Web based application for polynomial thermoelectric calculations and verification of its correction curve

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Agenda

- Introduction
- Reference software modules for thermocouple calculation
- Verification of polynomial correction curve given by temperature laboratories
- Case study - Thermocouples
- Web application demonstration
Introduction

- Eliminating SW as possible cause of discrepancies in (temperature) laboratory intercomparison, where different automated data acquisition system as well as different software system for postprocessing acquired data is used
- Comparing custom developed software modules with reference software modules for general users
Web based reference software modules

- Unifies custom temperature software testing
- Enables verification of custom program software modules
- Easily accessible to laboratories or public users
- System undependable
- Enables verification of polynomial correction curve given by temperature laboratories
Verification of polynomial correction curve given by temperature laboratories

Calculating temperature applying calibration certificate is done by using polynomial correction curve given by temperature laboratories using secant method, where assumption is made that the function is approximately linear in the local region of interest.

\[ x_{n+1} = x_n - \frac{x_n - x_m}{f(x_n) - f(x_m)} \quad (n = 1, 2, \ldots; \ m < n \ ; \text{where } x_0 \text{ and } x_1 \text{ are known}) \]
Case study - Thermocouples
ITS-90 standard

- Polynomial equation for calculation thermoelectric voltage from temperature except for K type which has additional exponential correction

- Polynomial equation for calculation temperature from thermoelectric voltage

\[
E(t_{90}) = \sum c_i t_{90}^i
\]

\[
k(t_{90}) = 1.18596710^2 \cdot e^{-1.18343210^{-4} \cdot (t_{90} - 1269686)^2}
\]

\[
t_{90}(E) = \sum d_i E^i
\]
Realization

- Perl script language with high precision Math module is used for calculations.
- Perl precision math module enables different calculation settings for accuracy, precision and rounding modes.
- Application is made as CGI (Perl) script enabling parsing data stream from user input or given files.
Technologies used

- Software under GPL license which makes project cost effective
- Apache Web server with a possibility of enabling secure connections for user identification and data protection (SSL, certificates)
- Perl (CGI) interpreter for calculations
- MySQL as an extension for storing data (coefficients, …)
Thermocouple calculations data flow

Server running Apache with CGI module and MySQL

HTTP or HTTPS connection

Firewall

Internet

User

Standard web browser
Thermocouple calculations

ITS Thermocouple Calculations

Temperature in [°C]:

Voltage in [mV]:

Preset Example

Clear

Coefficient A0 = 1.07259181E-06
Coefficient A1 = -0.53119956E-06
Coefficient A2 = 0.00070684E-06
Voltage for iteration in [mV] = 0.2136

Temperature for K Type is: 200.004 °C
Web application demonstration
(temporary host)

http://preizkus.fe.uni-lj.si/cgi-bin/start_v1.cgi
Future steps

- Debugging and design corrections
- Software validation
- Modules for other types of thermometers
- Some other?
Thanks, questions and comments