Group – 2

Tushar wadhwa (130010016)

Basu Parmar (130010003)

Micky (140010059)

Split savonius turbine

Savonius wind turbines are a type of vertical-axis wind turbine (VAWT), used for converting the force of the wind into torque on a rotating shaft. Aerodynamically, it is a drag-type device, consisting of two or three scoops.

Design methodology:

- Power requirement was fixed.
- From formula, $P = \frac{1}{2}\rho A(\omega R - V)^3 C_p$. Where C_p is the power coefficient, A be the area and V be the free stream velocity, Area is calculated assuming a wind tip speed ratio.
- Rpm is then calculated from wind speed tip ratio and diameter of the turbine.
- These are iterated until it we get a solution for rpm, diameter and tip speed ratio.
- Height is then calculated accordingly from the above calculated values.
- Now from the available power and rpm we can calculate the torque required.
- And from these data and experimentation we can get the cut-in speed of the turbine.

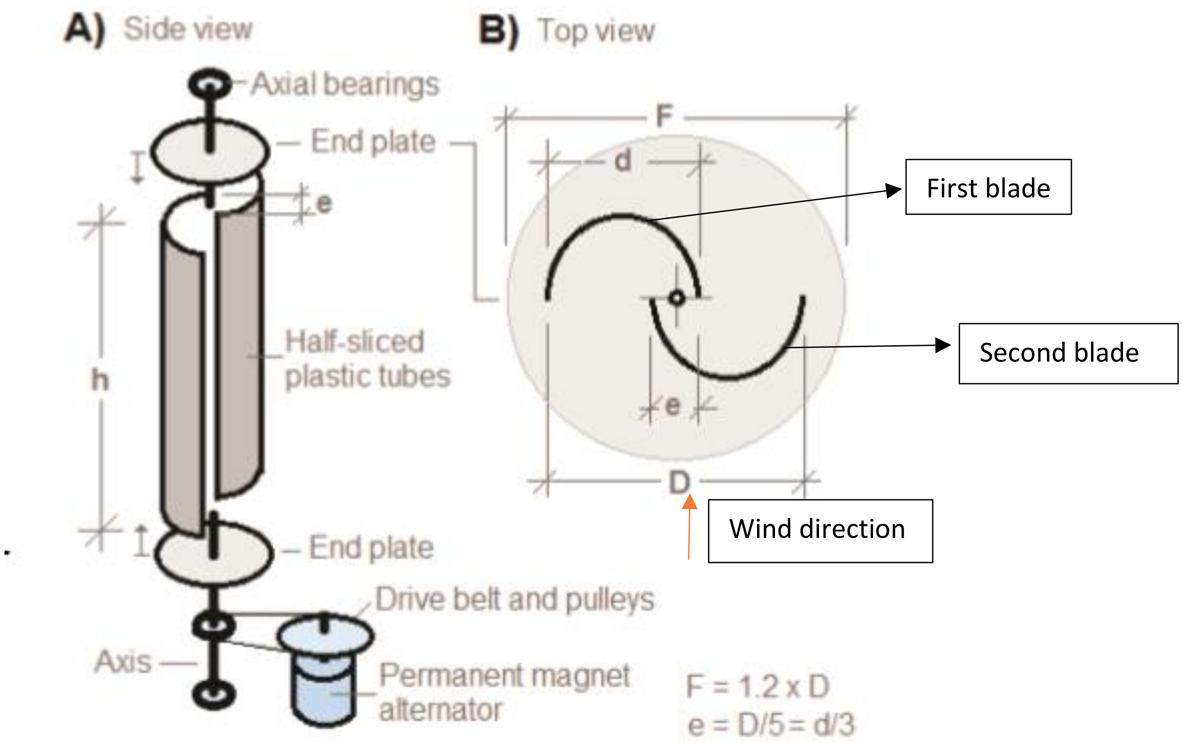


Fig. 1. Basic sketch of Savonius wind rotor

Parameters:

d – Diameter of plastic pipe = 7.2 cm

D – Wing spread of rotor = 12 cm

e – Pipe spacing = 2.4 cm

h – Height of blades / tubes = 7 cm

v – Wind speed = 10 m/s

F – Diameter of end plates = 14.4 cm

Rpm = around 1500 rotations per minute.

P design = 15 mW

Torque = 0.01 N-m

Results and efficiency:

Power output was calculated from a dynamo attached to the rotor shaft, which generates a emf when the turbine rotates.

Emf generated = 0.12 V

Resistance = 10 ohm

Power generated from the turbine at a wind speed of around 10m/s is around = V^2 / R = 0.00144 W

Efficiency of the turbine = p output/ p input = 10% approx.

Observations:

- Little split in between turbines causes the air to flow from higher pressure region of one blade to the backward of other blade, which is a lower pressure surface, and thus increasing the net torque acting in rotating the rotor.
- Spillage can be reduced by adding one more plate at the top of blades, thus increasing its efficiency.
- Spillage from the second blade can be reduced by adding a surface, which directs the flow over first blade instead of just spilling it over, i.e., acting as a nozzle.

Flow field simulations:

Flow over split savonius turbine from different angles is simulated.

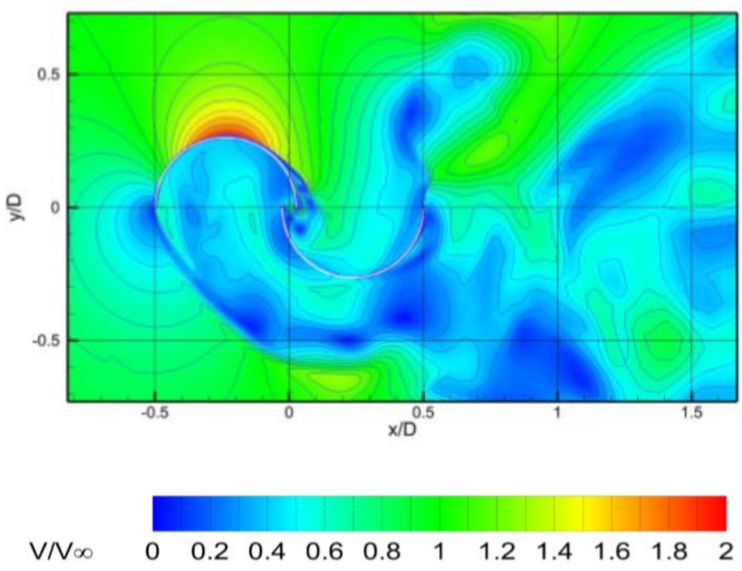
Fig. 1 represents 90 degree angle of the turbine from the wind.

6 different cases are represented:

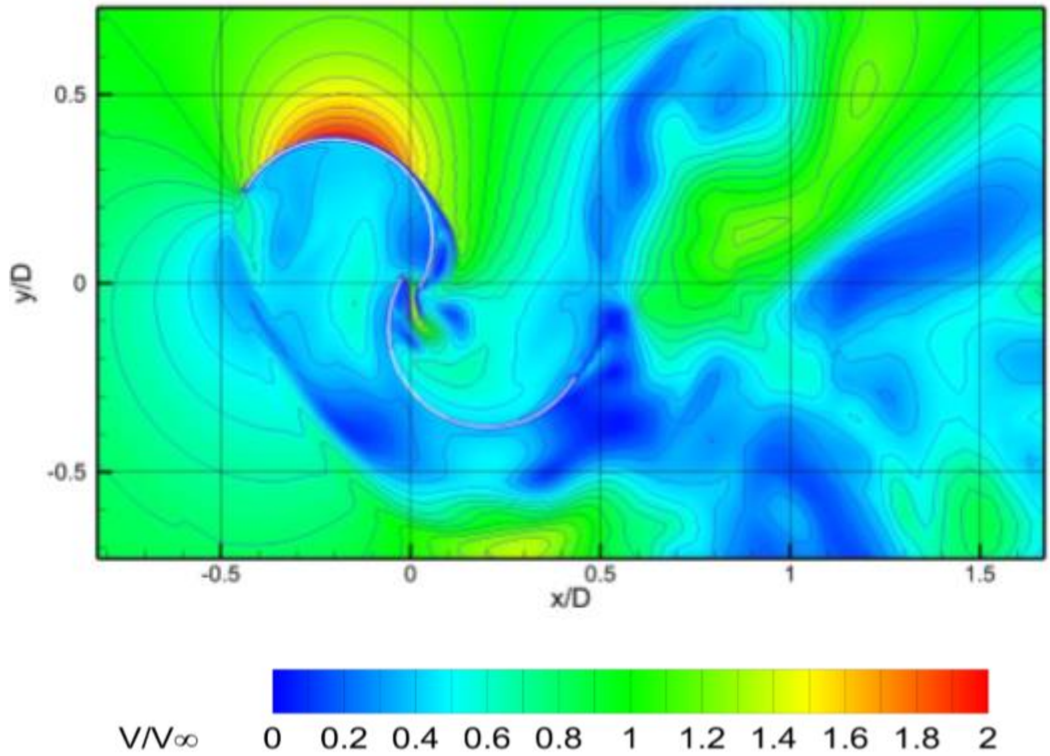
0/180, 30/210, 60/240, 90/270, 120/300, 150/330.

Following are the contours for **velocity field** obtained from simulations.

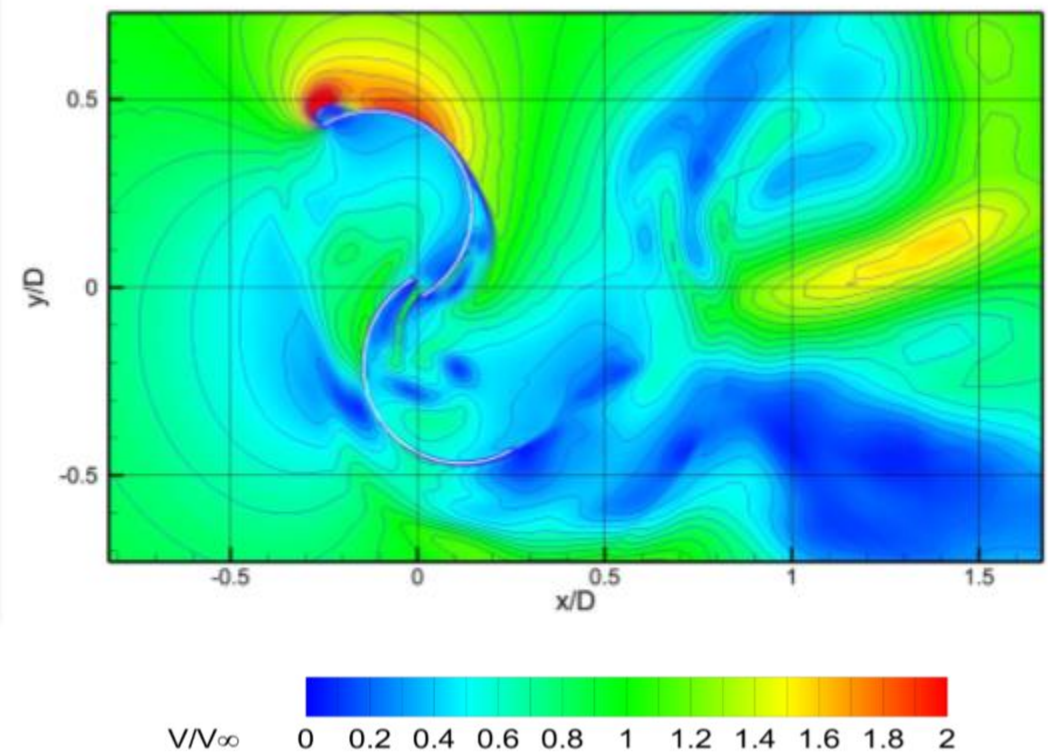
Case 1: 0/180 degrees. (flow velocity direction is from 0 to +ve x).



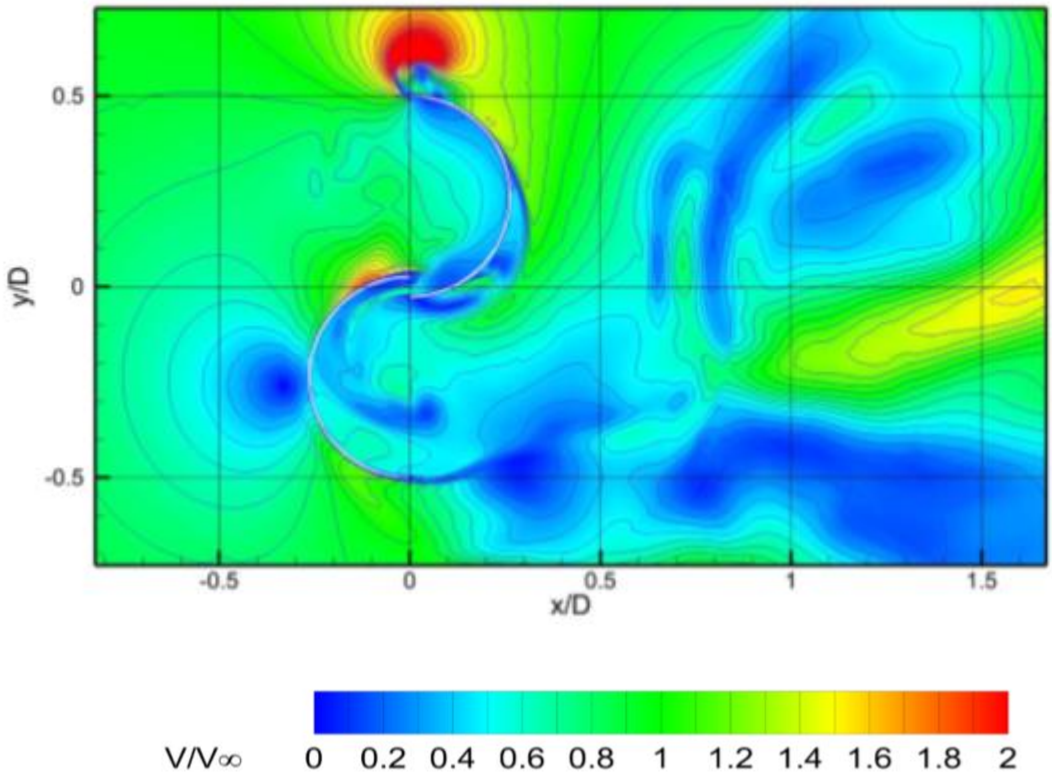
Case 2: 30/210



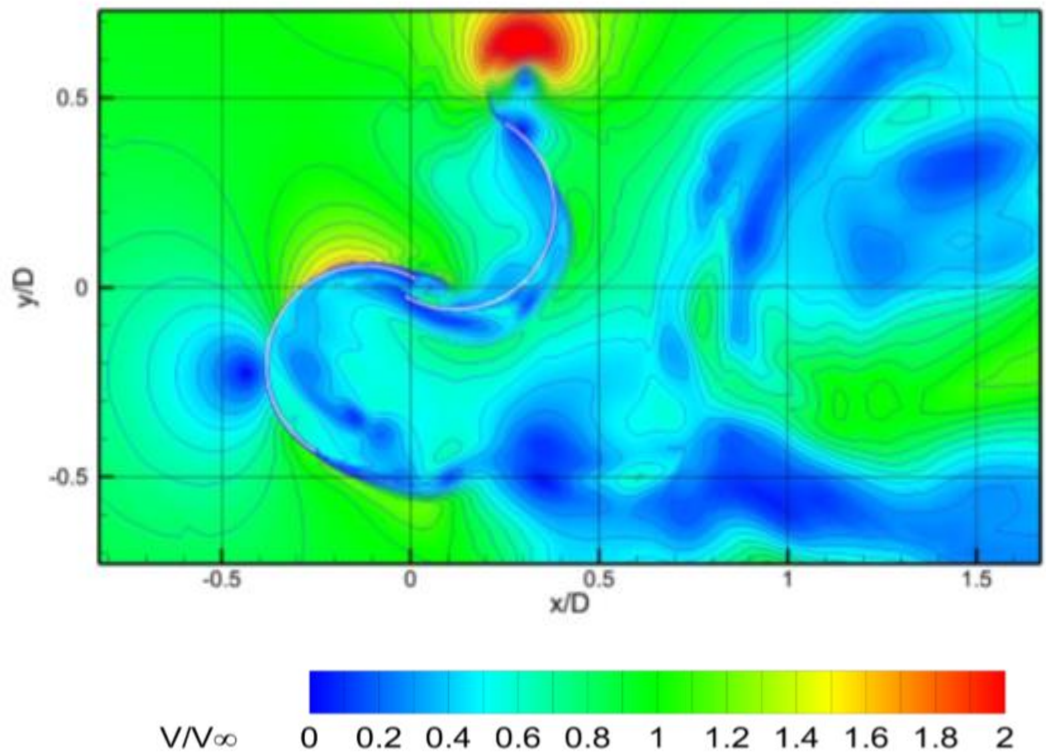
Case 3: 60/240



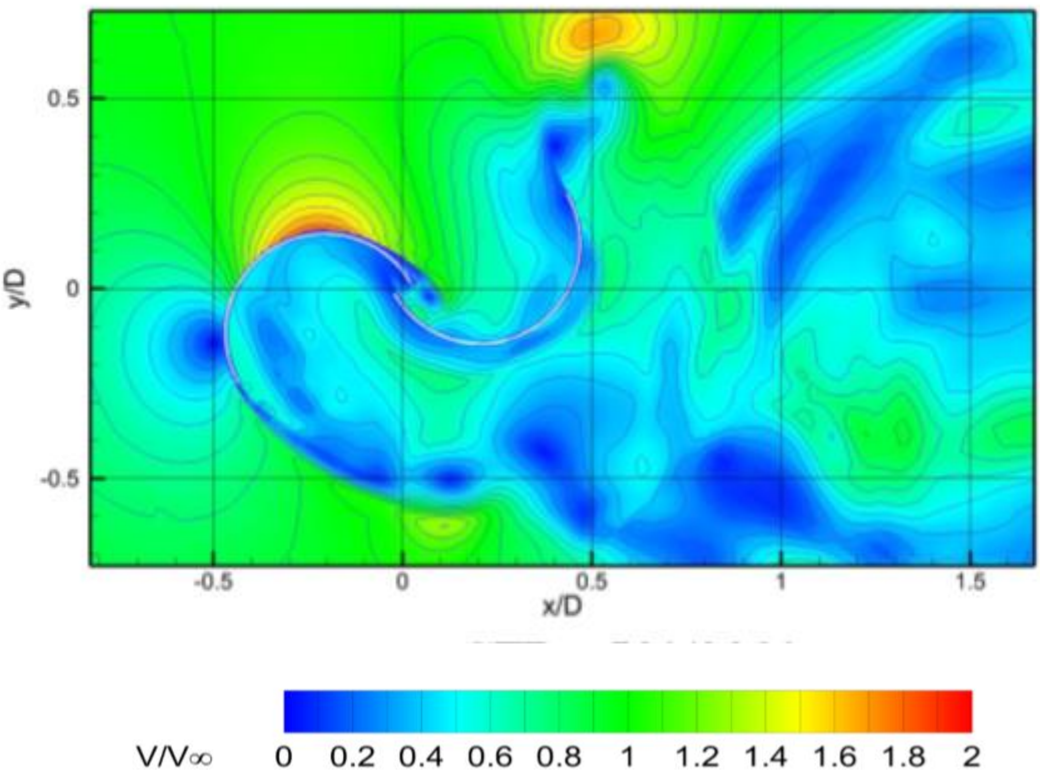
Case 4: 90/270



Case 5: 120/300



Case 6: 150/360



Conclusions:

- Because the aspect ratio of the rotor is low, there exists a flow leakage near the blade tip, between the suction and pressure surfaces.
- The blade circulation variation during rotation creates a periodical vortex structure downstream of the rotor.
- Flow on suction side of a pitching airfoil, the flow on the convex side stays attached for angles of attack up to 60° degrees. It must be noted that such high angles are attained because the blade surface moves in flow direction.