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Wind Energy Application in Indian Antarctic Station, Maitri, Antarctica

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Abstract

Wind Energy Division of NAL has been experimenting with designs of wind mill suitable for Installation at Indian Antarctic Base, Maitri. Antarctica with its extreme climatic conditions has made this task difficult as it has been found that yawing effect associated with gusty winds cause machine failure. This was also found true for the new prototype Savonius type vertical axis windmill introduced to charge batteries during 20th Indian Antarctic Expeditions. It was observed that the bearing design safety factors considered were not sufficient for use in Antarctica.

Introduction

Wind Energy Division, National Aerospace laboratories initiated Wind energy related studies during XVI Indian Scientific Antarctic Expedition. Main objective of the programme was to determine wind energy potential around the Maitri station, utilization of wind energy for Indian Station Maitri and to provide support for field experiments.

Wind Energy Activities at Indian Antarctic Station

There is considerable potential for the application of wind power at the Indian Antarctic station site; particularly given the need for environmentally sound, locally produced power. But experience shows that very few machines can survive the severe Antarctic conditions. The failure of the past has slightly hampered its use in Antarctica. But a systematic analysis on causes of failure has enabled NAL to make modifications that it believes will withstand the Antarctic adverse climatic conditions. Based on the studies and analysis carried out by NAL in previous expeditions a detailed proposal on utilization of wind energy at the Indian Antarctic base was prepared. Antarctica being the windiest continent it was observed that

the potential to use wind energy at Maitri and field camps were very good. The proposal looked at near term and long-term prospects for utilization of Wind energy. In near term it was essential to create an awareness of usefulness of Wind Energy hardware, particularly amoung scientific and logistic group. Under long-term prospects, it has been suggested that the station heating loads be met, with energy from wind power.

During XVII expedition two machines imported were installed & commissioned. In few months machine failed due to main bearing and Yawing Mechanism failure. Based on the experiences made it was found that one of the causes for the failure was the excessive hunting which was equivalent to gyroscopic movement related failures. This problem was addressed by incorporating a yaw bearing damping device. This arrangement reduced hunting considerably which has made the machines sturdier. The new machines introduced in Antarctica were replete with these modifications.

XX Expedition

During XX Indian Scientific Antarctic Expedition, Wind Energy Division of National Aerospace Laboratories successfully completed following tasks. This could be a step forward to gradually increase the utilization of Wind energy at the Indian Base.

1. Installation of portable Windmill on top of the mobile laboratory Sankalp to provide power supply to the instruments in field camps through the battery.
2. Installation commissioning and testing of indigenously Developed vertical Axis Windmill for remote area application, study the performance and survival.
3. Maintenance of existing windmills at communication repeater station in Vittiah peak and at station workshop.
4. Energy Audit in Maitri station.

Installation of Portable Windmill on Sankalp

A portable wind battery charger was experimented in this expedition to gain operational experience and study the applicability of wind power in remote field camps. The idea is to charge 12 V batteries, which would be used for energising communication systems, and provide stand by power for instruments used in measurements.

In Antarctica, communication between Maitri station and remote field camps is carried out by VHF communication. 12V Batteries are used to

supply electric power to the VHF Repeaters using for communication. Due to very low temperatures (-5 to 25°C), the batteries have excessive self-discharging in open camps in Antarctica. During blizzards and other critical periods when communication is very important, discharged batteries would cause difficulties for logistic and other groups.

In XX Expedition, Survey of India (SOI) proposed to setup Field camp near Trishul hills. Field camps exceedingly depend on portable generator for Power Supply and to run their equipments. Generally running and maintaining a generator at the field camp is not very easy.

It was proposed provide battery charging power to the SOI field camp team by installing portable battery charging windmill on the top of the Sankalp container experimentally. After visiting the camp site NAL team designed and fabricated the mounting arrangements to install windmill on the Sankalp container. The main structure of Snaklp was left undisturbed. The Workshop at Maitri was used to fabricate a mount for Sankalp. The Machine was successfully installed and it supplied power for charging batteries inside the container for the entire duration of the camp. Users were trained to operate and maintain the wind battery charger. Fig. (1) Shows the windmill installed on Sankalp container.

Fig.l: Portable wind battery charger top of the Sankalp.

Installation & Testing of Indigenously Developed Vertical Axis Windmill for Remote Area Application

In general, commercially available Windmills are designed for normal atmospheric load conditions. These machines work well under moderate wind conditions in tropical and semi tropical environment. The Antarctic atmospheric conditions are entirely different from rest of temperate world. The Climatic conditions prevailing in Antarctica are extreme, such as wind gusts reaching up to 150 knots and temperatures hovering around -30 for an extended period during Antarctic winter. Commercially available Windmills can not sustain these conditions for too long. Keeping this in view, National Aerospace laboratories, Wind Energy division developed a Windmill for charging batteries for use in remote areas of Antarctica. This machine was tested in laboratory under known conditions. It was able supply rated output at 15 m/s wind speed and cut in at speeds as low as 3 m/s.

The Fig. 2 shows the prototype of Savonius type vertical axis windmill battery charger designed for Antarctica, installed at Maitri Station, in front of the Nandadevi summer hut.

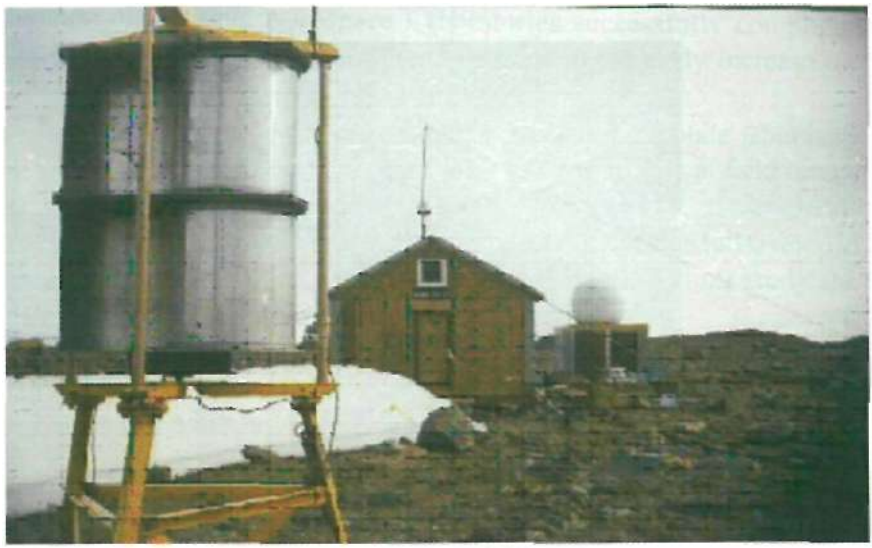

Fig.2: NAL's Savonius wind battery charger at Maitri.

Data logging instruments were installed and data was collected. Performance Parameters monitored were average wind speed, standard deviation; maximum and minimum wind gust were collected on a per

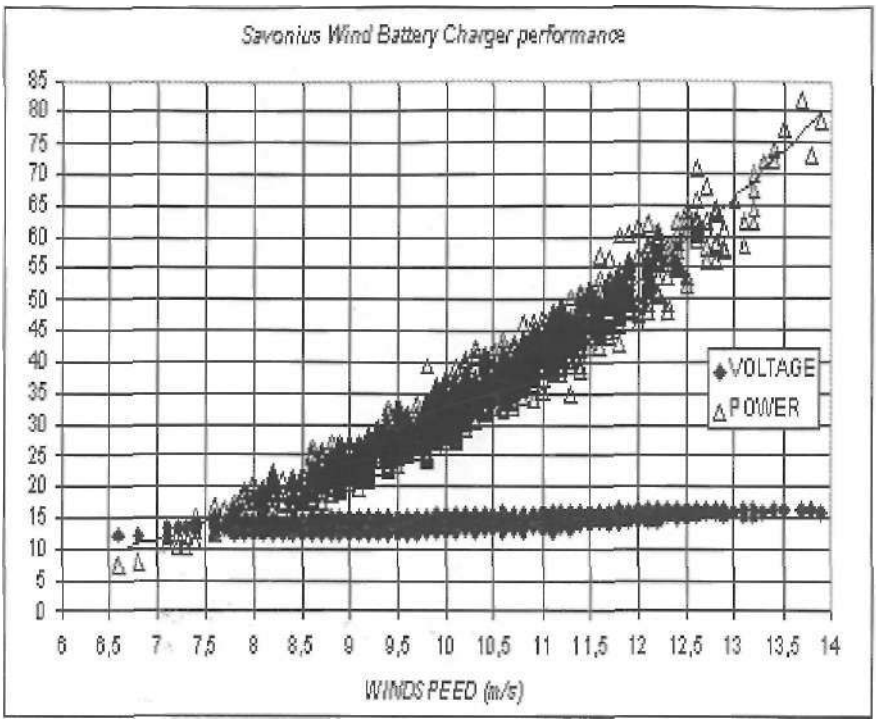

Fig. 3: Performance ofSavonius wind battery Charger.

minute basis. Machine output parameters like generated voltage, current and the RPM were collected in the same real time.

The machine worked satisfactorily for more than six weeks and survived a moderate blizzard too. However bearing related problems cropped in due to highly gusty wind conditions. It was observed that the bearing design safety factors considered were not sufficient for use in Antarctica. This was an important finding and was to be incorporated in future machine design.

Maintenance of Existing Windmill in Maitri

The Battery charger installed at Vettaiah peak was serviced. Scientist from DEAL was trained to operate and maintain the wind powered battery charger. The old machine installed during XVII expedition was dismantled because of transformer burnout. After completion of SOI fieldwork, the battery charger was moved to automotive workshop for charging of batteries during the winter.

Fig. 4: Servicing wind battery charger at communication repeater station at Vettaiah peak

Conclusions

The fierce Antarctic climatic conditions, with strong, gusty winds and freezing temperatures, place enormous stresses on wind mill turbines and cause frequent mechanical failures. The logistics of installing efficient turbines pose significant challenges. It will be worthwhile to make a concentrated effort to install effective Windmill that will survive Antarctic conditions to generate power without causing environmental damage. Besides this it will cheap also reducing the great burden of transporting fossil fuel to Antarctica.