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CONTROL AND ANALYZE OF TCPTF

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Abstract - *The method of study and experimental researches of the error of method of the thermocouple with controlled profile of temperature field along the main thermocouple are considered in this project. Thermocouple error is potential for thermocouple to lose accuracy over time, moving in positive direction. Thermocouple error is more common when thermocouple has been operating at higher temperature for a prolonged period. Thermocouple operating within normal operating parameter or at ambient temperature may still drift much slower. While with this project a thermocouple is used and its positive and negative terminals are connected to the DAQ and they are interfaced with PC for collecting the reading obtained from the thermocouples for the error analysis. Thermocouples are kept inside the control profile for the analysis of drift and the thermostat is kept at a set point of 800℃. The responses are taken for the thermocouples. Then the degradation is done for the thermocouple and again the drift is analysed and this process is repeated for certain period. Experimentally determined values of this method are compared to the theoretical estimations done using Thermocouple with Controlled Profile of Temperature Field.*

***Key Words*: DAQ, Thermocouple, Error analysis.**

1. INTRODUCTION

Type K (chromel- alumel) is the most common general-purpose thermocouple. When a thermocouple is used to measure the live temperature of an environment, it's expected that the voltage acquired doesn't change if the temperature of the environment is constant. If the voltage changes with time when the temperature of the environment is constant it could be a source of error in thermocouple measurement called drift. Due to drift, the thermocouple loses accuracy over time.

Temperature is one of the most commonly measured physical quantities. Statistical data show that about of all measurements in industry, the percentage of temperature measurements is 40 %. In some branches of industry this percentage may be even considerably higher, particularly in power industry it equals about 70 %. However, for existing measuring methods technological progress is challenging and expands the need for measurements in new conditions. At the same time, requirements for accuracy of measurements are increasing in areas and industry, where temperature has been measured for a long time.

A lot of effort has been directed to correct the error due to drift of conversion characteristics of thermocouple using periodic verification or calibration of thermocouple and drift prediction. However, this method does not lead to considerable improvement of accuracy due to thermoelectric inhomogeneity of thermocouple electrodes.

2. LITERATURE SURVEY

[1] Davor Zvizdic, Tomislav Veliki, et. al., proposed that techniques for inhomogeneity testing . In this variation of the thermovoltage recorded during measurement is employed in calculation of the uncertainty of the calibration.

[2] Holmsten, M., Ivarsson, J., Falk, R., Lidbeck, M., Josefson, L.-E, et. al., proposed a method that uses the thermoelectric inhomogeneity of wires to measure uncertainty when using thermocouples.To assess thermoelectric inhomogeneity over greater lengths, it's necessary to adopt a unique technique. Therefore, an apparatus with a brief, movable heating zone has been founded and evaluated.

[3] Hill, K.D., Gee, D.J., et. al., analysed the inhomogeneity within the seebeck coefficient is a function of position along a thermocouple wire frequently dominates the uncertainty budgets of thermocouple calibration and use.It explore how the inhomogeneity impacts the calibration uncertainty attainable with the varied thermal sources used for the calibration of thermocouples.

[4] Su Jun, Kochan, O, et. al., examines the explanations of error because of thermoelectric inhomogeneity of electrodes of thermocouples acquired during prolonged use and therefore the neural network method of error correction supported a generalization of verification leads to several temperature fields and also the tactic of investigating the impact of fixing the speed of the conversion characteristic drift of thermocouple on error correction and results of this investigation.

[5] Glowacz,A., Glowacz, A., Korohoda, P., et. al., predicated the study of thermal images of the motor. This method is useful for defense of electric motor. Moreover, this method is used to diagnose equipments in steelworks and other industrial plants.

[6] Webster, E.S., White, D.R., Edgar, H, et. al., describes a linear-gradient furnace and a thermocouple homogeneity scanner that, together, measure changes within the Seeback coefficient as a function of your time and temperature. The

furnace first exposes the test thermocouple to any or all temperatures within the range spanned by the furnace gradient.

[7] Koci, V., Koci, J., Korecky, T., Madera, J., Cerny. R, et. al., This employes a combination of experimental measurement and computational modeling. Within the experimental part, cement mortar specimen is heated during a laboratory furnace to 600°C and therefore the temperature field inside is recorded using built-in K-type thermocouples connected to an information logger.

[8] Glowacz, A., Glowacz, A., Glowacz. Z, et. al., this article present a diagnostic method of incipient fault detection. This approach relies on pattern recognition. It uses monochrome thermal images of the rotor with the applying of a region perimeter vector and a Bayes classifier. The investigations are administered for DC motor without faults. and motor with shorted rotor coils

[9] Habisreuther, T., Elsmann, T., Pan, Z., Graf, A., Willsch, R., Schmidt, M.A,et. al., This method reports on a brand new quite temperature sensor operating over a very large temperature range at high monitoring speeds. The gratings operate up to 1900 °C, which is that the highest temperature determined using Bragg grating to this point, and permit signal processing with a temperature resolution better than ±2 K. The sensor uniquely provides fast dynamic temperature monitoring at an unprecedented rate of 20 Hz.

[10] Kochan, O., Kochan, R., Bojko, O., Chyrka, M, et. al., A Thermocouple with controlled temperature field was proposed to address this error. An information-measuring system to perform proper measurements, measurement data acquisition and collection to construct mathematical models is proposed. They showed that the coefficient of penetration of the temperature field of the measured object is about 0.04.

3. PROPOSED WORK

3.1 EXPERIMENTAL PROCEDURE

The three set of thermocouples whose positive and negative terminals are connected to DAQ and interfaced with PC, the readings are collected from the thermocouple for the analysis of the error. The error analysis is done with the thermocouples which are kept inside the controlled profile at a set point of 800℃ The n the set point is reduced to 600℃ with this the down time and the settling time is noted.

The set point is increased to 800℃ for the degradation process. Since the error of the thermocouples is much larger than the error of method of TCPTF, the direct measurement of this error is impossible. That is why it is proposed to use the relative method of measurements to solve the problem. It is based on measuring the changes in temperature which occur when changing the power of the heater.

Fig -1: Experimental setup of TCPTF

Thus the systematic component of the measurement error will be mutually adjusted. Since the outcome of the experiment may be affected by some random temperature changes of the environment during the experiment time, the measuring junction of temperature sensor is placed into the passive thermostat. Its temperature is measured by an additional resistance temperature detector. During the first stage of the experiment, the heater is off. It is necessary to measure the temperatures of sensor several times and to check if their temperatures do not change more than random error of measurement. During the second stage of the experiment the heater is on. This causes the temperature change measured by temperature sensor. After a while the heat flux from the heater will change the temperatures of the measuring junction of temperature sensor and its passive thermostat.

3.2 DATA ANALYSIS

3.2.1 SMOOTHING

Smoothing is a sign processing technique generally used to remove noise from signals. In smoothing, individual factors which might be higher than the right away adjoining points are reduced and factors which are decrease than the adjacent factors are elevated in order that the data factors of a sign are modified. Discovering important patterns inside the statistics whilst leaving out noise, outliers and different inappropriate statistics. It also removes unwanted spikes, trends and outliers from a signal.

Filtering is used to perform smoothing. The purpose of smoothing is to generate slow changes in value so that it's easier to see trends in the data. Smoothing operations can be implemented more than as soon as, In a few instances it is able to be beneficial if there is a brilliant deal of high-frequency noise within the signal.

When the smooth width is larger, the noise reduction is greater. The easy width depends upon the width and shape of the sign and the digitization interval. For peak-kind alerts, clean ratio is the important aspect. Smooth ratio is the ratio between the width of the smooth signal and the wide variety of points in the half of-width of the height. In trendy, growing the smoothing ratio improves the signal-to-noise ratio however reasons a reduction in amplitude and boom in the bandwidth of the peak.

3.2.2 FFT

If the signal has high-frequency noise, FFT filtering method is used. This filter removes all the high frequency noise, leaving the true signal.

When the frequency of noise is higher than the true signal FFT low-pass filter is used. By using parabolic window it removes the high- frequency components. Frequencies more than the cutoff frequency will be discarded

3.3 OUTLIER DEDUCTION

3.3.1 DESCRIPTIVE STATISTICS

Descriptive facts are regularly generated as a primary step in performing a statistical evaluation. They are meant to provide a concise examine a group of facts factors, thru such information as imply and variance.

Descriptive analysis is one of the statistical information evaluation strategies which constantly being completed prior to undertaking any statistical checks or more complicated modeling. It is applied to summarize the records by describing and characterizing the records. Descriptive analysis is regularly used to measure statistics statistical distribution and relevant tendency. A statistical distribution specifies the amount of occurrences of the chosen records supported unique categorization. The quantity of occurrences can also be exact employing a percent fee for every category. A statistical distribution is illustrated via desk or graphical visualization like line charts, pie charts and bar charts. Meanwhile central tendency describes the middle values of the chosen statistics which typically represented the use of mode, suggest and median values.

3.3.2 GRUBBS TEST

An outlier is statistically an commentary which is numerically remoted from the relaxation of the information. To examine whether there's an outlier in a records set from repeated measurements, Grubbs test is employed.

Sometimes alerts are contaminated with very tall, slim “spikes” or “outliers” occurring random periods and with random amplitudes. This type of interference is hard to do away with the use of the above smoothing methods without distorting the signal. Many filters are sensitive to outliers.

A filter which is closely associated with the mean filter is that the FFT filter. However, a FFT filter out, which replaces every factor in the signal with the mean adjacent points can completely dispose of narrow spikes, with little trade inside the signal, if the width of the spikes is slightly one or a few factors and as much as or less than mean.

3.3.3 HYPOTHESIS TESTS

Hypothesis tests are frequently used to degree the same old of sample parameters or to check whether or not estimations for two samples on a given parameter are equal. Hypothesis testing with unknown parameters in null hypothesis and alternative hypothesis has been widely applied in many fields such as the signal processing system, the financial services and the wireless telecommunications system.

When the prior distributions of the unknown parameters are known completely, this method is applied in order to get the optimal estimation and detection. Other hypothesis testing methods solve the problem without considering the fact that the prior distributions are partly known. However, in practical, there are always some errors in prior statistical information, which are caused by small sample size, noises, model with uncertainties, etc.

3.3.4 T-TEST

The one-sample t-Test determines the average of a sample taken from a normally distributed population is steady with the hypothetical value for a given confidence level.

3.4 BLOCK DIAGRAM OF THE PROPOSED SYSTEM

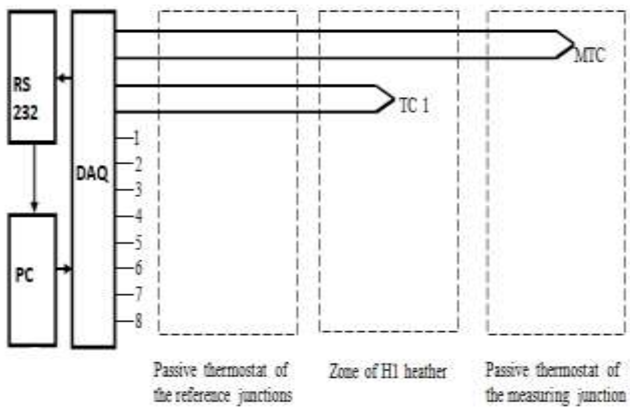

Fig -2: Block diagram of proposed system

The block diagram of TCPTF is in the top part of Fig.2. It shows all the sensors in the experiment - thermocouples (the MTC and the first zone of heating TC1) and the RTDs.During the first stage of the experiment, all the heaters are off. The temperature of all the sensors is the same as in the ambient air. It is necessary to measure the temperatures of all sensors several times and to check if their temperatures do not change more than random error of measurement channels.

During the second stage of the experiment the heater of zone 1 is run at full power. This causes the temperature change of the first heating zone, measured by TC1. After a while the heat flux from the heater of zone 1 will change the temperatures of the measuring junction of MTC and its passive thermostat. One must periodically measure these temperatures until they are steady (transition process of heating comes to the end). Since the transition processes are long-lasting during the temperature change, it is necessary to take into account possible changes of temperature in the thermostat of their reference junctions during the temperature measurement with thermocouples.

4. RESULT AND DISCUSSION

For RTD measurement there is used the potentiometer circuit with its four-lead arrangement. The results of the measurements and calculations is described below.

The result obtained from smoothing the data is shown in figure 3.

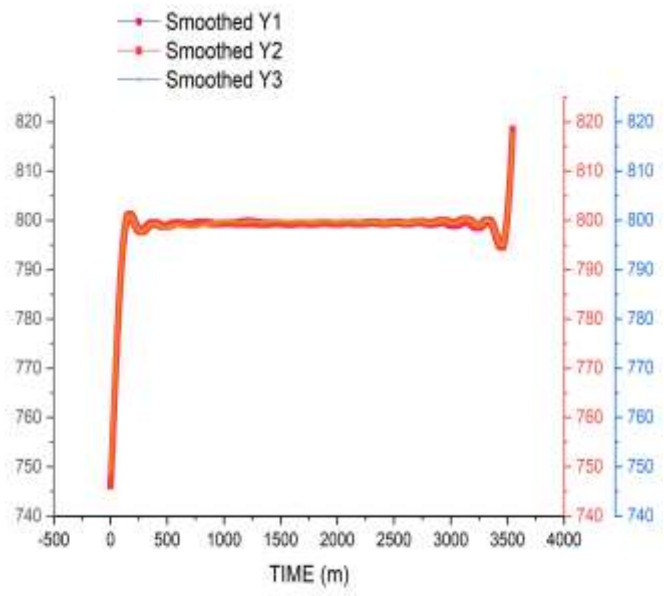

Fig -3 : Smoothing

Thus, the noise, unwanted spikes and trends is removed from the collected data through smoothing.

Fig -4: Grubbs test

From the figure 4,mean and standard deviation for smoothened data is calculated through Grubbs test.

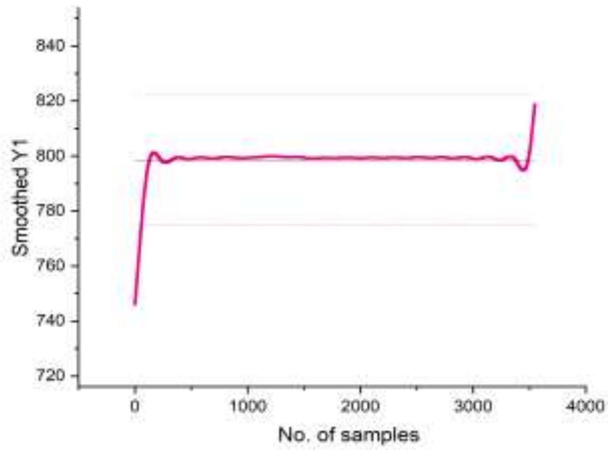

Fig -5: outlier deduction

From the figure 5,the outlier for the data is suspected

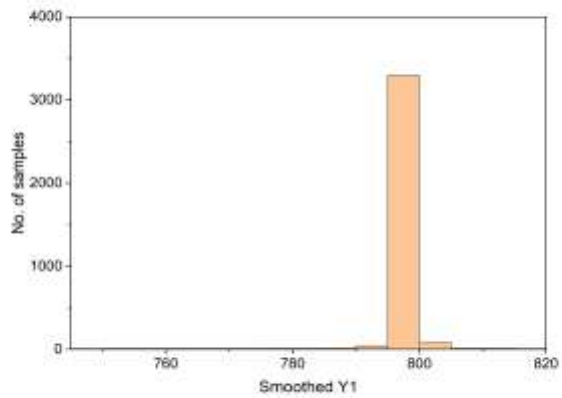

Figure 6: Histogram

The number of samples analysed using TCPTF method is shown in figure 6.

5. CONCLUSION

The proposed technique is primarily based on measuring the changes in temperature during the relative measurements. It reduces the error because of the heat flux from the auxiliary heaters of TCPTF. Thus the error values found the use of TCPTF technique is three times less than the error of thermocouples that may be used for calibration of TCPTF. So, the proposed method of the analysis may be used for the sensible purposes. Error also can be decreased by means of growing the thermowell heat transfer location by way of making use of both grooves or thread, or mount extra fins at the give up of the thermowell. This approach estimates the impact of thermoelectric inhomogeneity on the uncertainty of the calibration procedure. It is a great calibration practice to test thermocouples for homogeneity for the duration of calibration process

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