ECE 1896 – Senior Design

Spring 2017

Continuous Improvement of a Continuous Annealing Line Simulator –

VS2  
Requirements Document

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# Introduction

The continuous annealing simulator (CAL simulator-VS1) is a special piece of laboratory equipment that is used to anneal advanced high strength steels (AHSS) for the automotive industry. This system is capable to replicate the annealing of strip samples to produce the required microstructures in AHSS. The CAL-VS1 is also capable of rapid cooling rates in excess of 60 C/sec. The current project requires the optimization of an existing control software package to control the motion of the strip samples along the different stages of the simulator. In addition, it needs an optimization of the communication package to have a better temperature control of the samples during the heat treatment. The system uses two infrared devices to measure the temperature of the sample during processing. A final wish is to optimize the communication package of the computer controlled gates that are attached at each end of the simulator.

## Purpose

The purpose of this document is to give a detailed description of the requirements contained within the “Continuous Annealing Linear Simulator” software and hardware based optimizations. It will illustrate the purpose and interaction with other components of the system as well as users. This document is primarily intended for proposal to our advisor Professor Garcia and the University of Pittsburgh Mechanical Engineering Departments, Ferrous Metallurgy Group.

## Scope

The optimizations of the “Continuous Annealing Linear” are geared towards creating a more optimized and efficient operation of the simulator while operating and testing metal samples.

## Definitions, Acronyms, and Abbreviations

|  |  |
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| **Term** | **Definition** |
| CAL | The Continuous Annealing Linear Simulator |
| User | The operator of the CAL simulator |
| Anneal | Heating of metal and quickly cooled to remove internal stress and strengthen it |
| Sample | Section of the strip of interest to be heated and analyzed |
| Strip | Metal piece containing a sample attached to the CAL for annealing |
| Infrared Sensor | Sensor using infrared light to sense temperature of the strip during annealing |
| Upper Furnace | Main heat treatments occur here |
| Cooling Area | Between the two furnaces where the sample is cooled after treatment |
| Lower Furnace | Secondary heat treatments occur here |

# Behavior / Performance

## Operation of the Lower Furnace Gate

The CAL simulator shall allow the lower furnaces gate to open and close so the sample can pass into the cooling area or the furnace.

### Sample passing from lower furnace to cooling area

The gate shall open when the sample passes from the lower furnace to the cooling area and then close when the sample is within the cooling area.

### Sample passing from cooling area to lower furnace

The gate shall open when the sample passes from the cooling area to the lower furnace and close once the sample is within the lower furnace.

## Increase Quality of Temperature Control

A third sensor shall be introduced into the system to provide accurate temperature reading of the sample while in the lower furnace.

## Improve Sample Positioning

The CAL simulator software shall track and place the sample position within ¼ inch of its desired physical location.

# Design Constraints

## Variable Sample Length

The sample positioning shall accommodate sample lengths between 1.5 inches and 8 inches.

## Use Existing Control System

The Raspberry Pi microcontroller currently implemented to operate the CAL simulator will be used.

## Sensor Sampling Rate

The third temperature sensor shall sample the temperature of the sample while in the lower furnace at a rate no less than 1 Hz.

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