Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 141 (2017) 383–388

Energy Procedia

www.elsevier.com/locate/procedia

4th International Conference on Power and Energy Systems Engineering, CPESE 2017, 25-29 September 2017, Berlin, Germany

Review of savonius wind turbine design and performance

M.ZEMAMOU[a,] *, M.AGGOUR[a], A.TOUMI[b]

[a]*LR2E,University Ibn Tofail, Avenue de L'Université, Kénitra, Morocco*
[b]*laboratory of international university of rabat,Technopolis Shore Rocade 11100 Sala Al Jadida, Rabat, Morocco*

Abstract

The world adopts a policy of energy transition, which refers to the substitution of fossil fuels by renewable energies to reduce CO_2 emission, however the major issue is to develop a wind turbine which has a simple design, a relatively low operating speed and independent wind directions, the savonius rotor appears to be promising for such conditions, but suffers from major drawbacks: low efficiency and high negative torque.so far several scientific researchers aims to improve the performances of savonius turbine, by optimizing the effects of different geometric parameters and by developing new design. The range of the power coefficient values for the conventional Savonius rotors is between 0.1 and 0.25 .The installation of several extra set leads to new designs which achieve an improvement in the coefficient of performance of 27.3% compared to the conventional rotor.

Peer-review under responsibility of the scientific committee of the 4th International Conference on Power and Energy Systems Engineering.

Keywords: Power coefficient; Savonius rotor; torque coefficient;Wind turbine.

1. Introduction

Wind turbines fall into two main categories: HAWT horizontal axis wind turbines and VAWT vertical axis wind turbines. HAWT are the most widespread they are generally more efficient than VAWT at least for laminar winds of high speeds. However, they operate poorly in unstable winds or uncertain directions. On the other hand Savonius wind turbine which is classified among the VAWT have a simple construction operate independently of the direction of the wind and starts at low wind speed it was developed and patented by S.J. Savonius in the 1920s according to savonius the best of his rotors had a maximum efficiency of 31% while the maximum efficiency of the prototype was 37% [1].

* Corresponding author. Tel.: +6-064-477-23.
E-mail address: zemamou.mounia@gmail.com

Peer-review under responsibility of the scientific committee of the 4th International Conference on Power and Energy Systems Engineering.
10.1016/j.egypro.2017.11.047

Despite its various qualities savonius turbine suffer from a major drawback of low efficiency, over the years, extensive studies experimental, theoretical or numerical have been reported to identify a new design and they have proved a deep improvement at the level of power coefficient compared to conventional Savonius rotors [2],which have range values of power coefficient between 0.1 and 0.25[3].

Nomenclature

ρ	density of air (= 1.225 kg/m^3)
S	swept area of blades (m²)
V	wind speed (m/s)
P_T	maximum power obtained from the wind (watt)
P_A	total power available from the wind (watt)
C_p	coefficient of power
ω	angular velocity of rotor (1/s)
E	overlap ratio e/D
T	actual torque develop by the rotor (N.m)
T_w	theoretical torque available in the wind (N.m)
H	rotor height (m)
AR	aspect ratio H/D
C_m	torque coefficient
R	radius of rotor (m)
λ	tip speed ratio
D	rotor diameter (m)
θ	rotor blade angle(degree)

2. Working principle:

The Savonius wind turbine is a simple vertical axis device having a shape of half-cylindrical parts attached to the opposite sides of a vertical shaft (for two-bladed arrangement) and operate on the drag force, so it can't rotate faster than the wind speed. This means that the tip speed ratio is equal to 1 or smaller [4].As the wind blows into the structure and comes into contact with the opposite faced surfaces (one convex and other concave), two different forces (drag and lift) are exerted on those two surfaces. The basic principle is based on the difference of the drag force between the convex and the concave parts of the rotor blades when they rotate around a vertical shaft. Thus, drag force is the main driving force of the savonius rotor [5]. Fig.1.(a) shows characteristic parameters of a savonius wind turbine with two semi circular profile blades.

(a) (b)

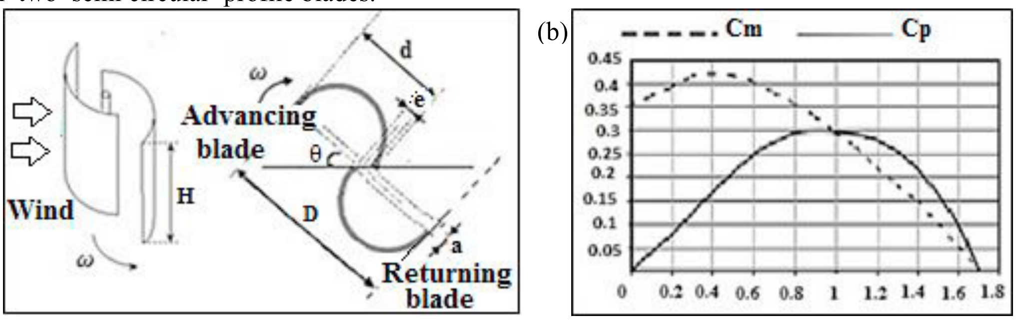

Figure.1. (a) two-bladed Savonius rotor, (b) Conventional Savonius rotor performance [6]

Butaud and Besnard have highlighted the concept of drag wind turbine for Savonius turbine. The dynamic analysis of its operation shows the influence of lift force. The Savonius can't really be classified into one or the other of these categories. Its efficiency at starting is in fact mainly due to drag force, but its maintenance in rotation is mainly due to the force of lift[7].

3. Performance of Savonius turbine

The performance of Savonius wind turbine can be expressed in the form of coefficient of power C_p Eq.(4) and torque coefficient C_m Eq.(5) in comparison with the tip speed ratio (TSR) λ Eq.(1). TSR is a ratio between the speed of tip blade and wind speed through the blade obtained by Eq.(1)[8].

$$\lambda = \frac{V_{rotor}}{V} = \frac{\omega R}{V} \quad (1)$$