Journal of Material Sciences & Engineering

Research Article Open Access

Response Surface Methodology for FCAW for Best Weld Condition on Desirability Function

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Abstract

Losses to society in term of life and property due to catastrophic failure of pressure parts are often traced to defective welds. Whereas the code/standard are collaborative experiences from welders and consumers voice which have recommended broad process parameters tolerance for the acceptable product (weld) quality but within that recommended window still, there is a scope to find the further narrowed down optimum or near optimal process parameters settings and authors researched narrowed down the code acceptable limits to find the best weld condition.

Moreover, major advances and researches are done in welding science and technology in recent years where researchers and scientists have focused mostly on welding works which were executed in the welding shop. The author studied on the FCAW which is widely used for welding in a remote area such as welding in the windy and dusty environment for cross country pipelines where the arrangement of welding shop is not economically feasible.

Fabricators and contractors consistently report that their welding issues are the need to reduce the welding costs due to rework of defected welds and to improve the welding productivity. The research is made to optimize the FCAW base on industries problems.

Keywords: Flux cored arc welding; Amperage; Arc length; Travel speed; Response surface methodology; Optimization

Introduction

Combined shielding is obtained from outer gas-shielding and from gasses produced from the arc. However, to make more convenient for field welding [1], Lincoln Electric invented the filler wire with a core which we filled with flux. In this way separate shielding gas is replaced by flux core wire moreover Lincoln Electric also declined to contribute to gas welding industry because Lincoln Electric used CO_2 as shielding gas. In 1954 Arthur Bernard was the one who refined the process of dual shielding and flux and began the creation of Flux cored arc welding (FCAW) exactly the same as we are using in industries [2]. However, CO_2 is still considered as additional protection of weld pool. Starting from 1959, self-shielding welding wire was available in the market which replaced the outer shielding with inner shielding during the welding process [2,3].

Gulhane et al. [4] produce research by analysis the major influence by means of Taguchi design of experiment philosophy that showed the effect on all factors. ANOVA was used to determine the influence input factors for a series of a run for FCAW process. Arivazhagan et al. [5] highlighted the importance of shielding gas composition for improved properties such toughness during welding by FCAW and he found that ideal gas mixture is argon (95%)+CO_2 (5%) for welding with flux-core wire to achieve the desired value of toughness. Sterjovski et al. [6] studied with Artificial Neural Network (ANN) on the diffusible H_2 amount and cracking proneness in welds welded by flux-core wire. Kannan and Murugan [7] showed study to investigate the properties of flux-core wire welding's controllable factors on clad (CS to SDSS) parameters. All above investigation and experimental study were conducted on automatics flux-core welding process under a controlled environment such as well-established and equipped closed welding workshop whereas we have studied the semi-automatic flux core arc welding performed under tough environmental conditions such as windy and dusty in the mobile or outdoor welding shop. Through data mining of field engineering on nominal identical data on which we have done field study and relevant data points are chosen. The portable welding shop is the shop which moves the location to location base on projects scope such as for cross-country pipeline.

Process Features and Parameters

The welding with flux-core wire has similarity with gas metal arc welding; however, the main difference is information of welding consumables. The FCAW use solid wire as welding consumables whereas FACW uses flux cored wire as welding consumables. The reason for flux which is wrapped inside the core wire is only to provide shielding to protect the weld pool similar to flux protect the weld pool in Shield metal arc welding [1].

Voltage

The open circuit and welding arc voltages are critical variables in any SAW process affecting bead shape and penetration profile. The arc voltage also governs arc length beneath the flux layer and any change in arc length will radically alter weld metal composition mainly due to change in elements from the flux being alloyed into the weld (Figure 1).

Design of Experiment Methodology

The factors can be classified as either continuous with low and high value or categorical with different level [8,9]. We have selected continuous type of factors instead of the categorical type with minimum and maximum value because FCAW factor's values fluctuate frequently due to welding in the temporary welding shop. Design of experiment is

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Received April 13, 2019; **Accepted** April 22, 2019; **Published** April 30, 2019

Citation: Nazir K, Sheikh AK (2019) Response Surface Methodology for FCAW for Best Weld Condition on Desirability Function. J Material Sci Eng 8: 518.

done by selecting current (A), wire feed (mm); heat Input (kJ/mm) and electrode extension (mm) as continuously controllable factors with low and high values as defined in Tables 1 and 2. These controllable factor's effects are studied on four responses such as bead width (mm), weld reinforcement height (mm), weldment hardness (HB) and deposition rate (lb/hr). Each response is assigned with minimum and maximum values which are obtained from design condition for ASME B31.3 process piping for non-sour and non-lethal service and are mentioned in Table 1. The response's results are studied and analyzed on mean values basis and target to minimize the mean of hardness and maximize the mean of deposition rate, reinforcement height, and bead width [9].

Design of experiment's run and the model was established by response surface methodology which is used to refine the model after determination of important controllable factors using central composite design. CCD (factorial matrix+axial points+center points) is used because of it fit quadratic model with sequential experiments. The design is rotatable in composite design because it provides constant prediction at all points that are equidistant from the design center which is placed in last. Below is the equation to calcuate the alpha:

$$\alpha = 2^{K-1} \times \frac{\text{No.of Corner Points}}{\text{No.of Axial Points}} = \frac{2^{4-1} \times 16}{8} = 2.0$$

The star points in rotatable center composite design are the distance of each axial point. Total 36 runs are designed with 12 center points per block. In below equation, author designates betas as the coefficient of linear, quadratic and interaction of input V (voltage), F (wire feed), S (travel speed), A (current), HI (Heat Input) and CTWD (cup to work piece distance). The β_0 is the intercept term whereas β_1, β_2, β_3, β_4 and β_{11}, β_{22}, β_{33} β_{34}, β_{14}, β_{24} are the linear terms and interaction between variables terms respectively.

Y (responses)=β_0+β_1 (current)+β_2 (wire feed)+β_3 (heat-input)+β_4 (CTWD)+β_{11} (current^2)+β_{22} (wire feed^2)+β_{33} (heat-input^2)+β_{12} (current × wire feed)+β_{13} (current × heat-input)+β_{23} (wire feed × heat-input)+β_{34} (heat-input × CTWD)+β_{14} (current × CTWD)+β_{24} (wire feed × CTWD).

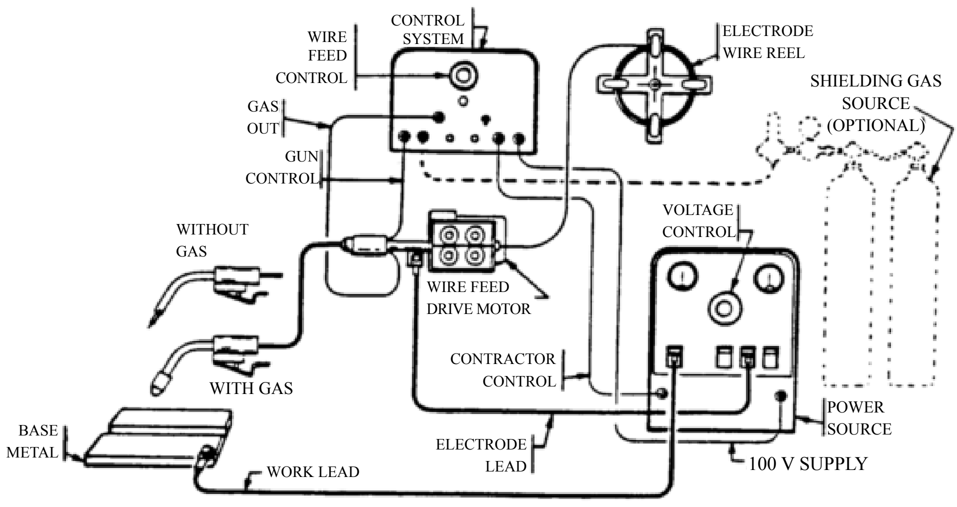

Figure 1: Flux core arc welding process schematic diagram (courtesy of www.weldingis.com).

Name	Units	Analyze	Objective	Impact	Sensitivity	Low	High
Hardness	HV	Mean	Minimize	3.0	Medium	160.0	230.0
Deposition rate	lb/hr	Mean	Maximize	3.0	Medium	10.0	16.0
Bead width	mm	Mean	Maximize	3.0	Medium	8.0	14.0
Reinforcement	mm	Mean	Maximize	3.0	Medium	2.0	4.0

Table 1: Defining of responses to be varied.

Name	Units	Type	Role	Low	High
A:Current	Amp	Continuous	Controllable	90.0	330.0
B:Wire feed	mm/min	Continuous	Controllable	135.0	235.0
C:Heat input	kJ/mm	Continuous	Controllable	12.0	20.0
D:CTWD	mm	Continuous	Controllable	12.0	25.0

Table 2: Defining of controllable factors to be measured.

Type of factors	Design type	Center Point		Design is Randomized	Total runs
		Per block	Placement		
Process	Central composite design: 2^4+star	12	Last	Yes	36=16+12+08 Total Corner Points=2^4=16 Total Center Points=12 Total Star Points=2 × n=2 × 4=8

Table 3: Design of experiments for a flux-cored arc welding process.

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The DOE is summarized in Table 3 [9].

To fit the results of the experiment, the quadratic model of factors interaction is used and below table is the statistical data collected from large data points of the mobile welding shop, 32 runs are collected and responses of each run are measured from actual testing in mechanical laboratory (Table 4). The welding was conducted on API 5L Gr. 70 (fine grain normalized 10 mm thickness) material with single bevel angle. Bevel angle was checked with dye penetrant testing for any possible defects like crack etc. FCAW machine of model Lincoln "Idealarc CV400" was used for welding, whereas reinforcement was measured by using Cambridge type welding gauge.

The welding joint design (joint design and bead width and reinforcement height etc.) and the test coupons welded to get the responses on data matrix as per CCD of RSM are given in Figure 2a and 2b, respectively [2].

Analysis of the Experiments Results

After welding data matrix is created through CCD of RSM, then data is passed through significance test [9]. Since the observed response values and expected response values are different, it mean there are possibilities of either it happened only by chance (5%) or it happened by manipulation of controllable variables (95%). Therefore we start from null hypothesis, mean that the obtained variables do not bear any relation or significance with the responses and to check the null hypothesis rejection or correctness, *p* value is calculated and if the *p* value is less than alpha value, then it will reject the null hypothesis.

The analysis of variance is calculated for each of response and is explained in detail. Refer to Table 5 for hardness, Table 6 for deposition rate, Table 7 for bead width and Table 8 for reinforcement height.

R-squared is a statistical measure of how close the data are to the fitted regression line; 0% indicates that the model explains none of the variability of the response data around its mean; 100% indicates that the model explains all the variability of the response data around its mean. Value of R-squared is calculated to explain the fitted in the model which is 86.982185% of the variability in hardness. The value of

	Controllable factors				Responses received from welded work pieces			
	F1	F2	F3	F4	R1	R2	R3	R4
Run	Current	Wire feed	Heat input	CTWD	Hardness of weldment	Deposition rate	Bead width	Reinforcement
Unit	Amp	mm/min	KJ/mm	mm	HV	lb/hr	mm	mm
1	330	235	12	12	175.5	11	10	2
2	330	235	20	12	190	15	12	3
3	90	235	20	12	171	13	9	4
4	210	185	16	20	188	12	10	3
5	90	135	20	12	162	13	8	4
6	210	285	16	18.5	195	12	10	3
7	210	185	24	18.5	198	14	11	3.5
8	90	135	20	25	168	13	8	4
9	300	185	16	18.5	210	13	13	2.8
10	450	185	16	18.5	205	14	10	3
11	90	135	12	12	165	10	9	2.5
12	90	235	20	25	175	13	9	3
13	210	185	16	20	181	12	12	3.5
14	210	185	16	18.5	177	12	11	3
15	330	235	20	25	225	15	14	3
16	330	135	12	12	185	12	11	4
17	330	135	20	12	212	14	12	3
18	330	135	12	25	165	11	10	3
19	90	135	12	25	166	11	10	2.5
20	90	235	12	12	178	10	9	2.5
21	210	185	12	18.5	187	10	12	2
22	90	235	12	25	178	11	10	2.5
23	330	235	12	25	180	12	13	3.5
24	330	135	20	25	225	15	12	4
25	210	185	16	18.5	181	11	11	3
26	210	185	16	18.5	177	11	11	3
27	210	185	16	18.5	181	11	11	3
28	210	185	16	18.5	177	12	11	3
29	210	185	16	18.5	181	11	11	3
30	210	185	16	18.5	177	11	11	3
31	210	185	16	18.5	181	11	11	3
32	210	185	16	18.5	177	11	11	3
33	210	185	16	18.5	181	12	11	3
34	210	185	16	18.5	177	11	11	3
35	210	185	16	18.5	185	11	11	3
36	210	185	16	18.5	180	11	11	3

Table 4: DOE data matrix based on CCD (factorial matrix+axial points+center points).

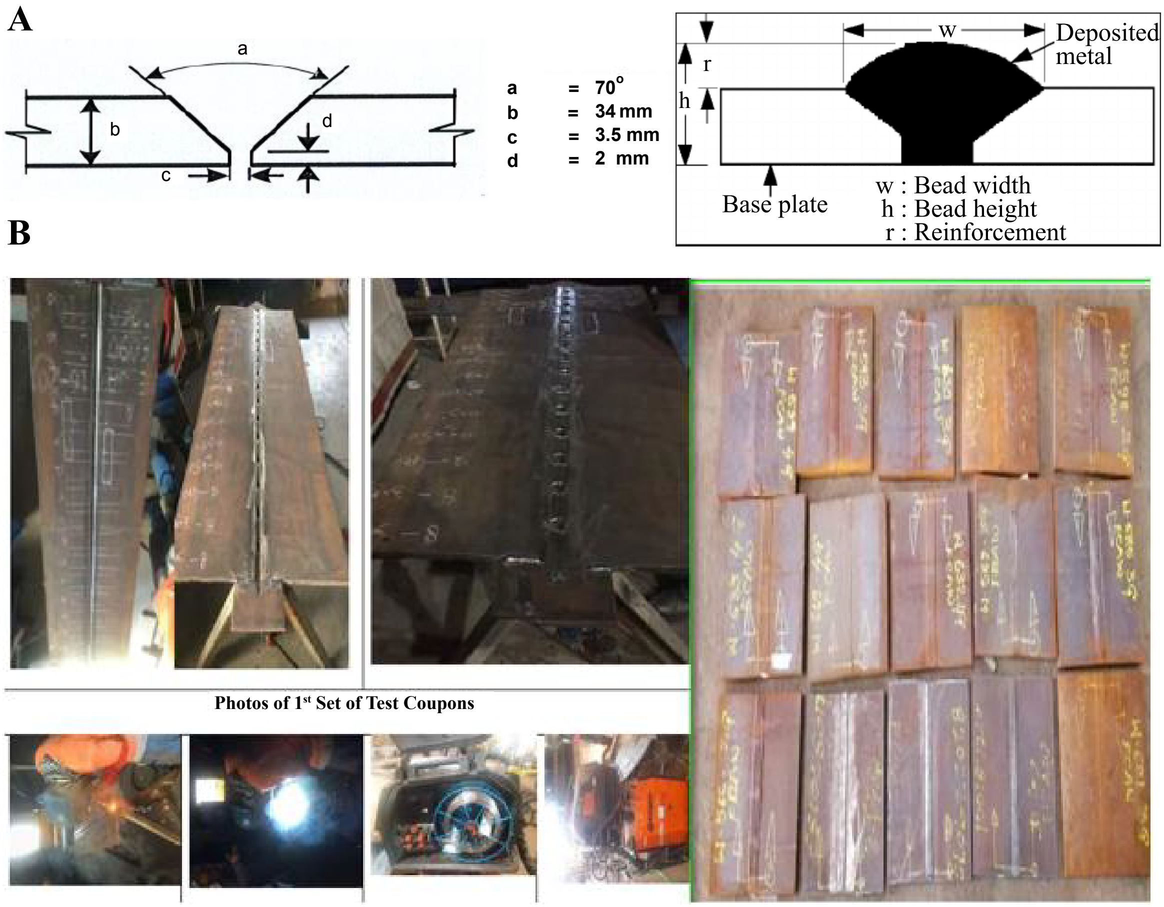

Figure 2: (a) Joint design detail used for FCAW welding. (**b**) Test coupon welded to get the data matrix as per CCD of RSM.

Factors/interaction	Sum of squares	Degree of freedom (df1)	Mean Square[1]	F-Ratio[2]	*p* value[3]
A:Current	2619.0604	1	2619.0604	51.51	0.0000
B:Wire feed	37.904121	1	37.904121	0.75	0.3977
C:Heat input	985.04658	1	985.04658	19.37	0.0002
D:CTWD	124.98295	1	124.98295	2.46	0.1319
AA	0.18639344	1	0.18639344	0.00	0.9523
AB	206.64063	1	206.64063	4.06	0.0568
AC	1550.3906	1	1550.3906	30.49	0.0000
AD	28.890625	1	28.890625	0.57	0.4593
BB	79.676263	1	79.676263	1.57	0.2244
BC	83.265625	1	83.265625	1.64	0.2146
BD	118.26563	1	118.26563	2.33	0.1421
CC	16.460496	1	16.460496	0.32	0.5754
CD	328.51563	1	328.51563	6.46	0.0190
DD	28.868497	1	28.868497	0.57	0.4595
Total error (df2)	1067.6805	21	50.841929		
Total (Corr.)	8201.6875	35			

[1] Mean square =Sum of square/df; [2] F-Ratio=Mean square/Total error; [3] *p* value=F. Dist (F-Ratio, df1,df2, False)

R-squared value=86.982185%; R-squared after adjustment for degree of freedom=78.303642%; Standard error of estimated=7.1303527; Mean absolute error=3.881992

Table 5: Variance's analysis for hardness.

R-squared is adjusted as 78.303642% and the value is most suitable for comparing models with a different independent response. In the same way, the standard error is 7.13 and MAE are 3.88 which is the average value of the residuals.

$$\text{R - Squared} = 1 - \frac{(\text{Sum of Square} - \text{Sum of square of Error})}{\text{Total Sum of Square}} = 86.90\%$$

$$\text{Adjusted R - Squared due to degree of freedom} = 1 - \frac{(1 - R_2).(n-1)}{n-k-1} = 79\%$$

Factor/Interaction	Sum of squares	Degree of freedom	Mean square	F-Ratio	*p* value
A:Current	8.3005897	1	8.3005897	29.85	0.0000
B:Wire Feed	0.066144076	1	0.066144076	0.24	0.6308
C:Heat input	36.882212	1	36.882212	132.63	0.0000
D:CTWD	0.66349255	1	0.66349255	2.39	0.1374
AA	1.2959405	1	1.2959405	4.66	0.0426
AB	0.0625	1	0.0625	0.22	0.6403
AC	0.5625	1	0.5625	2.02	0.1696
AD	0.0625	1	0.0625	0.22	0.6403
BB	0.17527193	1	0.17527193	0.63	0.4361
BC	0.0625	1	0.0625	0.22	0.6403
BD	0.0625	1	0.0625	0.22	0.6403
CC	0.042469031	1	0.042469031	0.15	0.6999
CD	0.0625	1	0.0625	0.22	0.6403
DD	1.5727648	1	1.5727648	5.66	0.0270
Total error	5.8396424	21	0.27807821		
Total (Corr.)	70.0	35			
R-squared value=91.657654%; R-squared after adjustment for degree of freedom=86.09609%; Standard error of estimated=0.52733121; Mean absolute error=0.34372867					

Table 6: Variance's analysis for deposition rate.

Factors/Interaction	Sum of squares	Degree of freedom	Mean square	F-Ratio	*p* value
A:Current	32.399373	1	32.399373	80.72	0.0000
B:Wire feed	2.2410869	1	2.2410869	5.58	0.0279
C:Heat input	0.026391575	1	0.026391575	0.07	0.8001
D:CTWD	2.1845427	1	2.1845427	5.44	0.0297
AA	10.67738	1	10.67738	26.60	0.0000
AB	0.25	1	0.25	0.62	0.4388
AC	6.25	1	6.25	15.57	0.0007
AD	0.25	1	0.25	0.62	0.4388
BB	2.6191071	1	2.6191071	6.53	0.0185
BC	0.25	1	0.25	0.62	0.4388
BD	2.25	1	2.25	5.61	0.0276
CC	0.0021814827	1	0.0021814827	0.01	0.9419
CD	0.25	1	0.25	0.62	0.4388
DD	1.4653593	1	1.4653593	3.65	0.0698
Total error	8.4291227	21	0.4013868		
Total (Corr.)	60.75	35			
R-squared value=86.124901%; R-squared after adjustment for degree of freedom=76.874835%; Standard error of estimated=0.63355094; Mean absolute error=0.34661996					

Table 7: Variance's analysis for bead width.

Factors/Interaction	Sum of squares	Degree of freedom	Mean square	F-Ratio	*p* value
A:Current	0.011056323	1	0.011056323	0.08	0.7805
B:Wire Feed	0.76015143	1	0.76015143	5.48	0.0292
C:Heat input	2.7666318	1	2.7666318	19.94	0.0002
D:CTWD	0.023376017	1	0.023376017	0.17	0.6856
AA	0.0049954797	1	0.0049954797	0.04	0.8513
AB	0.140625	1	0.140625	1.01	0.3256
AC	1.265625	1	1.265625	9.12	0.0065
AD	0.390625	1	0.390625	2.81	0.1082
BB	0.14519441	1	0.14519441	1.05	0.3180
BC	0.015625	1	0.015625	0.11	0.7405
BD	0.015625	1	0.015625	0.11	0.7405
CC	0.14045144	1	0.14045144	1.01	0.3258
CD	0.015625	1	0.015625	0.11	0.7405
DD	0.1089928	1	0.1089928	0.79	0.3855
Total error	2.9141605	21	0.13876955		
Total (corr.)	8.6430556	35			
R-squared value=66.283215%; R-squared after adjustment for degree of freedom=43.805358%; Standard error of estimated=0.37251785; Mean absolute error=0.18288048					

Table 8: Variance's analysis for reinforcement.

The variability in hardness is obtained by ANOVA table and is mentioned separately for all effects. By comparison between mean square with experimental error (estimated), the statistical significance is calculated. If the *p* value is less than 0.05 then the response or their interaction are significant and in our analysis, we found four cases where *p* value is less than 0.05 and are highlighted in the table with red color and it is the indicating factor for significantly different from 0 at 95% confidence level.

Based on analysis of variance through ANOVA, the significant controllable factors are identified and then plot against the standardized effect. Figure 3 shows that current, heat input, the quadratic effect of current and heat input have a major effect on hardness value whereas the other factors are ignored from Pareto chart and from the further process. Figure 3 shows only factors with *p* value 0.2% but we considered factors whose *p* value are less than 0.05%.

In an analysis of variance for deposition rate, we have found 4 interaction which is current, heat input and AA and DD effects the deposition because *p* values is smaller than 0.05, at the 95% confidence level. The value of R-Squared is 91.6% and adjusted R-squared value is 86.09% and standard error of test is 0.5 and mean absolute error is 0.343. Based on analysis of variance through ANOVA, the significant controllable factors are identified and then plot against the standardized effect. Figure 4 shows that current, heat input, the quadratic effect of current and heat input have a major effect on deposition rate whereas the other factors are ignored from Pareto chart and from the further process. Figure 4 shows only factors with *p* value 0.4% but we considered factors whose *p* value are less than 0.05%.

In an analysis of variance for bead width, we have found 7 interaction which is current, wire feed, AA, AC, BB, BD etc., effects the bead width because *p* value is smaller than 0.05, at the 95% confidence level. The value of R-Squared is 86.12% and adjusted R-squared value is 76.87% and standard error of estimated is 0.6 and mean absolute error is 0.346. Base on analysis of variance through ANOVA, the significant controllable factors are identified and then plotted against the standardized effect. Figure 5 shows that current, wire feed and CTWD and their combined interaction have a major effect on bead width. Whereas other factors are ignored from Pareto chart and from the further process. Figure 5 shows only factors with *p* value 0.4% but we considered factors whose *p* value are less than 0.05%.

In an analysis of variance for reinforcement height, we have found 3 interaction which is current, wire feed and AC effects the reinforcement height because *p* values is smaller than 0.05, at the 95% confidence level. The value of R-squared is 66.28% and adjusted R-squared value is 43.80% and standard error of estimated is 0.3 and means the absolute error is 0.18288. Based on analysis of variance through ANOVA, the significant controllable factors are identified and then plotted against the standardized effect. Figure 6 shows that current, wire feed and AC have a major effect on reinforcement height. Whereas, the other factors are ignored from Pareto chart and from the further process. Figure 5 shows only factors with *p* value 0.3% but we considered factors whose *p* values are less than 0.05%.

Optimization through Desirability Function

Optimum factors setting values are obtained through the value of

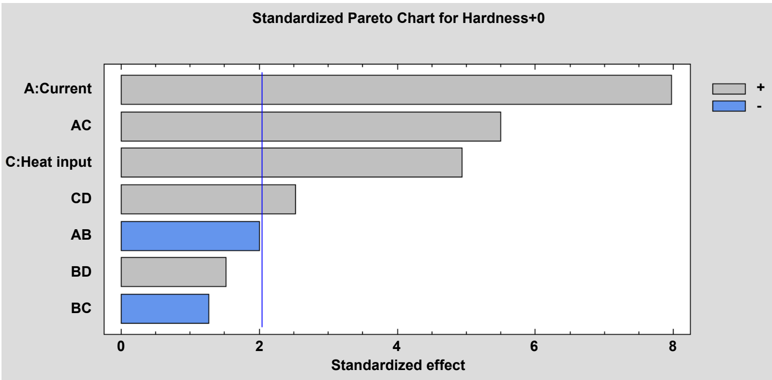

Figure 3: Standardized Pareto chart for hardness.

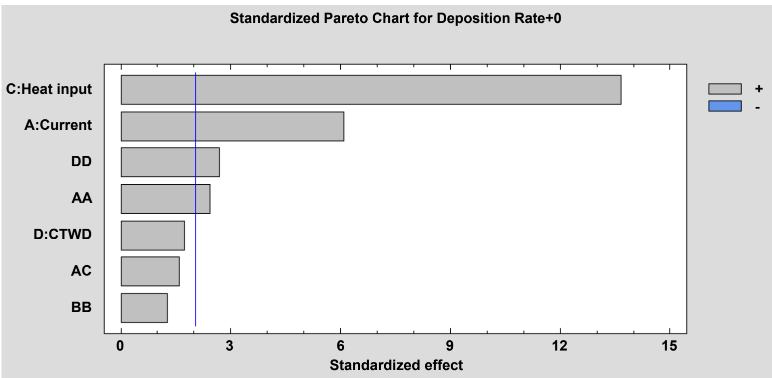

Figure 4: Standardized Pareto chart for deposition rate.

optimized desirability which is obtained by considering the combined results of all five responses for specific predicted values [9,10]. For optimization of response values, we have selected confident level of 95%. Whereas predicted values of each response is a mean value of upper 95% and lower 95% limit. Observed desirability is calculated from observed values of all response values for each run of an experiment by using Derringer's model. Whereas predicted desirability is obtained from predicted values of all response base on lower and upper 95% limits of the confidence level.

Desirability function

The desirability function and loss function are used optimized approaches and we have used desirability function methodology because it is more applicability and flexibility as compared to loss function [11-14]. As per definition is given by Harrington [11], "*converts every response value into scale-free value is known as desirability*". The desirability function was also studied and shared by Derringer and Suich's [12] which is used for nominal-the-best (NTB), larger-the-best (LTB), smaller-the-best (STB) type of measurable responses. In our DOE, we have selected the larger-the-best which is defined as:

$$d(i)=\begin{cases} 0, & yl =< LSLi \\ \dfrac{\hat{Y}l-USLi}{LSLi-USLi}, & LSL<\widehat{yl}<USLi \\ 1, & yl => USLi \end{cases}$$

Where d_i is the desirability function, y_{et} is the response, USL_i is the upper 95% limit and LSL_i is the lower 95% limits.

Table 9 shows all calculation where responses are optimized by getting their prediction by taking the mean of lower 95% limits and upper 95% limit for examples the optimized predicted values for hardness, deposition rate, bead width and reinforcement rate are 178.4, 15.05, 10.96 and 3.5, respectively. Based on Derringer and Suich's desirability function as defined above, the desirability is calculated for hardness, deposition rate, bead width, and reinforcement height are 73.5 %, 84.23%, 49.34% and 75.81%, respectively [9].

The overall desirability or optimized desirability is equaled 70%, which is obtained by considering the desirability of all responses then taking each value to the power equal to its impact, taking the product of both results, and the resultant product raises to a power equal to 1 divided by impact summation. A result is a number between 0 and 1, with more weight given to the response with the higher impact.

Composite Desirability=$[d1^{0.25}.d2^{0.25}.d3^{0.25}.d4^{0.25}]^{1/1}=(0.7359)^{0.25}(0.8423)^{0.25}+(0.49341)^{0.25}+(0.7580)^{0.25}=0.72=72\%$

Optimum setting of factors are obtained based on optimized desirability vs optimized responses values and are given in Table 10 and the graphical representation is mentioned in Figures 6, 7a and 7b.

Validation and Discussion

After getting the optimal values for factors next stage was to validate these values refer to Figure 7c. In order to do this final weld, the run was conducted by using these optimal values obtained during these analyses. Welding was performed under same circumstances using the same material. Final results were obtained and found very close to the optimal responses as mentioned in Table 11.

Here hardness testing was performed by using portable hardness tester of model Reichert K2662 and tensile testing was performed by using UTS machine of Galdabini model Sun60-V630 whereas, reinforcement was measured by using cambridge type welding gauge

Response	Optimized	Prediction	Lower 95% limit	Upper 95% limit	Desirability
Hardness	yes	178.48607	161.74129	195.23086	0.73591323
Deposition Rate	yes	15.054339	14.317798	15.790879	0.84238979
Bead Width	yes	10.960504	9.4417419	12.479266	0.49341736
Reinforcement	yes	3.5161812	2.8917234	4.1406389	0.75809058

Table 9: Optimum response values.

Factor	Setting
Current	216.62446
Wire feed	266.99596
Heat input	23.999996
CTWD	12.000014

Table 10: Factor settings at optimum.

Optimized factors	Optimized responses	Actual results (Responses)
Current=216.62446 amp	Hardness=178.48607	Hardness=170
Wire feed=266.99595 mm	Deposition rate=15.05339 lb/hr	Deposition rate=15.5 lb/hr
CTWD=12.0000014 mm	Bead width=10.960504 mm	Bead width=11 mm
Heat input=23.999996 KJ/mm	Reinforcement=3.5161812 mm	Reinforcement=3.3 mm

Table 11: Comparison between optimized and actual results.

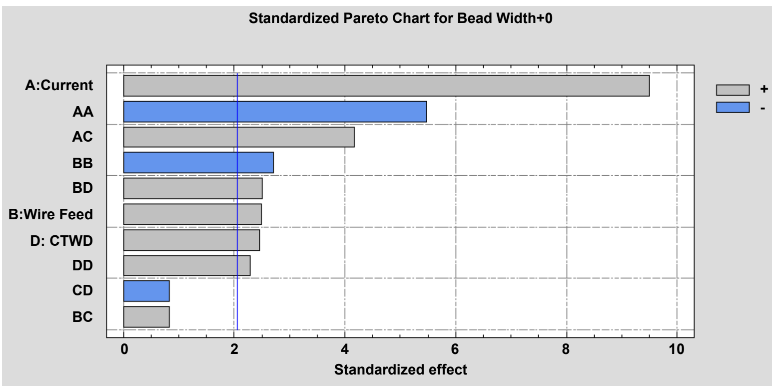

Figure 5: Standardized Pareto chart for bead width.

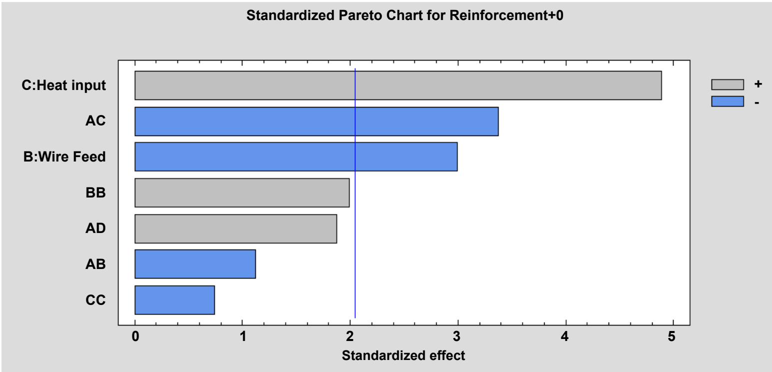

Figure 6: Standardized Pareto chart for reinforcement height.

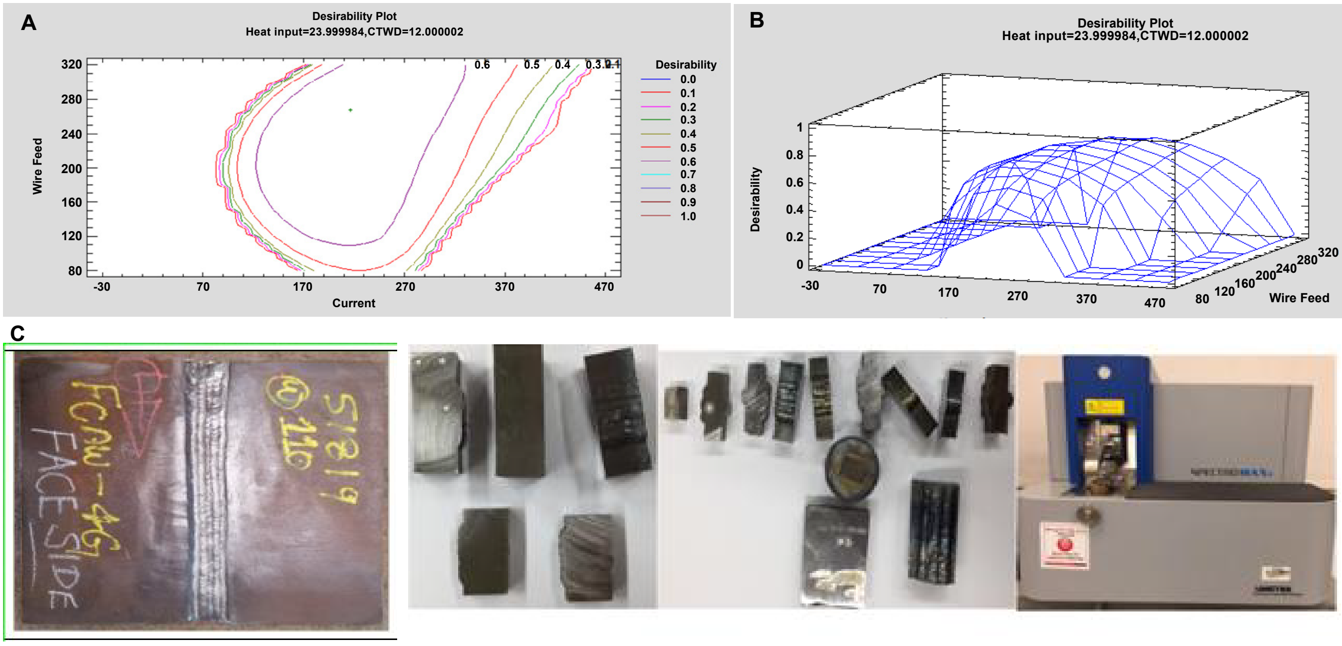

Figure 7: **(a)** Optimum factors setting at the optimum desirability, (**b)** Optimum factors setting at the optimum desirability, (**c)** Test coupon for validation.

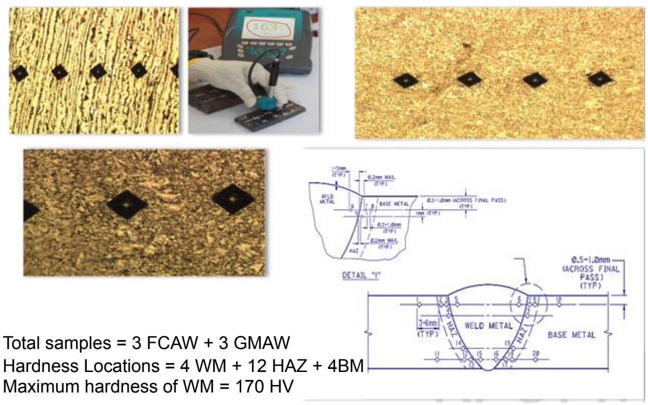

Figure 8: Hardness testing for the validated test coupon.

and bead width with a simple ruler (Figure 8).

Conclusion

Study highlight the need of narrow down the acceptance tolerance window as provided in International standard to reduce the rework and cost .Study explore the region for the best among the best weld condition based on multicriteria optimization. Study highlight the attempt to going through the international manufacturer standards by composite design and Box Behnken for the outdoor welding condition. Study was conducted by deploying response surface methodology on real life data collected from production line.

The above framework of the analyses can be applied for any such welding case and can be combined in a single software package to find optimal weld conditions leading to enhanced weld quality.

Acknowledgement

The completion of this research work could not be possible without support and assistance of so many people whose names may not all be enumerated, however, we would like to express our thanks to particular Mr. Ali Raza Lone, QC Manager of Saudi Arkad; Mr. Azhar, Ph. D. student of KFUPM; Mr. Saravanan, JGC Department Manager of Construction and the most Mr. ITO Kenji, Senior

Manager, JGC for their endless support during my research work. The research work's abstract of same methodology on FCAW was also presented in "15th Annual Congress on Materials Research & Technology" held during February 19-20, 2018 in Paris, France.

Compliance with Ethical Standards

All procedure performed in our research involving human participants are in accordance with ethical standards of the KFUPM and Govt. of KSA.

Conflict of Interest

The authors declare that they have no conflict of interest.

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