Chapter 7.

Discussion and Conclusion

1. The wind velocity is a dominant factor to Cp value, a small change in the wind velocity has large effect on Cp values as can be seen from the following equation:

$$C_P = \frac{T\Omega}{1/2\ \rho A U^3}$$

2. From this model if we construct a prototype of the windmill with Model : Prototype ratio = 1:4 by simulitude law,[12,13] then

$$\text{Prototype velocity} = \frac{\text{Model experiment velocity}}{4}$$

3. A large CD/CL ratio will restrict the design tip speed ratio. At low tip speed ratios the use of more blades is prefered.

4. Assumption of uniform flow in the theoretical analysis is difficult to realize for the experiment.

5. From the theoretical results it has been shown that at the design condition for $\lambda = 2$ one obtained the maximum value of Cp which is corresponding with the experimental results. However, there are descripancies in the value of Cp due to some correction factors which have not been included in the calculation

as follows:

5.1 The analysis is based on a 2-dimensional airfoil theory but in real state the flow becomes essentially 3-dimensional.

5.2 The assumption of axial flow is only acceptable for very high speed devices. The higher the generated torque, the higher the tangential momentum in the air downstream is.

5.3 Effect of wake rotation on power that recieves from the windmill is torque x angular speed. The torque is produced by forces acting on the blades in the tangential direction, or we can say that these forces are the result of velocity changes of the air in the tangential direction. Since the air has no tangential direction velocity before passing the rotor, this wake rotations means a loss of energy. High torque means large tangential velocities in the wake.

5.4 The actual values of Cp of for this this type of windmill should than the obtained results if we consider the loss in bearing friction at the windmill shaft which is large when considering the small size of the windmill model.

6. Because of the limitation of the fan size, this experiment could not be performed at high wind velocity. The testing wind velocities were about 2.4-2.8 m/s.

7. From the experimental results it was shown that the maximum Cp was about 16% at tip speed ratio of 2.0-2.2 which corresponded with the design tip speed

ratio.

8. During the experiment the pitch angle of blades were varied by +5 degrees around the design pitch angle in order to find the effect of the pitch angle on Cp. The experimental results show that the design pitch angle of blades was at the optimum condition.

9. Because of low wind velocities the experiment cannot be carried out at wider range of tip speed ratios.

10. The torque coefficient (CQ) for this type of windmill is greater than that of the propeller type, but less than that of the multiblade type.

11. For low speed windmills, simple airfoils like arched plate airfoils, are recommended for better results than the conventional ones.

12. Considering the cost of construction with a multiblade type windmill, this type of windmill can reduce the cost of construction not only the blade cost but also the tower cost as well.