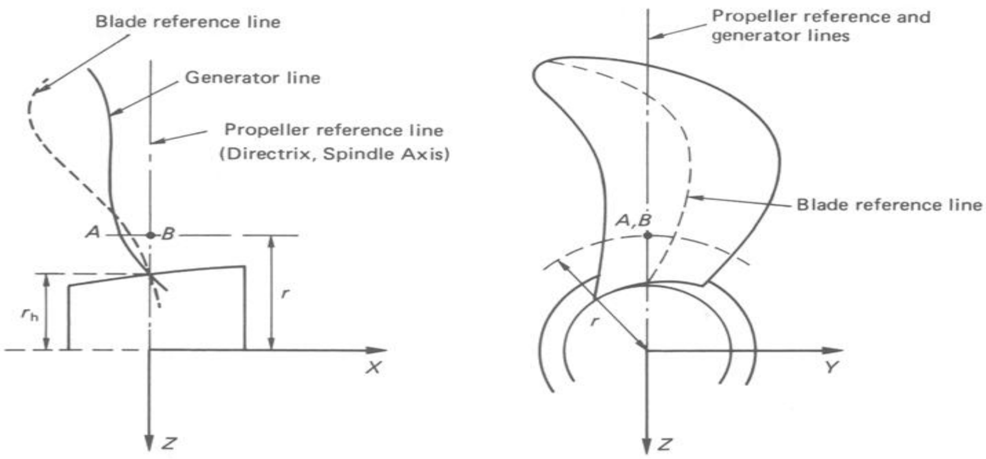

Figure 2.4: Blade Reference Line

Source: Carlton (2007)

- The line normal to the shaft axis is called either propeller reference line or directrix. In the case of controllable pitch propeller the spindle axis is used as synonymous with the reference line.

- Generator line: The line formed by intersection of the pitch helices and the plane containing the shaft axis and propeller reference line.

- The aerofoil sections which together comprise the blade of a propeller are defined on the surfaces of cylinders whose axes are concentric with the shaft axis.

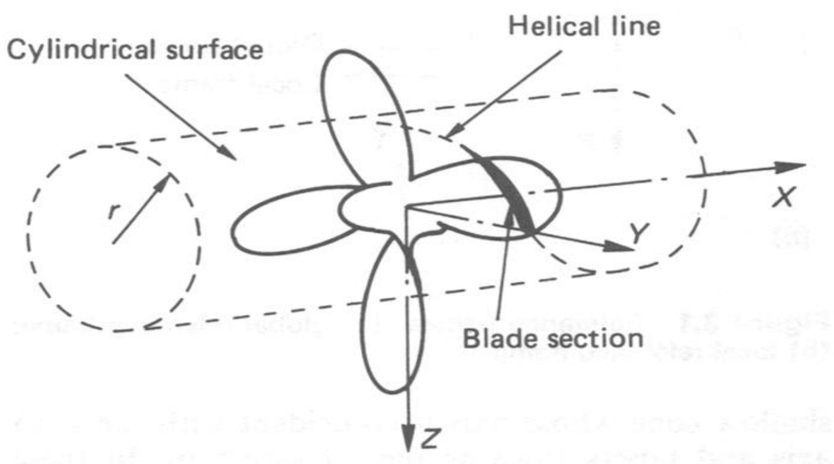

Figure 2.5: Cylindrical Blade Section

Source: Carlton (2007)

2.2.3 CROSS SECTION OF PROPELLER BLADE

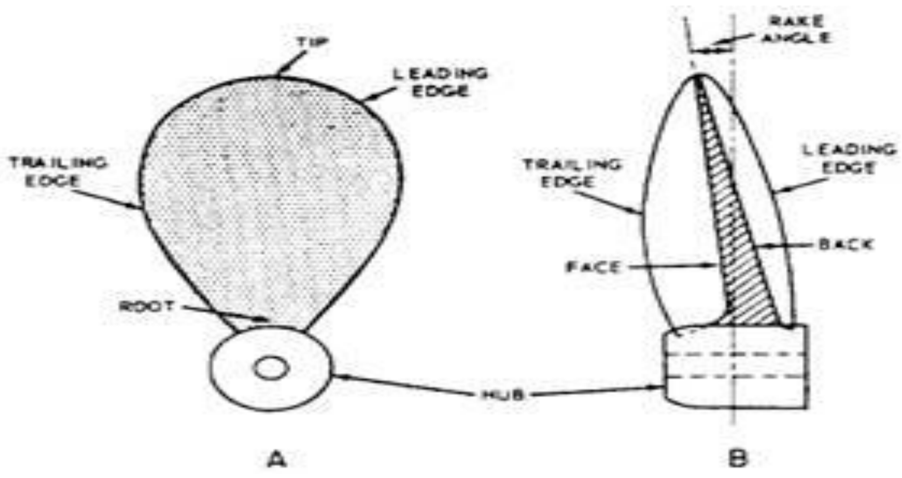

Figure 2.6: Cross Section of The Propeller Blade

Source: Carlton (2007)

Face: The side of a propeller blade which faces downstream during ahead motion is called face or pressure side (when viewed from aft of a ship to the bow the seen side of a propeller blade is called face or pressure side).

Back: The side of a propeller blade which faces generally direction of ahead motion is called back or suction side (when viewed from aft of a ship to the bow the unseen side of a propeller blade is called back or suction side).

Leading Edge: When the propeller rotating the edge piercing water is called leading edge.

Trailing Edge: When the propeller rotating the edge trailing the leading edge is called trailing edge.

2.2.4 PITCH

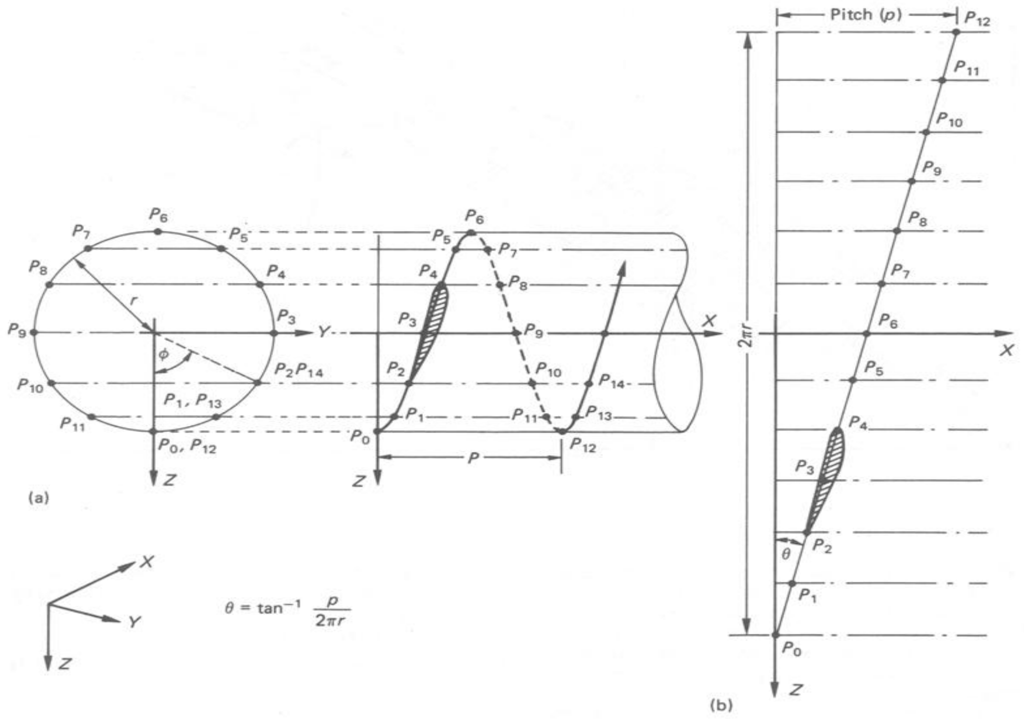

Figure 2.7: (a) Helix Definition On A Cylinder Of Radius R And (B) Development Of Helix

Source: Carlton (2007)

- Consider a point P lying on the surface of a cylinder of radius r which is at some initial point P0 and moves as to from a helix over the surface of a cylinder.
- The propeller moves forward as to rotate and this movement create a helix.
- When the point P has completed one revolution of helix that means the angle of rotation of the cylinder intersects the X-Z plane and moves forward at a distance of P.

$$\varphi = 360o \; or \; 2 \qquad (2.1)$$

- If the cylinder is opened out the locus of the point P lies on a straight line.
- In the projection one revolution of the helix around the cylinder measured normal to the OX axis is equal to 2πr.

- The distance moved forward by the helical line during this revolution is p and the helix angle is given by:

$$\theta = \tan -1\left(\frac{p}{2\pi r}\right) \quad (2.2)$$

- The angle θ is termed the pitch angle and the distance p is the pitch.

There are several pitch definitions.

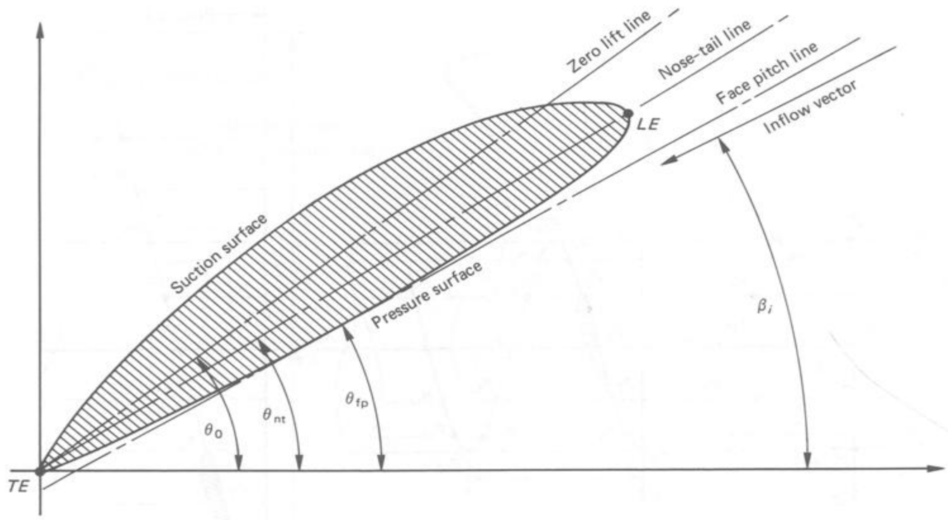

Figure 2.8: Pitch Lines

Source: Carlton (2007)

Where

- θ_0 is the effective pitch angle of the propeller
- θ_{nt} or θ is the geometric pitch angle of the propeller
- βi is the hydrodynamic pitch angle
- α is the angle of attack of section

The important pitch terms with which the analyst needs to be thoroughly conversant are as follows:

- **Nose-tail pitch:** The straight line connecting the extremities of the mean line or nose and tail of a propeller blade is called nose-tail pitch line the section angles of attack are defined to the nose-tail line.
- **Face pitch:** The face pitch line is basically a tangent to section's pressure side surface and you can draw so many lines to the pressure side. Therefore its definition is not clear. It is rarely used but it can be seen in older drawings like Wageningen B series.
- **Effective or no-lift pitch:** It is the pitch line of the section corresponding to aerodynamic no-lift line which results zero lift.
- **Hydrodynamic pitch:** The hydrodynamic pitch angle (βi) is the pitch angle at which the incident flow encounters the blade section.

Effective pitch angle (θ0) = Noise-tail pitch angle (θ, θnt)
+ 3-D zero-lift angle (2.3)

Where 3-D zero lifts angles is the difference between θ_0 and θ.

θ_0 = Hydrodynamic pitch angle (βi) + Angle of
attack of section (α) + 3-D zero lift angle (2.4)

2.2.5 SLIP RATIO

If the propeller works in a solid medium (has no slip), if the water which the propeller "screws" itself through does not yield, the propeller will move forward at a speed of $V = p \times n$, where n is the propeller's rate of revolution, as seen in the below figure. The similar situation is shown for a corkscrew, and because the cork is a solid material, the slip is zero and, therefore, the cork screw always moves forward at a speed of $V = p \times n$. However, as the water is a fluid and does yield, the propeller's apparent speed forward decreases with its slip and becomes equal to the ship's speed *V*, and its apparent slip can thus be expressed as $p \times n - V$.

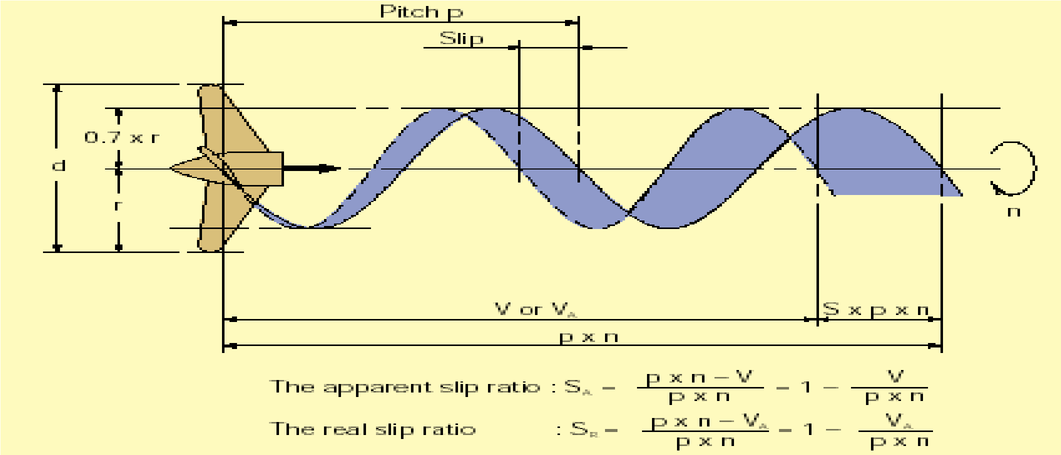

Figure 2.9: Apparent Slip Ratio

Source: Harvald and Guldhammer (1974)

The apparent slip ratio SA, which is non-dimensional, is defined as:

$$S_A = \frac{pm - V}{pm} = 1 - \frac{V}{pm} \tag{2.5}$$

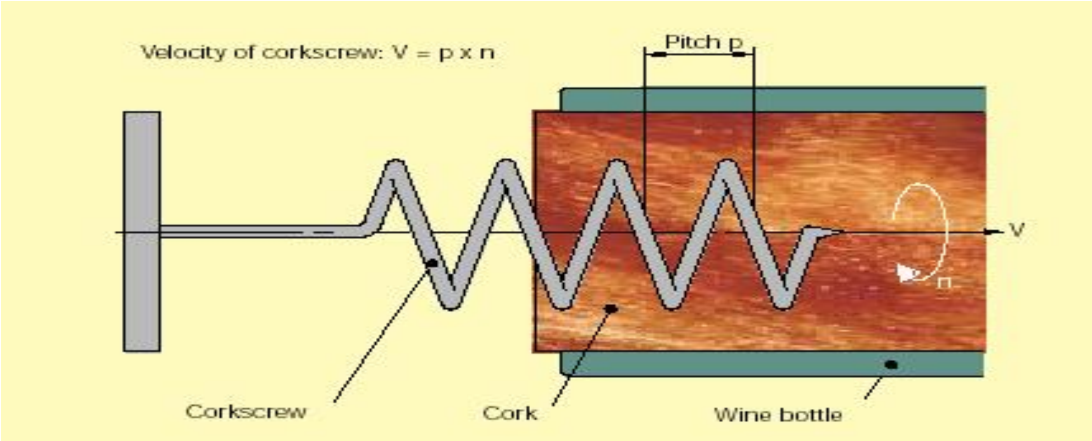

Figure 2.10: Real Slip Ratio

Source: Harvald and Guldhammer (1974)