Effective Method of Prolonging the Life of Wind Blades in Wind Mills

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Abstract—Considering today the demand of power is more than the production. Sources which are non renewable are dwindling nowadays. Among the renewable sources wind takes a fresh part. So many entrepreneurs are coming forward to erect wind mill all over the world. Since they are larger in number there is no protective measures taken yet. They can get damage during winter season by the lightning or by other calamities. This can damage the blades of windmill. So in this paper I have discussed about the new methodologies to protect wind blades from lightning by attaching a safe receptor in turbine blades and by using two ring electrodes, Insulated Lightning Protection System (ILPS) compatible with IEC 61400-24, which is the International Standards for Lightning protection of blades.

Index Terms—dwindling, calamities, safe-receptors

I. INTRODUCTION

In recent years the establishment of wind farms is increasing. At the same time there occurs severe economical loss due to damage of wind blades by natural calamities. In summer there is no need to take much protective measures for the blades but in winter protective measures more than expected should be taken. There requires huge man power and machine power to replace the damaged blades. Since there are lightning conductors to protect the blades they are not as much effective.

II. EXISTING METHODOLOGY

Considering the types of wind mills, they are from 230KV (basic) to about 4MW each. The height of wind mill depends upon capacity of the wind mill. For example a 230KV windmill has a height of about 28.9m, whereas a 440KV windmill has a height of around 31.5m. Thus the chance of getting damage is more for the higher one. In low capacity windmills, the blades are just combined by a strong adhesive, there exist gap inside the blades. When the lightning strikes the blade a part may enter into the cavity and damages the blades. Keeping this mind, for high capacity windmills a metal rope is inserted inside the blades and they are connected with the earth. When the lightning strikes the blade it travels via the metal rope and reach the earth bottom.

![Existing wind blade.](image)

III. GROUNDING

Clouds are negatively charged particles whereas our metal receptors contain both positive and negatively charged particles. When the cloud crosses the receptor negative particles are repelled towards the earth wire whereas the positive charges ionize with the atmospheric air, then the negatively charged cloud and positive charged air gets neutralized and reduces the charge of the cloud. The earth wire is buried deep inside the earth and thus the windmill is protected.

The earth wire coming from the blades to the ground is kept separated or they were attached to the body of the tower itself. The current flow inside the tower may create a large inductive current in low voltage circuits like control panel. Thus these circuits may get affected owing to lightning.

Even though there are metal ropes present inside the blades they are not as much effective. Still now there occurs damage. Windmills that are erected in off shore meets a lot of damages due to periodic bad weather conditions.

Manuscript received March 13, 2013; revised June 21, 2013.
IV. NEW METHODOLOGY

Keeping in mind, the damages occurred and the wastage of money in replacing the blades new methods were implemented and analyzed to protect the wind turbine and blades. One method by using two ring type electrodes and another one by using copper receptor. For the blades, the chance of getting damaged is less in such type of protection.

A. Ring Method:

Ring method contains two ring type electrodes of certain diameter. One electrode is placed on the nose of the windmill and another one is kept at the neck of the windmill tower. The gap between these two electrodes should be 1 meter. The bottom electrode is connected with ground through low resistance wire. Now when the lightning strikes the blade; it reaches the upper ring electrode via the metal receptor present inside the blade. Now the electric field difference between the two electrodes will become high and therefore spark occurs. Thus the produced large current will reach the ring present in the neck of the tower. Then the transient current will flow to the earth through the ground wire. Here a main thing to be noted is the ground wire is kept outside the tower so that it can’t damage the low voltage circuits present inside the tower.

B. By Copper Receptors:

In this method we use a copper round shaped receptor at the top of the blades. And from the receptor a metal rope is attached and grounded. Since the windmill is in rotation there are three possibilities of striking of lightning striking

- In vertical
- In oblique position (45 deg)
- In horizontal

The experimental results are,

1) In vertical:
   If the lightning strikes the blade while in vertical position, it reaches the receptor directly via air or it reaches the receptor by traveling via the edges of the blade and the high electric current is grounded through the metal rope.

2) In oblique (45 deg):
   If the lightning strikes the blade in oblique position, the discharge (lightning) will travel through the surface of the blade and reaches the receptor safely.

3) In horizontal:
   If the lightning strikes the blade while in horizontal position, there are two things to be noted. If positive charge in the discharge dominates then there may be a chance of causing damage to the blade. If negative charge in the discharge dominates then it is directly attracted towards the copper receptor. So to protect the blade from positive discharge a negative impulse voltage is given additionally to the metal conductor, so that all the positive charges will be easily attracted and thus reducing the high electric charge.

If these both techniques are merged and then implemented in a windmill means, definitely there is a chance of 99% of protecting the blades.

V. DATA ANALYSIS

By analyzing the data for copper receptor protection method it is found that

- Copper receptor has long life.
- Copper receptor can adopt to temperature range of -40deg to 105deg
- It has a dielectric strength of 20KV/mm
- The copper wires weave from centre to edge
- Weaving minimizes “skin effect”
- Increased cable diameter reduces the inductive losses.

Skin effect means the flow of current on the surface of the conductor is more than the current flow inside the conductor.

By analyzing the data for ring method it is found that

- Since the ground wire is outside the tower, the low voltage circuit inside the tower can be easily protected.
- This method is a cheap one.
- Easy to implement with in short span of time.
- Since the ring electrodes are directly kept outside the tower and nacelle, there may occurs corrosion from atmospheric air.

Due to application of the above both techniques in a windmill the efficiency of the windmill won’t gets affected. The windmill will generate its rated power according to its manufacturing rate. In India, Suzlon Company has its 2.25MW windmill at Tamilnadu with copper receptors at its blades. The characteristics of the windmill is given in Table I.
TABLE I. CHARACTERISTICS OF WIND MILL

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated power</td>
<td>2.25MW</td>
</tr>
<tr>
<td>Cut-in wind speed</td>
<td>4m/s</td>
</tr>
<tr>
<td>Cut-off wind speed</td>
<td>25m/s</td>
</tr>
<tr>
<td>RPM</td>
<td>12-18rpm</td>
</tr>
</tbody>
</table>

VI. CONCLUSION

Various companies are coming forward to put all of their assets in emerging wind energy. So, protective measures are very important. Today the capacity of each windmill is increasing day to day, so corresponding measures should be taken to make it function properly for a long time. The above mentioned methods are very effective in protecting the windmill blades, since it is the most vulnerable part. Students of these generations should get involve in doing innovative projects based on clean wind energy. Whatever the growth may be the cooperation of people in conserving the electric power is must for a green future.

REFERENCES


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