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Analysis of Karaikal winds with special reference to installation of windmills

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सार — उर्जा संकट को देखते हुए विश्व के लिए यह आवश्यक हो गया है कि तेल व ईंधन के अलावा ऊर्जा के विभिन्न स्रोतों पर विचार करें। भारत जैसे विकासशील देश में जहां तेल की खपत प्रतिवर्ष बढ़ती चली जा रही है, यह महसूस किया जा रहा है कि विशेषत: उन स्थानों पर जहां दीर्घावधि तक प्रबल पवन चलती है, पवनचक्की शक्ति का एक वैकल्पिक एवं सस्ता स्रोत हो सकता है। पवन चक्कियों के अभिकल्पन और उन्हें लगाने के लिए स्थान का चुनाव करने में अच्छी योजना की आवश्यकता होती है। इस दृष्टि से कड़ाईकल की पृष्ठीय पवनों के आंकड़ों का विश्लेषण किया गया है। शोधपत्र में 1975 से 1979 तक की पांच वर्ष की अवधि में कड़ाईकल में लगे कप टाइप पवन वेगमापी से 3-3 घंटे पर लिए गए आंकड़ों की बारम्बारता का विश्लेषण किया गया है। तीन-तीन घंटे पर लिए गए पवन के मानों की बारंबारता के बंटन को चार अंतरालों में बांटा गया है, अर्थात् 0–9 कि॰ मी॰ प्र॰ घं॰ और इससे ऊपर। साथ ही महीनेवार बारंबारता बंटन भी प्रस्तुत किया गया है।

ABSTRACT. Due to energy crisis it has become a necessity for the world to think of different sources of energy besides oil as fuel. In a developing country like India where oil bill is increasing every year, it is felt that, an alternate and cheap source of power would be from windmill, particularly at places where winds are strong for long periods. Proper planning for selection of site and design of windmills is essential. It is with this view that the surface wind data at Karaikal was analysed. In this paper, a frequency analysis of three hourly values of winds recorded by cup type anemometer at Karaikal during the five year period 1975-1979 is made. The frequency distribution of three hourly values of winds in four ranges, *viz.*, 0-9 kmph, 10-15 kmph, 16-19 kmph and 20 kmph and above has been determined. Monthwise frequency distribution is also presented.

1. Introduction

The main source of fuel for power is oil. Either due to fear of possible exhaustion of oil resources from oilfields or due to ever increasing oil prices in the world market, many of the advanced as well as developing countries are now focussing their attention to find out different other sources of power. Atomic power and solar power are being utilised and a lot of attention is paid to develop their technology. But the cheapest being wind power, which is a form of solar power, some of the advanced countries like USSR and USA have already started utilising energy from windmills which can deliver power easily upto 20-30 kw. In France windmills are available for three different ranges of wind speeds (*i*) Areas of light winds, (*ii*) Areas of moderate winds and (*iii*) Areas of strong winds.

The wind power in kilowatt (P) is represented in the formula below :

$$P = 2.14\ \psi\ AV^3 \times 10^{-3}$$

Where, P = Wind power in kilowatt

ψ = Air density in slugs per cubic feet.

("Slug" is a unit of mass and 1 slug = that mass to which a force of 1 lb will impart an acceleration of 1 ft sec^{-2})

A = Projected area swept by the turbine.

W = Wind velocity in miles per hour.

It is seen from the formula that power is directly proportional to the third power of wind velocity. Hence wind velocity is an important factor for wind power. So strong wind is a very advantageous factor. At Karaikal during south-west monsoon period winds are very strong.

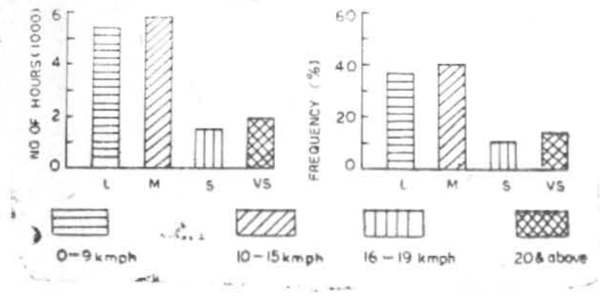

Fig. 1 Fig. 2

Windmills can easily be installed in the vast areas available in the coastal regions of Tamil Nadu and Pondicherry. The power developed by windmills can be made use of for running agricultural pumpsets particularly during southwest monsoon months when wind is very strong during this period. Coastal belt of Tamil Nadu and Pondicherry gets inadequate rainfall during this season and pumpsets using electricity are invariably used to pump water out of wells. Sowing operation during this pesriod frequently gets affected due to long periods of power shut down. Power from windmills during these periods will be helpful to the farmers in operating their pumpsets. Power from windmills can also be utilised for domestic use, such as running of rice mills, flour mills etc.

Before installing a windmill, proper planning is necessary to run it with optimum efficiency. For this purpose the wind data of the locality has to be analysed to decide the right type of windmill to be installed in that locality. In order to study the strength of winds at Karaikal, the author has divided winds at Karaikal into four ranges of windspeeds, *viz.*, 0-9 kmph, 10-15 kmph, 16-19 kmph and 20 kmph and above.

Cup type anemometer is used recording windspeed at Karaikal and it is installed at a height of about 10 metres above ground level. This hieght may approximately correspond to the height of the roters of the windmills. In case the height of the roter differs appreciably from the height of the anemometer, correction can be applied using the logrithamic relationship given below :

$$\frac{\bar{U}}{u} = \frac{1}{k} \frac{(u^*z + N)}{(N + r/9)}$$

Where,

$\bar{U}$ = Wind velocity at height z

u^* = Friction velocity

$k = 0.4$

TABLE 1

Frequency distribution of winds

(Period; 5 years 1975-1979)

Month	L 0-9 kmph	M 10-15 kmph	S 16-19 kmph	VS 20 kmph and above
January	529	553	99	59
February	499	500	66	34
March	770	426	34	10
April	524	517	96	63
May	245	462	186	345
June	157	382	191	470
July	267	470	199	303
August	246	536	206	251
September	440	534	131	84
October	681	448	57	54
November	593	399	94	113
December	365	571	159	145
Total	5316	5798	1518	1931
Percentage	36.5	39.8	10.4	13.3

$N = u^*z$ (Macro viscosity)

r = Kinematic viscosity

For smooth surface $N = 0 \neq u^*z$

2. Procedure

Wind data of the cup type anemometer is used in the present analysis. Cup type anemometer is located at the top of RS/RW building at Karaikal. The cups are fixed at a height of 10.3 metres above ground level. At Karaikal three hourly observations are recorded from cup type anemometer. These three hourly observations numbering eight in 24 hours are used for the analysis. Each observation is a 3 minute average wind speed. The data for a period of 5 years, *viz.*, 1975-1979 is analysed and tabulated.

The strength of winds has been divided into four groups. The first group is light winds of speed between 0-9 kmph denoted by symbol L, the second group is moderate winds of speed 10-15 kmph denoted by symbol M, the third group is strong winds of speed 16-19 kmph denoted by symbol S and the fourth group is very strong winds of speed 20 kmph and above denoted by VS. In the case of light winds (L) windmills may not be operative. However, windmills will be operative for the remaining three groups of winds M, S and VS. The reason for dividing the frequencies of occurrence of winds into three groups M, S and VS is to decide the type and sturdiness of the windmills to be employed and also to decide upon the uses to which the wind power derived could be put.

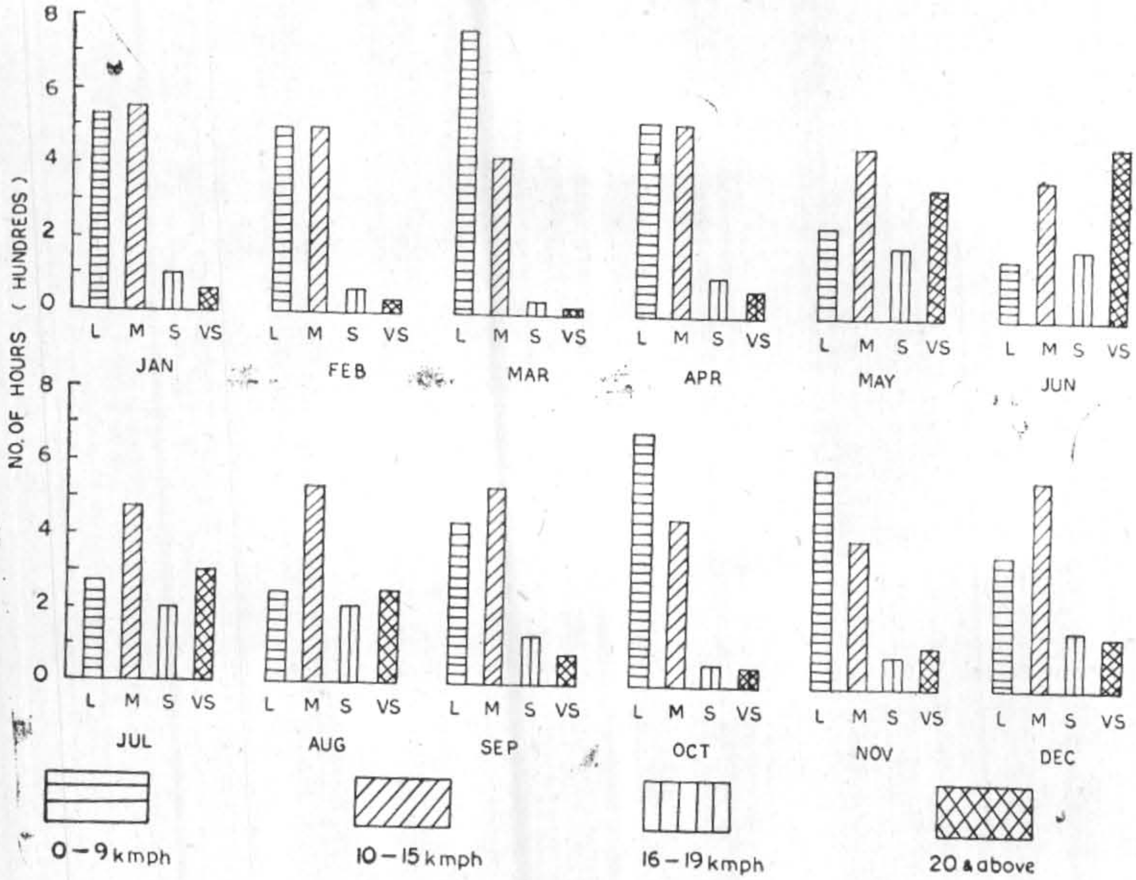

Fig.3

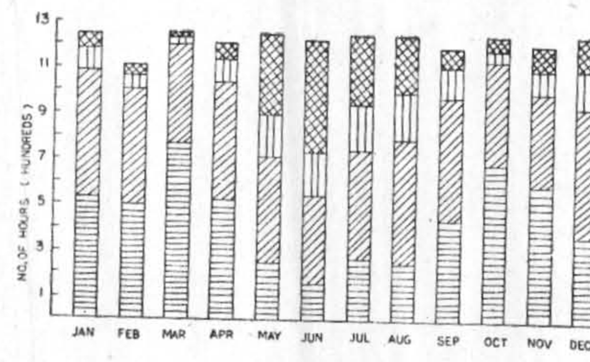

Fig. 4. Histogram

The number of observations for all the five years falling into each of the four groups L, M, S and VS were tabulated for each month. Thus the frequency of occurrence in each group were tabulated for all the months. Frequency of occurrence for five years prepared and tabulated monthwise is shown in Table 1. This data is used for various kinds of analysis.

3. Conclusion

In the first type of wind analysis the number of three hourly observations for the entire period of five years falling into each of the four different groups L,M,S and VS were added up. Frequency of occurrence of winds falling into the four groups L,M,S and VS for five years are graphically represented in Fig. 1. The percentage frequency of occurrence falling into the four groups L,M,S and VS are also shown graphically in Fig. 2. Out of the total number of 14,563 observations, the frequency of occurrence of light winds is 5316, the frequency of occurrence of moderate winds is 5798, the frequency of occurrence of strong winds is 1518 and the frequency of occurrence of very strong winds is 1931 (only for three observations during the five years period data is not available). In terms of percentage frequencies, the frequency of occurrence of light winds is 36.5%, the frequency of occurrence of moderate winds is 39.8%, the frequency of occurrence of strong winds is 10.4% and frequency of occurrence of very strong winds is 13.3%. From Figs. 1 and 2 it is seen that there are more than sixty per cent of occasions when winds are moderate, strong and very strong. During this period windmills can be made effectively operative. Light winds are only 36.5% of the total winds. This means that windmills can be really inoperative only for short duration considering the fact that light winds prevail more often in night time than day time.

In the second type of analysis the number of occurrence of winds falling in each of the four groups L, M, S and VS are added up monthwise for the entire period of five years. The monthwise frequency distribution is graphically represented in Fig. 3. Wind histograms for the period of five years are also shown monthwise in Fig. 4. It is seen from Figs. 3 and 4 that March is the least favourable month to operate windmills. May, June, July and August are the most favourable months for putting the windmills into optimum use. In the coastal areas of Tamil Nadu and Pondicherry the sowing season commences from June and ends in August. During this period there is plenty of wind power available to operate agricultural pumpsets. Further May is the month when power shut downs are frequent and prolonged. Therefore windmills can be effectively put into use from May to August in this region. This analysis may be helpful in planning and executing projects using wind power for different seasons of the year.

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