Optimization Of Steel Compositions Using Genetic Algorithm.(Vol-2)

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ABSTRACT

The process of steel making is done by alloying iron with other alloying elements like carbon, nickel, manganese, molybdenum etc. Engineering processes currently being used, depends on the experience of the operating engineers overseeing the execution. This causes a lot of oversights and inaccuracies in the process. These inconveniences can be reduced or eliminated by computational optimization, but many of these problems are complicated and deal with multiple factors affecting the final product. Even more so, many of these problems also suffer from the unavoidable drawback of having sub-optimal solutions. All of these problems can be overcomed by process simulation and using robust optimizing techniques such as genetic algorithm. The process of selecting an alloying composition for steel requires computation of many variables and also includes multiple compositions that can provide the desired hardness and also provide the ideal "depth of hardness".

Keywords: *Hardenability of Steel, Optimization, Genetic Algorithm, Steel Composition.*

1. INTRODUCTION.

The process of steel making is done by alloying iron with other alloying elements like carbon, nickel, manganese, molybdenum etc. Each of these elements have different effects on the hardenability of steel. There may be several combinations of these element which may produce the required "depth of hardness", but this requirement alone is not sufficient enough to gauge the quality of the steel. The combination of the problem faced being a multi-variable problem as well as the presence of several "pseudo-optimum" solutions is why genetic algorithms are being used for this project. Genetic algorithm is an evolutionary algorithm which uses the process of recombination and mutation to randomly induce changes in the dependent variables. We will go about the optimization of the composition of steel through the following steps:

1. Generate an initial population of strings that define the composition of steel.
2. Compute the population using a fitness function, and find the "strongest" among them.
3. Carry out crossovers among the strongest members of the population to create the next generation
4. Go back to step 1 and repeat until the specified benchmarks are satisfied.

2. LITERATURE REVIEW.

Uncertainty inadvertently exists in most real-world applications. In the optimization process, uncertainty poses a very important issue and it directly affects the optimization performance. In order to efficiently and effectively solve Robust Multi-objective Optimization Problems (RMOPs) [1], a novel Robust Multi-objective Optimization Evolutionary Algorithm (RMOEA) is developed.Traditionally genetic algorithms work by providing hurdles to successive genrations. The ability to overcome these hurdles defines the strength of the individual. Through the use of schema, these hurdles are scaled with respect to the generations, thus forcing each individual to ”work harder” to be able to survive onto the next genration [2,3]. A schema describes a set of individuals, the strength individuals decide the strength of the entire schema.To further improve the odds of survival of the fittest the concept of elite count or eliteism is implemented [4]. It selects the cream of the crop ,so to speak, and gaurantees it is carried forward into the next generation. This has been mathematically shown in .The best individual of the generation is selected and crossover is gauranteed.While the continuous casting and heat treatment process has not been implemented in our system the application of genetic algorithm in optimization of steel composition provides usefull in sight into steel manufactuaring processes and varibles involved such as the jominy hardenability process.

3. PROBLEM STATEMENT.

Generating an alloy compostion for steel using genetic algorithm whose characteristics allign with the propsed requirements given by the onsite engineer.

4. EXISTENT SYSTEM.

While there are optimization tools for the process of steel casting the task of selecting a suitable composition of steel is dependent on a mixture of the experience of the onsite engineer, and trial and error. The composition of steel is set by the engineer using a method of exprinence and trial and error. the method for testing steel is physical process that requires time and effort. If the composition does not provide the required quality, the entire batch is scraped, and new composition is tried.

4.1 Drawbacks of Existent System:

1. Time consuming.
2. Wastage of resources.

5. PROPOSED SYSTEM.

System depends heavily on randomly generated variables that are used to create next genrations that finally result in the final answer. Therefore the input provided is just used as a comparision point.It provides the ideal jominy graph whos composition needs to be found.The Jominy method is descrbed as an exprimental method that describes hardenabillity (the ability of the steel to harden) with respect to the depth of the steel smaple. There are several steps involved in finding the Jominy graph:

1.A solid steel cylinder of 2 inch diameter and 32 inches in lenght is heated above 850°C.

2.A spray of water is applied to one end and the entire sample is allowed to cool down to room temperature.

3. some material is shaved of the sample lenght wise to avoid tainted results due to oxidation and impurities.

4.The hardness of the sample is determined using Rockwell Hardness tesing machine in 0.25 inch interval.

5.this provides a jominy graph as shown in fig2

Fig.1 shows the proposed flowchart for the design of the optimizaion process.

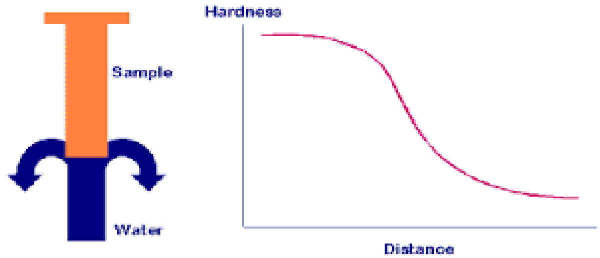

Fig. 5.1. jominy graph and test apparatus.

6. OBSERVATION.

6.1 Overview of Project Modules:

Generating an alloy composition for steel using genetic algorithm whose characteristics align with the proposed requirements given by the onsite engineer.

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The process of steel making is done by alloying raw iron with other elements like carbon, nickel, manganese, molybdenum etc. Each of these elements have different effects on the harden-ability of the steel. There may be several combinations of these element which may produce the required "depth of hardness", but this requirement aloneis not sufficient enough to gauge the quality of the steel. the combination of the problem faced being a multi-variable problem as well the presence of several "pseudo-optimum"

Solutions is why genetic algorithms are being used for this project. Genetic algorithm is an evolutionary algorithm which uses the process of recombination and mutation to randomly induce changes in the dependent variables. We will go about the optimization of the composition of steel through the following steps:

1. Generate an initial population of strings that define the composition of steel.
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Decreased time requirements and resources used in the lengthy test method used in the industry Gives precise compositions of the required steel.

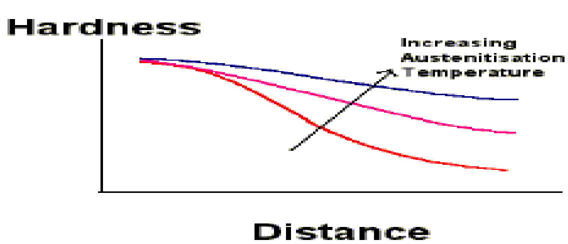

Fig 6.1:jominy graph.

Our hole project flow starts, with the user will take input as file and select boron or non-boron.

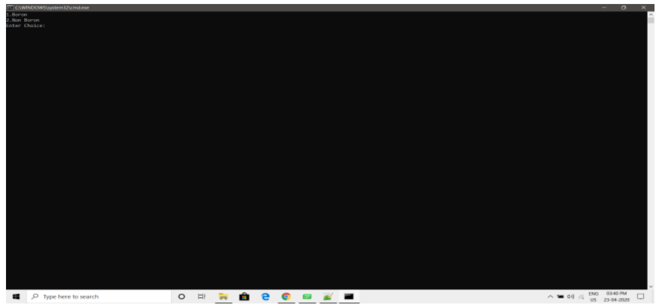

Fig 6.1.2: Selection of boron and non-boron.

6.2 Code flow:

Now,first it takes input from client in graph or manual data format and then enters in schemata and generates binary numbers in 48 block of array in which it fill values as “1”,”0”,”NULL”. While filling the NULL point we generate ten new binary numbers of the parent family which is initially generated.

Then we distribute that 48 bit binary array into 8-parts as follows.

Which include: 0 - 7 = carbon

8 - 15 = manganese

16 - 23=silicon

24 - 31=Nicole

32 - 39 = coromine

40 – 47 = molybdenum.

Now we convert the 8-block of binary array into decimal number. here setting all the range of elements

Carbon 0.01 to 0.90

Manganese 0.01 to 1.95

Silicon 0.01 to 2.00

Nicole 0.01 to 2.00

Cromine 0.01 to 1.75

Molybdenum 0.01 to 0.55.

Then we convert that decimal number generated by the binary number to the range of between the percentage given of the provided elements.

Example: 2^8.

1	1	1	1	1	1	1	1	=256

So we will convert that 256 in the range between 0.01 to o.90, so that value will be converted into 0.09.then we are passing that percentage value to the jominy program after that we are getting the generated graph point from jominy program. then we are comparing that value with the user input and we will repeat this process until we get the value which is equal or almost similar to the given graph.

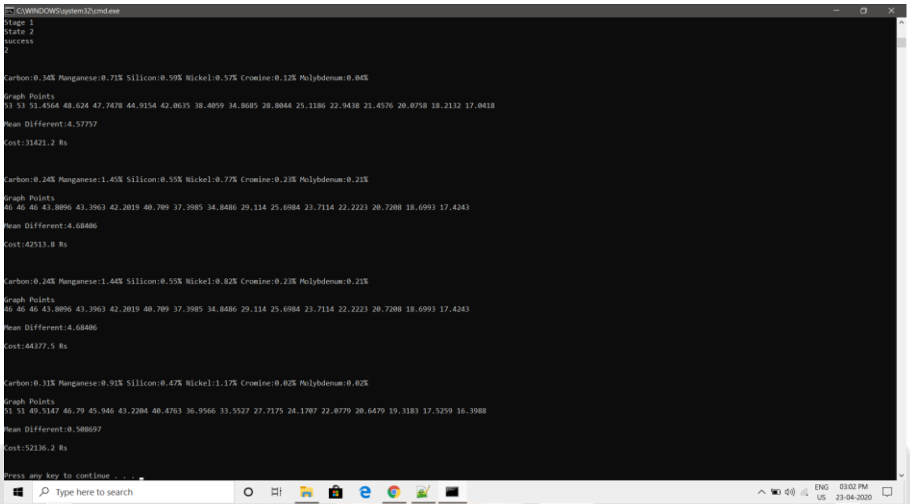

Fig 6.2: Final Compositions.

Hence, all this value is now converted into graph (jominy curve) to compare with the predefined graph.

6.3 Jominy curves:

A typical plot of hardness along the length of the 10 cm long steel rod. En 8 is a low hardenability steel when compared with En 24.

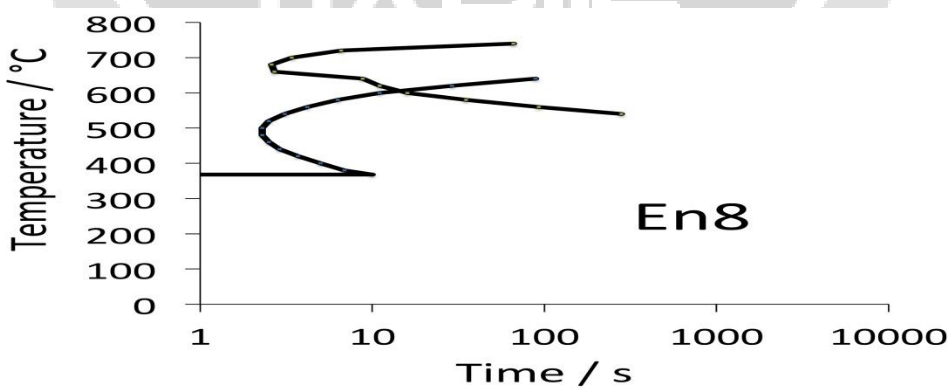

Fig: 6.3.1:jominy curve

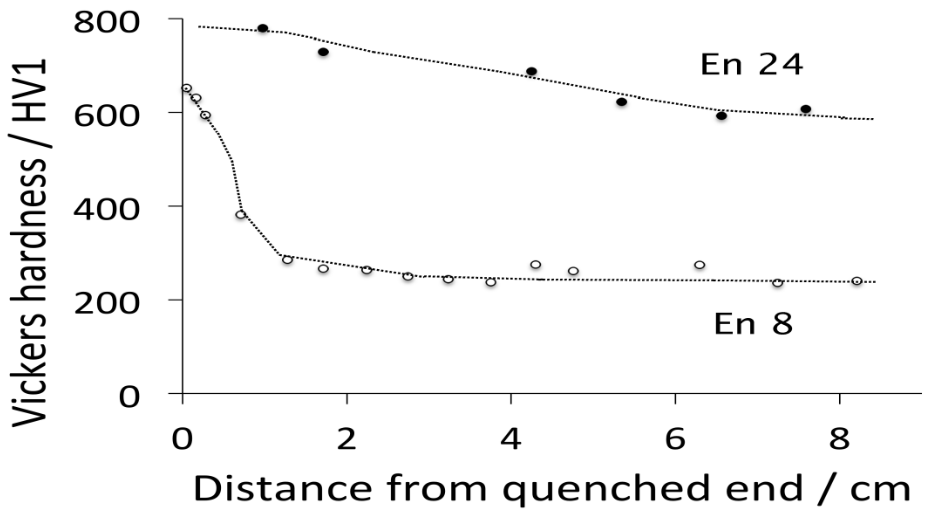

Fig:6.3.2 jominy curve.

6.4 Result Achieve:

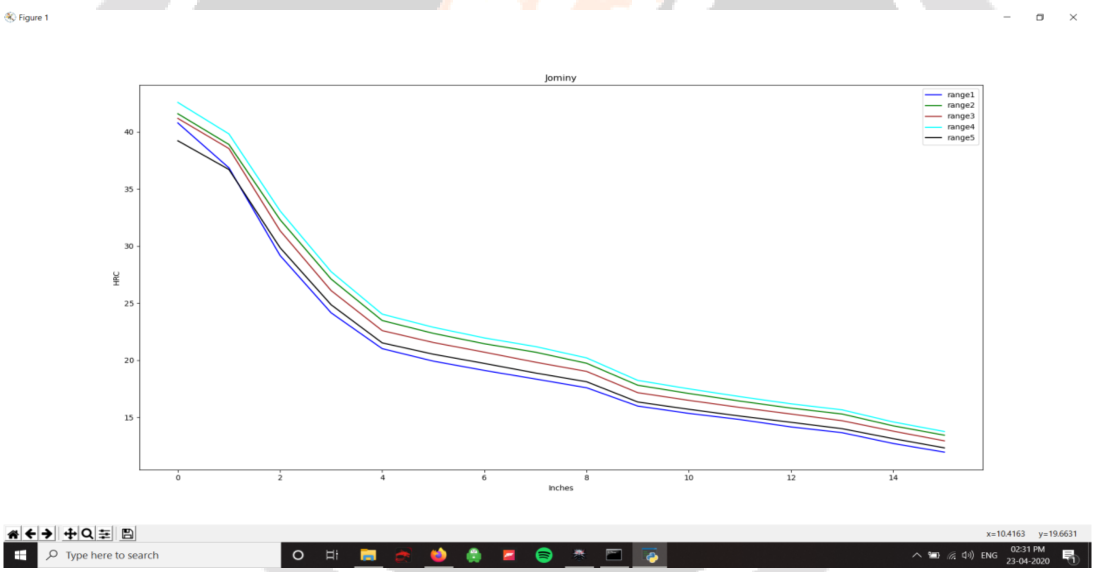

Fig 6.4: Final jominy curve.

7. Future Work:

The harden-ability of the steel effectively depends on the cooling rate of the steel. This project does not yet include that aspect of steel making, it only focuses on providing the ideal composition required to provide the optimum hardness.

Optimizing the cooling process for the steel is the next step in completely optimizing steel making, however increasing cooling rates are limited by sample size and the composition of the alloy.

8. Conclusions:

Using the algorithms and methodology listed in this paper we will be able to design and implement an optimization technique based on genetic algorithms that will allow us to reduce the shortcomings of the current testing processes of the steel industries.
Hence using all this technologies we are successfully implemented our application “Optimiation of steel compositions using genetic algorithm”.

9. References:

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