**IARJSET** ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

State Level Conference – AITCON 2K24

Adarsh Institute of Technology & Research Centre, Vita, Maharashtra

Vol. 11, Special Issue 1, March 2024

# Development of Wind Energy Water Pump: A Review

**Karan B. Pawar[1], Raj M. Gavali[2], Ajay A. Thoravat[3], Sourabh R. Nikam[4], Vishnupanth J. Sargar[5]**

Student, Mechanical Engineering (poly.), AITRC Vita, India[1-4]

Lecturer, Mechanical Engineering (poly.), AITRC Vita, India[5]

**Abstract**: Wind energy water pumps involve converting the kinetic energy of wind into either mechanical or electrical energy to operate water pumps. These pumps draw water from sources such as wells or reservoirs. The beauty lies in their flexibility, scalability, and eco-friendliness, making them suitable for diverse applications. From agricultural irrigation to industrial water supply, wind-powered water pumps offer an efficient and environmentally conscious solution.

In this paper, we explore the development of a windmill-driven water pump and its integration into a small-scale irrigation system. This innovative project combines mechanical engineering principles with sustainable development, particularly relevant for rural areas in developing countries.

**Keywords:** natural resources, renewable energy, wind pumps.

## I. INTRODUCTION

The pumps used by farmers are generally fuelled by gasoline and diesel (conventional energy) [1]. Conventional energy is currently diminishing, scarcity often occurs, and the price is high. High fuel prices make it difficult for farmers because it causes high production costs. Thus, farmers need the right technological solutions to reduce production costs. Appropriate technologies such as wind power pumps, hydropower pumps, and solar power pumps are types of pumps that do not require engines and fuel [2]. The wind is a non-conventional energy source.

The purpose of this study is to produce a prototype of a simple water pump using a TSAV (vertical axis wind turbine) wind turbine as a prime mover and to analyze the relationship between wind speed and wind speed with a dependent variable in the form of water discharge from the pump.

Our endeavor revolves around a simple yet ingenious concept: wind-powered water pumping**.** Picture a windmill standing tall, its blades slicing through the air. As the wind whispers secrets, the windmill transforms its energy into a rhythmic dance—a dance that lifts water from wells, rivers, or reservoirs.

### 1. Historical Context:

- Wind power technology has a rich history dating back centuries. Ancient Egyptians are believed to have used wind machines to harness its energy.
- By the late 17th century, the iconic “European Windmill” became commonplace, and further developments occurred during the 18th century.
- Major advancements in wind pump design took place in the USA, where millions of wind pumps were in use by the 1920s.

### 2. Water as a Vital Resource:

- Water is fundamental for human life and rural development. Access to potable water remains a challenge in many rural areas.
- Mechanized water pumping systems are essential for lifting water from the ground, especially in regions lacking reliable access to other water sources.

### 3. How Wind Turbine Water Pumps Work:

  

Windmills with horizontal axis rotors (typically 3–5.5 meters in diameter) are common.

- These windmills feature 12–24 blades mounted atop 10–20 meter high mild steel towers.
- The rotor connects to a reciprocating pump (50–150 mm in diameter) via a connecting rod.
- As wind speed reaches 8–10 kilometers per hour, the windmill starts lifting water

**4. Economic Feasibility:**

- Economic comparisons favor windmill water pumping systems over diesel-based alternatives.
- Windmills harness renewable wind energy, preserving the environment and providing a sustainable solution.

## II. PURPOSE AND OBJECTIVES

The primary goal is to design and construct a windmill-driven water pump capable of drawing water from a nearby source (such as a well) and transferring it to a storage tank. Here are the key objectives:

1. **Windmill-Driven Pump**: The windmill will harness wind energy to drive a water pump, lifting water from the source to the storage tank.
2. **Demonstration**: The project aims to demonstrate the feasibility of wind-powered water pumping techniques to local farmers.
3. **Irrigation System**: The water stored in the tank can be used for **irrigation** purposes, showcasing small-scale irrigation methods.

**Why Wind Energy?**

- **Abundant and Renewable**: Wind energy is an abundant and renewable resource, making it an ideal choice for remote locations where power supply infrastructure is limited.
- **Cost-Effective**: Windmills offer a cost-effective solution for conveying water without the need for extensive transmission lines.
- **Environmental Benefits**: Utilizing wind power reduces reliance on fossil fuels, contributing to cleaner air and a healthier environment.
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## III. MATERIAL SELECTION

Material selection plays very important role for design and fabrication of any prototype. Material selected should have optimum and reliable properties as per requirement of variable environmental condition. Commercially many material with high strength and rigidity are available in the market.

**Commonly used material in wind turbine blade:** From the past time wood was primarily used for making wind turbine blade. Wood has high rigidity but is possess low stiffness, so it has limitation of bending. Due to this region it lost its potential for manufacturing of wind turbine blade with advancement of technology related to wind turbine. With the further research alloy steel was preferred for manufacturing wind turbine blades, but it is excessive weight brought various problem for turbine assembly. Moreover it has low fatigue resistance and high cost another material which proved to be useful for manufacturing wind turbine blade was polymer matrix composite and is used still today. Composite are proving good material for manufacturing the turbine blades but they are suffering in mechanical properties due to limitation of resin transfer.

**FEW MATERIALS USED IN WIND TURBINE BLADES DUE TO THEIR SPECIFIC CHARACTERISTICS:**

**Polyester resin** - Polyester Resin is most commonly used material in industry. This material is most preferred for manufacturing turbine blade as it shows better water resistance ability, its mechanical properties could be improved with the help of suitable catalyst accelerator and additives. Polyester is chemically resistant but sometimes become brittle where certain shock load is applied. When turbine blade reaches to certain level while rotation well before its ultimate strength cracks start to appear.

Thus it is poor to handle high fatigue stresses, due to these small cracks water, moisture is well able to penetrate or adsorbed in the material decreasing its mechanical strength.

**Epoxy resin** - Epoxy resin is another most wide and suitable material for manufacturing turbine blades. It possess superior properties in terms of load carrying ability, resistance to environment degradation highly adhesiveness, and tensile strength of 85Mpa and Young's modulus of 10.5Gpa. It causes low viscosity and low shrinkage capacity thus maintaining good dimensional tolerances.

**Vinyl easter resin** - This resin had good chemical structure due to which it shows improved shock loading capacity. It has high stiffness, rigidity, water and chemical resistance, inspired operate good physical and mechanical properties. It is less popular as found to be having adverse effect of human health.

**Thermoplastic** - Matrix here is having good fatigue strength abrasion but, it has problem of disposal techniques which include in land fill, recycling, incineration etc.

**Aramid fiber** - It is also material which possess the properties suitable for manufacturing of turbine blade. It has a high specific strength and available in the bright golden filament. In spite of its such accident properties t is susceptible to water in grace, ultra violet ray erosion, sand erosion, insect collision due to this limitation its impact in manufacturing of wind turbine blades is decreases.

**Carbon fiber** - It is one of the material which has proved to be most suitable material from the manufacturing point of view in every application in the developed world. Carbon fiber available in three different categories high strength, intermediate module, ultra-high module. It has highest strength in tension and compression can possess very high resistance to fatigue, creep and corrosion. In spite of this most suitable optimum and reliable properties it proves to be less feasible due to its high cost.

## IV. PERFORMANCE PARAMETER

**Power available in wind**

$$P = \frac{1}{2} pAv^3$$

Where, P = Power available in wind

p = Air density in $kg/m^3$

r = Radius of blade in m

A = Cross sectional area of blade in $m^2$

**Torque**

$$T = p/\omega$$

Where, T = Torque of shaft in Nm

P = Power available in wind in Watts

$\omega$ = Angular velocity in rad/sec

**Efficiency**

$$\eta = pt/pw$$

$\eta$= Efficiency

  

Pt = Power in turbine in Watts

Pw = Power in wind in Watts

**COMPONENTS OF THE SYSTEM**

1. **Windmill**: The heart of the system, the windmill converts wind energy into rotational motion.
2. **Water Pump**: The pump lifts water from the well and transfers it to the storage tank.
3. **Storage Tank**: Stores water for future use in irrigation.
4. **Irrigation System**: Designed to efficiently distribute water to crops.

**BENEFITS AND APPLICATIONS**

- **Farmers**: Local farmers can adopt this cost-effective technique for water supply and irrigation.
- **Sustainable Development**: The project aligns with sustainable development goals by promoting renewable energy and efficient water management.

## V. CONCLUSION

1. **Success of the Windmill-Driven Pump**: Our windmill-driven water pump proved its mettle. It efficiently drew water from the well, defying gravity with each rotation of its blades. The rhythmic creaking of the windmill became a reassuring melody, echoing resilience and innovation.
2. **Community Impact**: As we integrated our system into the local community, we witnessed its transformative impact. Farmers, once reliant on manual labor and erratic water sources, now had a consistent supply for their crops. The verdant fields stood as a testament to progress.
3. **Challenges Overcome**: Our journey wasn't without challenges. We fine-tuned the windmill's design, optimized blade angles, and battled maintenance woes during monsoons. But each obstacle fueled our determination to create a reliable solution.
4. **Educational Outreach**: We organized workshops and demonstrations, inviting curious minds—children, elders, and everyone in between. Their eyes widened as they watched the windmill spin, realizing that nature's force could be harnessed for their benefit.
5. **Sustainability**: Our wind-powered water pump exemplified sustainability. It danced with the wind, whispering promises of a greener future. We hope this project inspires similar initiatives worldwide.

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