Graphical Analysis of Day - Night Temperature Difference by Interpolation and Approximation Methods for the Energy Converter of the Environment

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Abstract. Today, a lot of attention is paid to the search for environmentally friendly renewable energy sources. The most frequently considered such energy sources are wind energy, solar technology, the use of the energy of sea waves and biomass. Each of them has a drawback that prevents its widespread adoption. For example, wind farms create noise during their operation, are rigidly tied to the place where there are acceptable wind resources.

To date, an energy converter has been developed, which works on the basis of the use of the ambient temperature difference during the day - the temperature is high during the day, and the temperature decreases at night. As a rule, this temperature difference is in the range of about 5-9 degrees, although there are regions in which this difference is much higher, for example, in winter in Urengoy it can reach up to 30 degrees. An energy converter of this type is considered in works / 1-2 /.

The basis of the operation of such a converter is the change in the linear size of bodies, for example, plexiglass, with a change in temperature. When the temperature rises during the day, when the temperature is high, the rod lengthens, while at night, when the temperature is low, the linear dimensions of the rod decrease. This is exactly what is used to obtain energy through the use of a container. A conventional capacitor is used, one plate of which is fixed, the second plate of this capacitor is movable and connected to a dielectric plexiglass rod. When the temperature changes, for example, at a high temperature, the rod lengthens, the plates of the container come closer and the capacity will be maximum. At night, when the temperature decreases, the plexiglass rod is shortened, the plate moves away and the capacity decreases.

If, at maximum capacity, the capacitor is charged and disconnected from the source, then the charge on it will be constant. At night, when the rod shrinks its linear dimensions, the movable plate moves away, the capacity falls. Since the charge on the container is constant, the voltage increases and we get an increase in energy, which is obtained from the day-night temperature difference and the change in the linear dimensions of the dielectric rod.
1. Introduction

The most promising way of the principle of operation of such a conversion is the use of capacitive devices, with a change in the relative permittivity (NDC) in the dielectric between the plates of the capacitor capacitance. As you know, the accumulated charge on the container is directly proportional to the product of the charging voltage of the container and the value of its capacity. The capacitance of a capacitor is directly proportional to the area of the plates, the value of the relative permittivity of the dielectric (NDC) placed between the plates, and is inversely proportional to the distance between the plates. When the distance between the plates of the capacitor changes, its capacity changes.

In this converter, during its operation, the distance between the capacitor plates changes due to the change in the linear dimensions of the dielectric in the form of a bar or cylinder placed between the capacitor plates or separately.

As follows from the principle of operation of such a converter, it is necessary to enter the values of the difference in ambient temperatures during the day into its control system. Such regional statistics are available at hydrometeorological stations.

However, such statistics are somewhat rough, for example, only one value can be indicated per month, but for example, in the middle of the month or some part of the month, this temperature is not indicated. But it may be necessary when setting up the control system of the converter. Therefore, known interpolation and approximation techniques can be applied to find this exact value. This method of using interpolation and approximation to clarify the temperature difference in a given place in the region is discussed in the article.

2. Main part

As an example, let us give statistical data in tabular form for the location of the city of Komsomolsk-on-Amur for three years, Table 1.

| No. | Months | 1998 Day | Night | 1999 Day | Night | 2000 Day | Night |
|-----|--------|----------|-------|----------|-------|----------|-------|
| 1   | January| -22.7    | -26.7 | -17.7    | -21   | -22      | -25.35|
| 2   | February| -12.5   | -20.4 | 16.26    | -22   | 17.2     | 21.87 |
| 3   | March  | -2.3     | -6.17 | -9.58    | -    | 13.87    | -6.9  | -10.9 |
| 4   | April  | 8.6      | 4.1   | 6        | 1.19  | 6        | 1.69  |
| 5   | May    | 15.38    | 10.14 | 11.6     | 6.7   | 15       | 9.7   |
| 6   | June   | 20.4     | 15.1  | 18.3     | 13.6  | 19.96    | 13.1  |
| 7   | July   | 23.4     | 17.9  | 24.2     | 19.3  | 23.3     | 18.6  |
| 8   | August | 19.9     | 16.5  | 20.6     | 16.5  | 22.5     | 18.8  |
| 9   | September| 15.2    | 10.5  | 14.7     | 9.5   | 15.8     | 11.2  |
| 10  | October| 8.6      | 4.5   | 6.4      | 5     | 4.8      | 1.7   |
| 11  | November| -10     | -12.8 | -7.9     | -6.6  | -8.3     | -11.4 |
| 12  | December| -16.7   | -20.2 | -19.5    | -16.4 | -19.9    | -23.1 |

As you can see from this table, the ambient temperature difference is indicated only once a month. Differential statistics temperatures during the day are not indicated here. But, as mentioned earlier, such values may be necessary for the control system of the converter. Therefore, in this case we will use the methods of interpolation and approximation.
If you present these data graphically using the EXEL program, Fig. 1, you can also see that there is only one measurement during the month.

**Figure 1.** Graphically data of the temperature difference from table 1, using the EXEL program.

To find intermediate values in this case, we will carry out an approximation according to these data in two ways:
- graphically using the EXEL program;
- analytically.

First, for each year separately, then completely for three years.

For the first year in Fig. 2, shows an approximation for this year, where polynomial series 1 and 2 show the required values.

Figure 3 shows an approximation of the second year, where polynomial series 1 and 2 also show the required values.

Figure 4 shows an approximation for the second year, where polynomial series 1 and 2 also show the required values.
Figure 2. Approximation for 1998.

Figure 3. Approximation for 1999.

Figure 4. Approximation for 2000.
As can be seen from the graphs above, any point on the curve can give the desired value of the temperature difference at any time of the year.

However, approximation plots give numerical values of unknown quantities, but their accuracy may be slightly less than required. Therefore, in this case, analytical calculation methods should be applied, in particular, interpolation methods.

It is known from theory that interpolation is a way of finding intermediate values of a quantity from an available discrete set of known values.

Interpolation of functions is used in the case when it is required to find the value of the function $y(x)$ with the value of the argument $x_i$ belonging to the interval $[x_0, ..., x_n]$, but not coinciding in value with any of the values given in the table 1. When interpolating, the interpolating function strictly passes through the nodal points of the table due to the fact that the number of coefficients in the interpolating function is equal to the number of table values.

Calculation of unknown values of the function given in table 1, can be carried out according to the following method.

Let it be required to find the value of the function $y(x)$ with the value of the argument $x_i$ belonging to the interval $[x_0, ..., x_n]$, but not coinciding in value with any of the values given in Table 1.

Suppose you want to know the temperature in January 2008 during the daytime, for example, 6 a.m.

According to the table, we have the values of January

| Month   | Year |       |       |
|---------|------|-------|-------|
|         | 2008 | Day   | Night |
| January | -20.58 | -25   |

Let's denote:
X is the required time, in this case 6 hours;
X1 - night time, 2 am (time of measurement at the station);
X2 - daytime, 1 2 o’clock in the afternoon (time of measurement at the station);
Y - unknown temperature value;
Y1 - minus 25° temperature at night;
Y2 - minus 20.58° daytime temperature at 12 noon (time of measurement at the station);

Then, by the linear interpolation formula, we have:

\[ Y = Y_1 + \left[ \frac{X - X_1}{X_2 - X} \right] (Y_2 - Y_1) \]

Numerically

\[ Y = \text{minus} 25° + \left[ \frac{12 - 2}{12 - 6} \right] (\text{minus} 20.58° - \text{minus} 25°) = \text{minus} 19° \]

At 6 a.m. the temperature will be minus 19°
Other intervals are calculated in the same way.

3. Conclusion
When it is necessary to obtain accurate values of the temperature of the energy flow in a given time interval, if these values are not specified in the original table, and are in the intervals of tabular values, the calculation of unknown values can be carried out according to the proposed method, using analytical methods of calculation, in particular, interpolation or approximation methods.
At the same time, the advantages of this method of obtaining energy are as follows:
- the ability to use without being tied to a specific place;
- stability and low weight of the entire device;
- relative ease of use and ease of maintenance;
- implementation at any scale on a modular basis up to any power value;
- the possibility of using it as a decentralized source of energy;
- environmentally friendly source of energy;
- It can be used to obtain energy on Mars, the Moon, where the temperature difference is high.

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