OE 5020 Design Project
M.Tech OE1 (2020-22)
Department of Ocean Engineering
Indian Institute of Technology Madras

Design of Fluidic Diode for an Oscillating Water Column

Guide: Prof. Abdus Samad

Course Coordinator: Prof. Sannasiraj S A

Submitted by

PRASAD S DESHPANDE

OE20M012

July 2021

1. Problem Statement

Design of Fluidic Diode for an Oscillating Water Column.

2. Objective and Scope

2.1 Objective

Design the Fluidic Diode for an Oscillating Water Column type wave energy converter.

2.2 Scope

1. Improve the performance of the twin turbine
2. Designing a fluidic diode for the twin turbine
3. Verify the shapes for a potential fluidic diode application
4. Determine the dimensions of potential fluidic diode shape.
5. CAD model of the designed fluidic diode.

3. Design Methodology

1. To Obtain the performance characteristics of the twin turbine.
2. To Calculate operating range of pressure drop of twin turbine through curve fitting technique.
3. To Match the working pressure of diode and flow rate with the pressure drop and flow rate of twin turbine.
4. To Choose the optimum dimensions of the diode so that maximum efficiency is obtained from system.

4. Work Done till now :

4.1 Turbine :

1. Parameter Assumption:
   - Guide vane angle – 20 degrees
   - Air Density – 1.2 kg/m^3
   - Hub ratio – 0.7 Flow rate- 0.15 m^3/s
   - Inner Diameter – 0.24 m
   - Sinusoidal flow is assumed
2. Performance curves for the chosen guide vane angle are obtained
3. Performance curves are then digitized to calibrate it. This plot is then exported to the excel sheet to use the curve fitting technique
4. Obtained the regression coefficient as high as possible to fit the data and obtained the equation of the performance curve.
5. Channel cross- sectional area is calculated and mean radius is calculated so that axial flow velocity (u) can be calculated.
6. Took the different flow coefficients to calculate the rotational speed and tangential velocity.
7. Forward flow coefficient and reverse flow coefficient are obtained and forward and reverse input coefficients are also obtained.
8. Pressure drop in forward and reverse direction is made same. Output power, Input Power and efficiency is calculated.

B. Diode :

1. Nozzle type fluidic diode is chosen. The restriction on its diameter was imposed due to the inner diameter of the turbine as the 240mm. So the Larger end has been kept with the diameter of the 240 mm.
2. The forward direction pressure drop and reverse direction pressure drop is calculated analytically.
3. This is added to the pressure drop of the turbine in forward and reverse direction respectively.
4. Output power, Input Power and efficiency is calculated.
5. D/L ratio is varied to check the effect of parameter on efficiency.
6. Semi- Cone angle is varied at steps of 2.5 degrees to check its effect on the efficiency of the system.
7. Diodicity is calculated for each of this combination.

5. Results :

For the varying D/L ratio and varying semi-cone angle the graphs are plotted.

D/L = 1.0

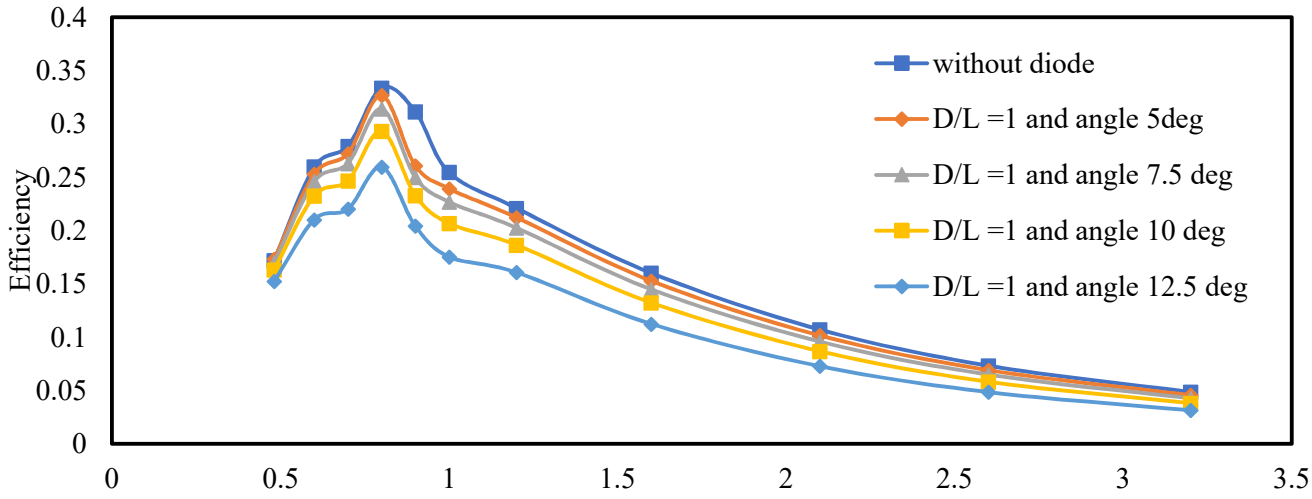

Fig 1: Efficiency vs Flow coefficient curve for D/L = 1.0

D/L = 0.8

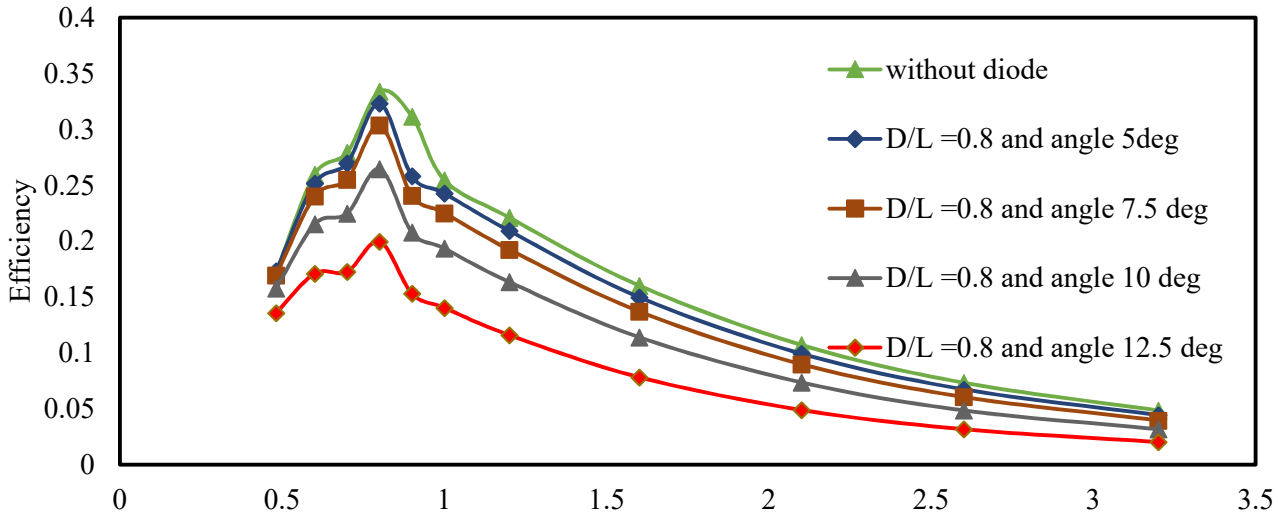

Fig 2: Efficiency vs Flow coefficient curve for D/L = 0.8

D/L = 0.6

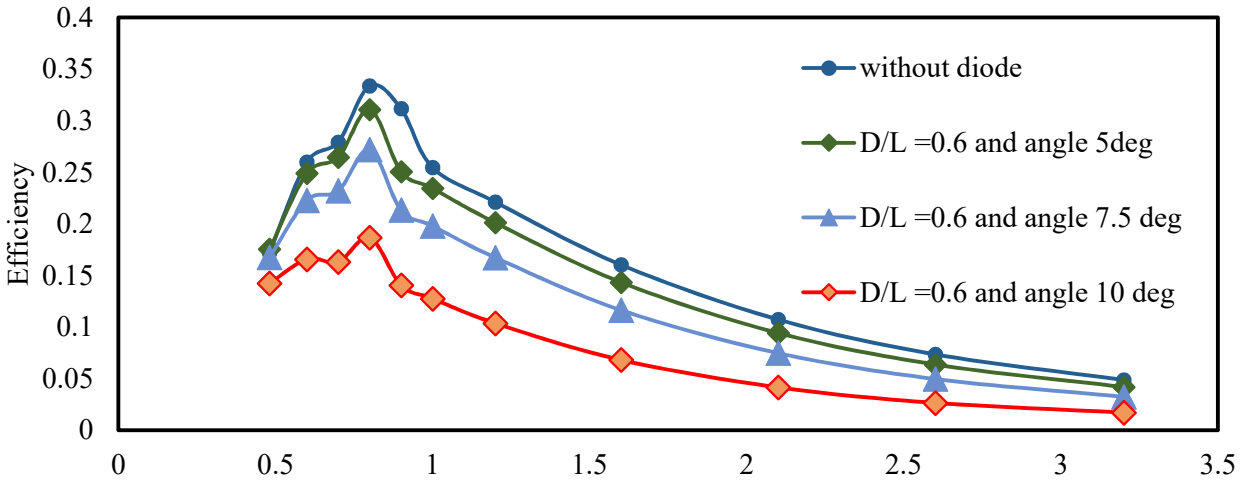

Fig 3: Efficiency vs Flow coefficient curve for D/L = 0.6

D/L = 0.5

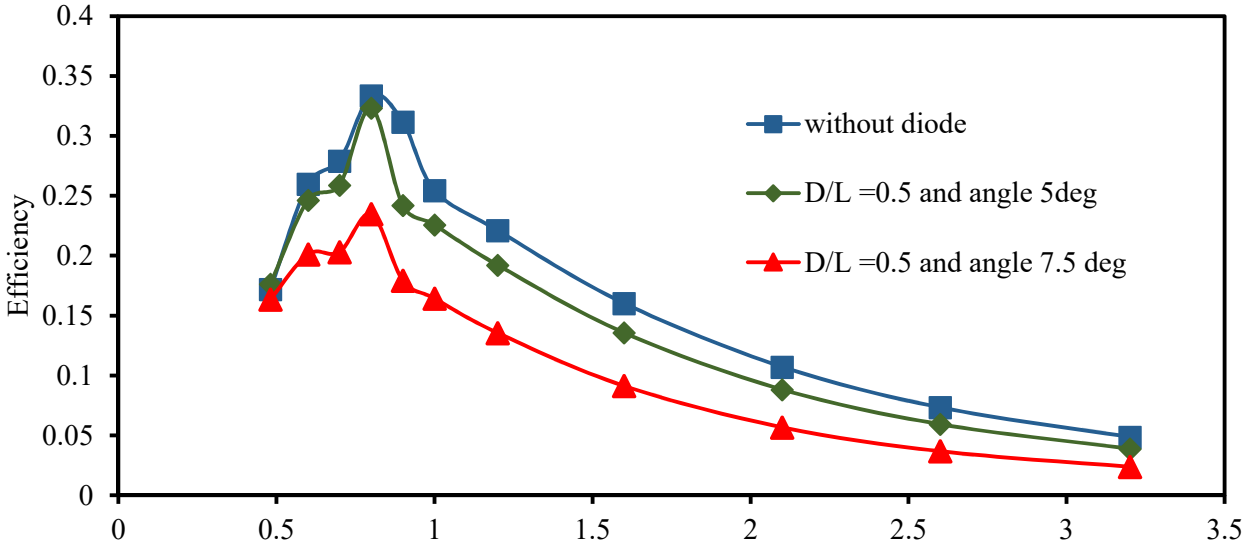

Fig 4: Efficiency vs Flow coefficient curve for D/L = 0.5

Diodicity for different angles

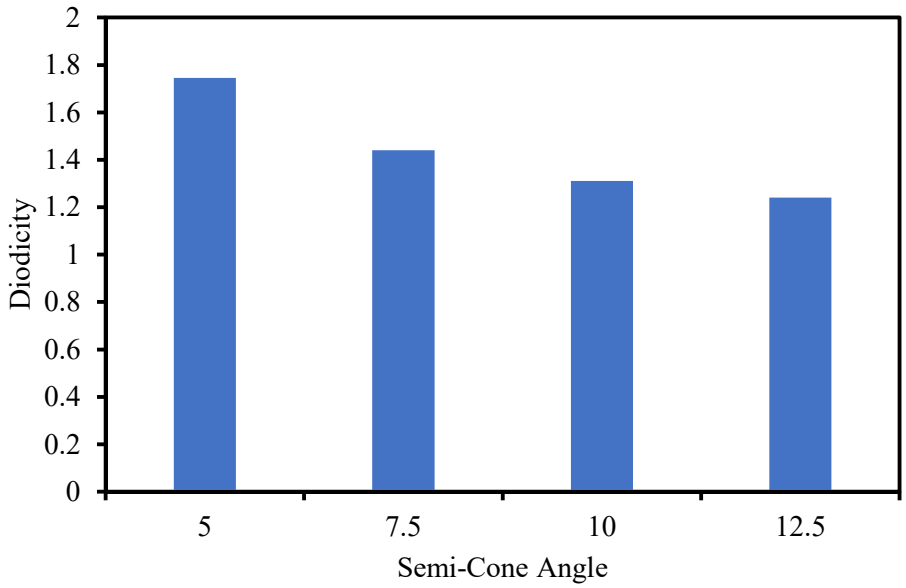

Fig 5: Diodicity for different cone angles

5.1 Inferences:

1. Diodicity for chosen nozzle type fluidic diode is decreasing with the increment in the semi-cone angle. This diodicity is relative term which also depends on pressure difference of the turbine and pressure drop of this diode in forward and reverse direction.
2. The efficiency of the system in presence of fluidic diode increases up to some point and then it starts decreasing.
3. As D/L ratio decreases, the efficiency increment is much significant.
4. The flow coefficient due to the implementation of fluidic diode suggests that the flow in the forward direction has improved.
5. Reverse flow coefficient is reduced it indicates more flow in the forward direction.
6. The efficiency improvement due to incorporation of nozzle type fluidic diode is not significant.

6. Work to be Done :

1. CAD model of the nozzle type fluidic diode.
2. Report formation.