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THE CHINESE TRADITIONAL METHODS FOR ENERGY SAVING AND THEIR APPLICATIONS IN MODER STRUCTURES

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ABSTRACT

Energy saving is a very important subject for research workers nowadays. While most people are concerning with the modern methods, the author investigated this problem from another angle -- the chinese traditional methods for energy saving. The tunnel wind technique and its combination with computer simulation and fuzzy comprehensive judgement methods are discussed. Earth heat green house, marsh gas, solar energy underground storage system, storing of nature cold sources, have been introduced in this paper.

INTRODUCTION

China is a large country with a huge population, what happened in china has great effect to the other part of the world. While its economic is growing rapidly, it has the increasing requirement to the energy supply. It will be a great pressure to the world if this requirement increasing as quick as its economical growing speed. To investigate the energy problems in China and to tap its energy potentialities, therefore, will be an important project. At present, most of the researchers devote themselves to the study of new and high technical methods for energy saving, and the traditional methods are left out in the cold. The author think that it is necessary to do the investigation from the other way, to investigate the traditional methods of energy saving, and try to combine the new techniques to them in order to increasing their efficiency. This could very important to China and other developing countries.

THE COMBINATION OF TUNNEL WIND AND NEW TECHNOLOGY

The author has devoted in the research of "tunnel wind" for some years. In south China, the summer season is long and hot, funs and air conditions are widely used to reduce the temperature, and consumption a lot of energy. The tunnel technique is a traditional method used China as a cooling technique. For some historical reasons, there are great amount of tunnels under the buildings in many cities in China. The air in these tunnels are much cooler than the air on the ground in summer. It can be used as the source of the cool air and be transferred to where need it. This is called "tunnel wind" technique.

Our experiments were undertaken in a modern research base - a 80 cube meters green house of the "seedling nursing factory for biological engineering". In summer, the maximum temperature in this green house could reach 42 degree and is much higher than the required temperature of approximate 27 degree. In order to solve this problem, a cooling system was required. Two schemes were carried out for comparison. One was using an air condition to control the temperature. another was using the "tunnel wind" technique. There was a 1000 meters long tunnel 20 meters away from the green house. It was used as the source of cool air. The installation is shown in Fig.1. Computer simulation technique was introduced to optimize the parameters in order to derive the best combination, and therefore, gain the maximum benefit by minimum investment.

Computer was used to control the switch of the blower to transform the tunnel wind into the green house. The experimental processes are as follow:

1. The determination of the most suitable blower, and the optimum working point.

The selection of the blower is very important. If the blower is too small, the blow rate and blow pressure input to the green house will be not enough, and the cooling effect will be poor. On the contrary, if the blower is too big, the investment will increase and also influence the stability of the temperature in the green house. The blower was selected using the blow rate which was calculated from the maximum cold load of green house derived from the simulation of recent years, and then examined according to the blow pressure.

The determination of the optimum working state of the blower: the blow speed of the blower is adjustable, change the blow speed, the blow rate and pressure will be changed(it was shown in table 1), and the pressure loss in the transfer tube will be influenced as well. It is required, therefore, to check that if the total loss of pressure of the tunnel wind in the transfer tube is located in the pressure range of the selected blower. The ordinary method to do this requires to simulate all ranges of the blow speed (each range requires to repeat several times), and, derives the optimum working state of the blower and then, gains the total pressure loss, re-check the selected pressure of the blower. This process is very complicated and time consume, therefore, the "optimum seeking method" was introduced to deal with the simulation experiments. Only half of the experiments was required finding the optimum working point.

2. The simulation of selecting the optimum upper and lower limits.

The temperature in the green house was required to be about 27°c, and the upper and lower limits were 23 and 30°c. In order to find out a best temperature range which is among the upper and lower limits and consuming minimum power, some simulations were conducted. The step length was 0.5 °c, and therefore, total temperature ranges were 42. There were three criteria for judgement: a).close to 27°c; b)the change of temperature was more smooth; c)power consume was low. Because it was difficulty to make decision from the 42 simulation results with three criteria, a fuzzy comprehensive judgement method which was easy to achieve was introduced by author. The principle of the method is as follow:

1). Let the staff of the green house give a mark degree to each judgement criteria for each scheme. For example,the table 2 was similation result of a scheme ,the staff of the green house have given the mark degree by the similation result: in "the change of temperature stable" hand y1=0.2, y2=0.3, y3=0.4, y4=0.3, because 2 staff think that the change of temperature was most stable, 3 staff think that the change was stable , 4 staff think that it was passable, 3 staff think that it was fail. Using these data to set up a fuzzy relation matrix, shown below:

$$\tilde{R} = \begin{pmatrix} 0.2 & 0.7 & 0.1 & 0 \\ 0 & 0.4 & 0.5 & 0.1 \\ 0.2 & 0.3 & 0.4 & 0.3 \end{pmatrix}$$

2).Let the staff of the green house give a weight to each judgement criteria. The big weight gives to the important criteria, small weight gives to the less important criteria. The results were used to set up a fuzzy set. For example, "saving energy"(x1) is the most important criteria, and then, give the weight 0.5. "temperature is about 27°c"(x2) is less important, give a weight 0.3. "the temperature change smoothly"(x3) is even less important, give a weight 0.2, then we have a fuzzy set

$$\tilde{A} = O.5/X1 + 0.3/X2 + 0.2/X3$$

3). Using fuzzy transform to carry out comprehensive judgement for the schemes.

$$\tilde{A}\ o.\tilde{R} = (0.2\ \ 0.5\ \ 0.3)o\begin{pmatrix} 0.2 & 0.7 & 0.1 & 0 \\ 0 & 0.4 & 0.5 & 0.1 \\ 0.2 & 0.3 & 0.4 & 0.1 \end{pmatrix}$$

$$= (0.2\ \ 0.4\ \ 0.5\ \ 0.1)$$

$$\tilde{B} = (0.2/1.2,\ 0.4/1.2,\ 0.5/1.2,\ 0.1/1.2)$$
$$= (0.17,\ 0.34,\ 0.4,\ 0.09)$$
$$= 0.17/y_1 + 0.34/y_2 + 0.4/y_3 + 0.09/y_4$$

Max {0.17, 0.34, 0.4, 0.09} = 0.4.

Therefore, this simulation result belongs to y3 "passable".

In same way we can carry out comprehensive judgement for all the schemes. Then we have the result: few better schemes belong to y1.

Use the same way for the few better schemes in y1 until only a scheme in y1.

Using this method, it is possible to find out the optimum scheme from big amount of fuzzy comparison which is nearly impossible to deal with by hand. It was found that the best scheme of this green house was shown in Fig.2, where the upper and lower limits are 29°c and 26°c.

3. After find out the optimum scheme, it was possible to simulate the situation of power consuming for whole year, and then compare this number with the power consumed by the air condition, calculate their benefit.It was shown in table 3. and table 4..The result shown that the maximum effect of energy saving reached 83%.

From the analysis above, we can see that great benefit can be achieve by combine the traditional method with the modern technology.

OTHER TRADITIONAL METHODS USED IN CHINA

Beside of the method discussed above, there are some other traditional energy saving technique used in China. Some samples are using the heat of the earth's interior and marsh gas to warm the green house and animal house, to develop the aquatic farming. In north China, the the ground heat store system is widely used in the green house. The principle is very simple: in the day time, to transform the superfluous heat in the green house into the soil and store the heat there. At night, when the temperature in the green house is lower, the heat in the soil will release out to keep the green house warm. Another simple technique used in north China is the store of nature cold source. Its' principle is very simple as well: when the ice forms, some heat will be released. Transform this heat into the store for fruits and vegetables, the temperature there can be keep at 0-5°c. These traditional methods are very simple and useful, but do not need any industry energy. It is worth while to introduce these techniques to all the developing countries, and this is actually the main purpose of this paper.

CONCLUSIONS

1. "Tunnel wind" is a simple and effective traditional cooling method.

2. Introducing computer simulation technique and fuzzy comprehensive judgement method to select the equipments and determine the optimum work point for the tunnel wind cooling system, can make the tunnel wind be used more efficiency.

3. Heat of the earth's interior, marsh gas, green house ground heat store system, store of nature cold resource are some simple and useful energy saving traditional technique used in China. It is worth to introduce these technique to more developing countries.

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TABLES

TABLE 1. Performance of the blower (the type 4-72I)

Blow rate $Q(M^3/H)$	Blow pressure PS1(Pa)	Blow speed of the entrance V3(M/S)	Blow speed of the exit V4(M/S)
4540	490.20	4.4603	5.5068
5070	480.39	4.9809	6.1497
5630	470.59	5.5311	6.8290
6220	450.98	6.1107	7.5446
6760	421.57	6.6413	8.1996
7220	401.96	7.0932	8.7576
7840	362.75	7.7023	9.5096
8360	313.70	8.213	10.1404

TABLE 2 Judgement for three criteria

R	Y			
X	(y1)Most suitable	(Y2) Suitable	(Y3) Passable	(y4) Fail
Low power consuming (x1)	0.2	0.7	0.1	0
Around 27 degree (tempera-ture) (x2)	0	0.4	0.5	0.1
The change of tempera-ture stable (x3)	0.2	0.3	0.4	0.3

TABLE 3. Comparison of used energy between tunnel wind system and air conditioning system

Unit:Degree

Data	1986.7		1987.7		1988.7	
	Tunnel wind	Air con- ditioner	Tunnel wind	Air con- ditioner	Tunne wind	Air con- ditioner
1	22.5	132.16	24	140.22	16.5	105.16
2	19.5	118.63	22.5	127.01	19.5	121.44
3	15	94.84	21	119.86	22.5	133.72
4	16.5	101.36	19.5	114.62	19.5	120.35
5	19.5	115.36	19.5	116.92	19.5	120.33
6	19.5	117.50	19.5	115.40	19.5	119.23
7	19.5	120.73	16.5	99.34	0	0
8	16.5	105.04	15	96.54	24	144.30
9	19.5	127.12	16.5	103.79	24	151.88
10	19.5	129.03	19.5	118.50	15	101.48
11	16.5	102.33	21	126.97	15	96.92
12	0	0	21	130.19	9	62.49
13	9	61.91	25.5	154.75	15	98.04
14	15	95.54	25.5	156.79	16.5	104.58
15	15	99.76	24	131.45	19.5	115.62
16	16.5	102.64	18	117.04	19.5	121.01
17	16.5	102.70	21	122.53	21	124.73
18	19.5	116.89	16.5	98.84	22.5	142.26
19	16.5	103.18	18	113.79	16.5	108.50
20	12	79.29	22.5	127.79	4.5	30.55
21	0	0	24	136.65	16.5	106.66
22	12	81.29	16.5	104.43	18	116.07
23	16.5	102.53	10.5	67.97	22.5	131.93
24	15	98.35	15	96.02	19.5	121.38
25	16.5	101.69	0	0	19.5	121.15
26	16.5	106.98	0	0	24	137.65
27	18	114.14	15	100.51	19.5	121.39
28	19.5	120.21	9	62.43	0	0
29	19.5	120.10	0	0	10.5	67.46
30	36	168.99	0	0	12	80.50
31	22.5	141.48	0	0	19.5	123.31
Sum	516	3181.80	496.5	3000.34	520.5	3250.05

TABLE 4. Comparison of total used energy between tunnel wind system and air conditioning system

Unit:Degree

Year / Month	1986		1987		1988	
	Tunnel wind	Air conditioner	Tunnel wind	Air conditioner	Tunnel wind	Air conditioner
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	5	19.5	9	56.9
4	81	548.8	75	503.1	49.5	335.2
5	267	1757.2	180.5	1075.0	297	1914.1
6	343.5	2214.8	366	2241.2	486	3031.9
7	516	3181.8	496.5	3000.3	520.5	3250.1
8	589.5	3554.7	514.5	3151.8	429	2676.7
9	453	2730.8	327	1952.8	357	2145.8
10	195	1161.3	222	1286.0	208.5	1208.8
11	3	25.1	45	231.7	0	0
12	0	0	0	0	0	0
Sum	2448	15174.4	2209.5	13461.5	2356.5	14619.4

FIGURE

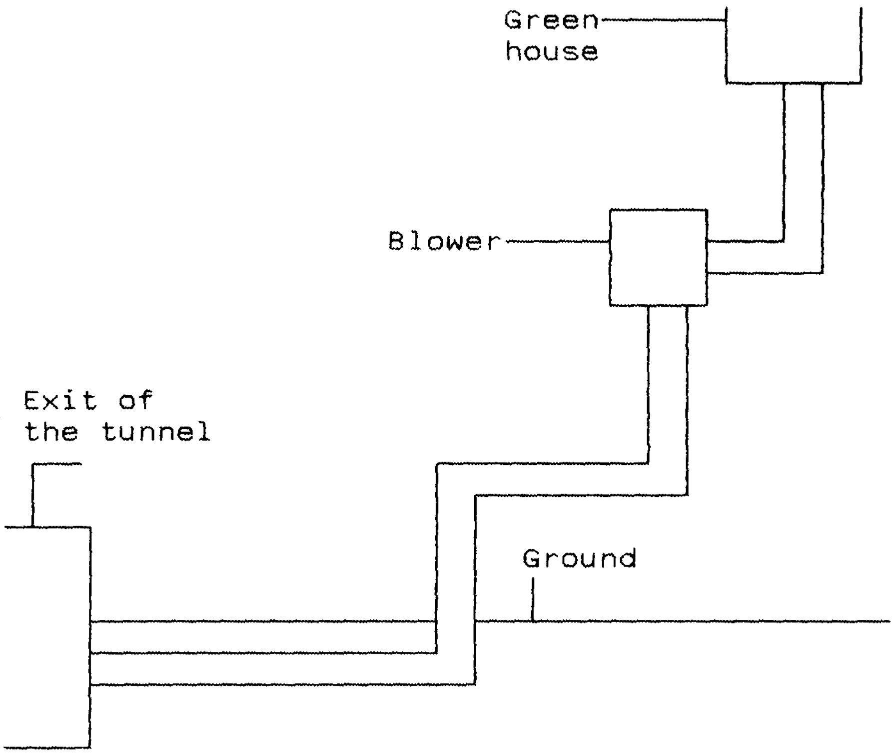
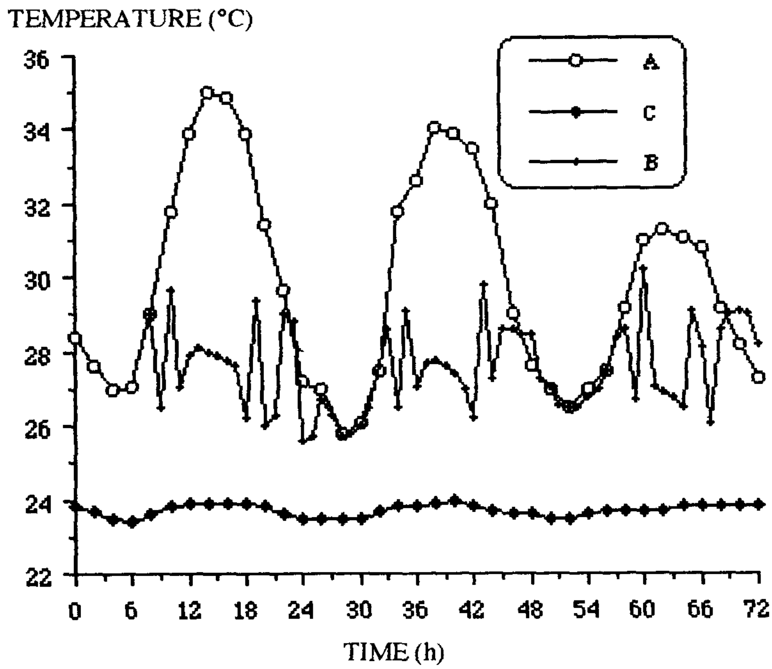


Fig.1 The system for bringing in tunnel wind to lower the temprature



A : Temperature out of the green house;
C : Temperature in the tunnel;
B : Temperature in the green house.

Figure 2. THE CURVES OF TEMPERATURE OF THREE DAYS (72h)