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Optimization of control factors for % Strip Thickness Variation of cold rolling mill for Dual Phase Steel Sheet by Using Taguchi Method

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A B S T R A C T

In this research work, dual phase steel sheet is used for cold rolling process. Exit tension, entry tension, rolling speed and bending pressure are selected as the input process parameters of cold rolling process which is responsible for the quality of rolled sheet.Taguchi Method is applied to find out the S/N ratio and optimal set of input process parameters. L9 orthogonal arry design has been used for experimentation of cold rolling process. Furthermore conformation test case has been conducted for the validation results. Based on the results, the good agreement has been observed between the actual and predicted values of process parameters.

Keywords: Cold rolling process, % strip thickness, Taguchi Method

1 Introduction

The three principal type of rolling mill used for the rolling of steel are referred to as, two high, three high, four high as shown in Figure 1.1. According to the type names, the classification is based on the manner of arranging the rolls in the housing, a two high sand consisting of two rolls, one above the second one, a three high mill has three rolls, and a four high mill has four rolls, arranged similarly. When rolling is in one direction only on two high mills and the piece is t returned ever the top of the rolls to be rerolled in the next pass, the mill is known as a pull-over or drag-over mill. This type of mill formerly was used mainly for production of light sheets and tin plate; it still is used by merchant mills for rolling o of tool and high-alloy steels On two-high reversing mills, the direction rolling in of rotation of the rolls can be reversed, and alternately in oppose in opposite directions, with work possible to done on the piece while traveling in each direction. Vivek A et al. [7] has investigated the optimum set of exit tension, entry tension and rolling pressure for cold rolling process. They had applied L9 orthogonal array design by using the Taguchi method. ST29DC cold rolling sheet material was selected for the cold rolling process S Babu et al [8] they developed the FEM based numeric model for cold rolling process and also applied multi objective optimization of rolling process parameters technique. Author's considered the following input process parameters of rolling process; rolling torque, load capacity, and residual stress. For the validation of developed numeric model, experiments had been conducted. Their results shown that rolling torque is most important process parameter (99.7 %), second position force (99.33%), third position residual stress (96.62 %).

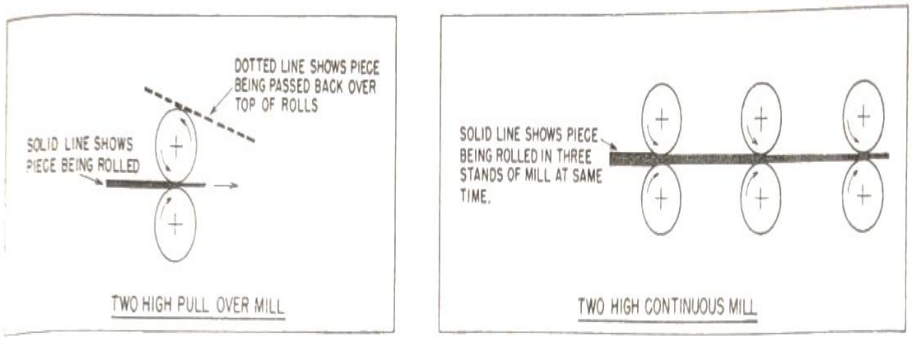

Figure 1: Two high pull over mill and two high continuous mill [1]

In the present work, dual phase steel sheet is used for cold rolling process. Exit tension, entry tension, rolling speed and bending pressure are selected as the input process parameters of cold rolling process which is responsible for the quality of rolled sheet. Taguchi Method is applied to find out the S/N ratio and optimal set of input process parameters. L9 orthogonal arry design has been used for experimentation of cold rolling process

2. Experimental process

2.1. Experimental Design

Experimental design is a statistical tool that helps researcher in following ways

- To conduct proper experiments
- Effectively examine data
- Draw significant conclusions from the analysis.

The purpose of systematic research is generally to express the statistical significance of an effect of input process parameters on the responses that helps to improve the quality of it. The purpose of DOE (Design of Experiments) is to recognize the best suitable set of process parameters for desire responses. The main aim to opt statistically designed Experiments is to determine the maximum information from minimum amount of resources being employed

Table 1 Cold rolling Mill process parameters range and their levels

Input parameters	Unit	Level 1	Level 2	Level 3
Exit tension	Kg	11000	11500	12000
Entry tension	KG	5500	6000	6500
Rolling Speed	mpm	450	550	650
Bending Pressure	Kg/cm2	65	85	95

Figure 2Dual phase steel coil

The main aim of the cold rolling process is to increase percentage of the total length of dual phase steel within acceptable tolerance limit is the better performance. The other aim of this cold rolling process is to minimize the I value for flatness improvement. Hence the larger the better length of strip under permissible tolerance limit and flatness lesser than specified limit is selected for obtaining optimum rolling performance characteristics.Larger the better has been opt as objective function for thickness variation. The following S/N ratios for the larger the better case could be calculated

$$S/N\ Ratio = -10*Log(sum(1/Y**2)/n)$$

3. Results and Discussion

Based on the design matrix which was developed by level and range of input process parameters experiments has been conducted.

Table 2 % of thickness variation of rolling sheet

S. No	Exit Tension (Kg)	Entry Tension (Kg)	Rolling Speed (mpm)	Bending Pressure (Kg/cm2)	Strip Length %
	11000	5500	450	65	71.1
2	11000	6000	550	75	65.56
3	11000	6500	650	85	74.15
4	11500	5500	550	85	75.12
5	11500	6000	650	65	72.05
6	11500	6500	450	75	68.5
7	12000	5500	650	75	78
8	12000	6000	450	85	70.42
9	12000	6500	550	65	66.88

Table 3 Response for Signal to Noise Ratio for each factor (Strip length)

Levels	Exit Tension (Kg)	Entry Tension (Kg)	Rolling Speed (mpm)	Bending Pressure (kg/cm2)
1	36.92	37.46	36.90	36.90
2	37.13	36.81	36.78	36.96
3	37.10	36.87	37.47	37.29
Delta	0.20	0.65	0.68	0.39
Rank	4	2	1	3

Determination of each response (% variation and I value) was carried out. In the % variation response, larger the better type of control function has been applied and smaller the better for the I value (flatness) was applied to identified the S/N ratio. The S/N ratios of all the experiments were calculated and tabulated for both the response

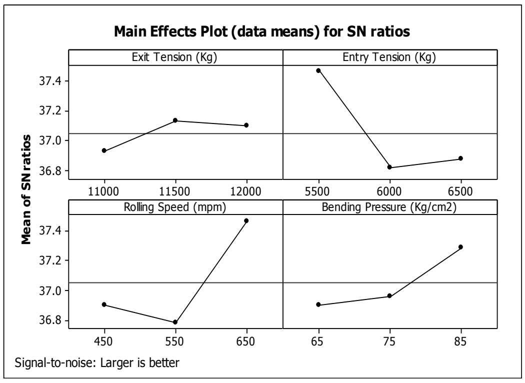

Figure 3 Main effect plot for Thickness variation

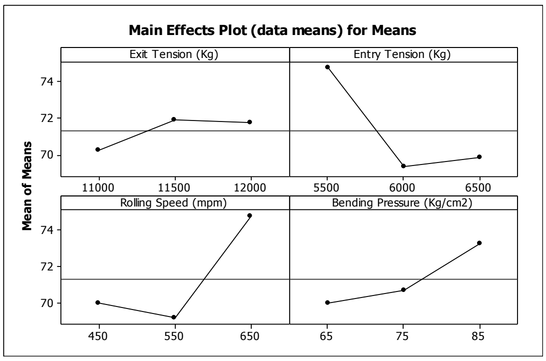

Figure 4 Main effect plot for mean

4. Conclusions

In this research work the optimum set of input process parameters has been identify to improve the quality of cold rolling process. Taguchi Method has been used in this work to find out the optimum set of input process parameters.Dual phase steel sheet has been used for the base material. Exit tension, entry tension, rolling speed and bending pressure has been selected as input process parameters. % of strip thickness variation has been considered as an output responses. Based on the results the conclusion has been drawn; Exit tension 11500 kg, entry tension 5500, rolling speed 650 and bending pressure 85 are the optimum set of input process parameter for better quality of cold rolling process.

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