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# To Investigate the Process Parameters for Reducing Wear by Hard Facing in Dual Plate Check Valve

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**Abstract:** WEAR is an important consideration while determining different properties of valves. A detailed analysis of dual plate check valve is done using different parameters like Sliding velocity, Applied load, Current, welding filler rod diameter on the contacting surfaces of valve disc and seat. Samples of dimensions (Diameter 10mm,length 30mm) of mild steel is prepared having composition wt% C-0.16,Si-0.03,Mn-0.32,S-0.05,P-0.2,Ni-0.01 and Fe. In this process, TIG welding is used in which an arc is drawn between a Stellite12 and Stellite 1 coated consumable electrodes and the work piece. In the Present study orthogonal array L9 was selected as there are three process parameters with three levels. In this three process parameters Applied load, Sliding velocity, Welding Current are used. Different tests like Wear test, Hardness test and Hydraulic tests are implemented to make the required results. Design of experiment including Taguchy analysis used to investigate optimum process parameters. Condition of least sensitive to noise to produce high quality products with low manufacturing costs.

**Keywords**: Hard facing, welding parameters, abrasive wear testing .taguchi experiments

## I. Introduction

Dual plate check valve is a unidirectional flow device: it allows flow in one direction only. The pressure of flowat inlet opens the valve disc and the pressure from outlet closes it, Controlling the movement of the disc towards the valve seat.

Fig.1 Dual plate check valve

It has wafer type valve shaped attached with the two flanges. It controls the flow rate loss at the lowest level. It prevents shocks and disturbance. Initially, the flowing fluid enters the valve from the seat end and open the two disc to fully open. During counter flow, valve closes instantly with help of the springs.

## II. Treatment of Surface

Surface treatment involves heating materials in environmental reactive and non reactive conditions to produce structural changes or the formation of chemical compounds only on the upper layer of little micron thickness.

Surface Coating: Coatings can be classified as

1) Soft coatings with low or moderate-to-low friction
2) Hard coatings with wear resistance and moderate friction.
   Examples Chromium, nickel, cobalt and nickel- based alloys, Satellite 12.

### 2.1 Applications

1) Hard metallic coating bearings and seals, cylinder liners, piston rings, and compressors, gun and metal-

working tools, etc.

2) Soft coatings of polymers and soft metals are used in bearing, seals, pumps, impellers, electrical contacts etc.

Coating deposition techniques:

- Hard facing
- Vapour Deposition Process

Hard facing is used for thick depositing of hard wear-resistant material.Vapour deposition method are used for thin deposits.

Fig. 2- Dual plate check valve before welding

Fig 3- Dual plate check valve after welding

**2.2 Problem Formulation**

Valve seat is an integral part of a valve. It provides a stable, uniform and shut down surface. The erosion of seat cause galling, valve destruction and Breakdown. The figure locates wear.

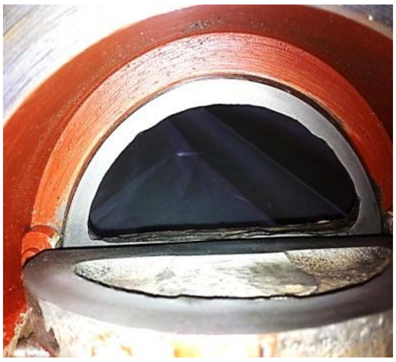


Fig 4: Wear occurrence place

To reduce the wear of the valve seat, hard-facing of surface is done by welding process

Controlling parameters:

- By varying applied load.
- By varying sliding velocity.
- By varying welding current.

**2.3 Tig Welding**

An arc is drawn between a Satellite 12 and Stellite 1 coated consumable electrodes alternatively and the work surface for analysis.. This satellite 12 act as a base layer on the specimen. After this one layer of Satellite 1 is applied; which dissolved in satellite 12 and helps in making secondary layer for the improvement of properties like hardness, stability etc.

**Table 1: GTAW Welding input parameters**

| **S. No.** | **Parameters** | **Values** |
|---|---|---|
| **1** | Arc Current (A) | 170-210 |
| **2** | Arc Voltage (V) | 20 |
| **3** | Electrode Diameter (mm) | 3.5,5,7 |

| | | |
|---|---|---|
| **4** | Welding Speed or Travel Speed (mm/min.) | 20-50 |
| **5** | Electrode or sample distance(mm) | 1.5-5mm |
| **6** | Electrode kind | Stellite 12 &Stellite 1 |
| **7** | Temperature(C) | 33-45 |
| **8** | Humidity (%) | 30-34 |

Fig. 5- Dual plate check valve after machining

Fig. 6- Assembled view of dual plate check valve

**2.4 Taguchi Experimental Design**

**Table 2 Process Parameters and Levels Of The Experimental Design**

| **Parameters** | **Labels** | **Level 1** | **Level 2** | **Level 3** |
|---|---|---|---|---|
| Applied Load (kgs) | A | 1.5 | 3 | 5 |
| Sliding Velocity (mm./min) | B | 25 | 30 | 45 |
| Welding Current (Amp) | C | 170 | 190 | 200 |

2.5 Orthogonal Array Selection
Orthogonal array L9 used because 3 process parameters with 3 levels.

**Table 3: L9 Orthogonal Array used in Taguchi method**

| Trials | A | B | C |
|---|---|---|---|
| 1 | 1 | 1 | 3 |
| 2 | 1 | 2 | 2 |
| 3 | 1 | 3 | 1 |
| 4 | 2 | 1 | 2 |

| | | | |
|---|---|---|---|
| 5 | 2 | 2 | 1 |
| 6 | 2 | 3 | 3 |
| 7 | 3 | 1 | 1 |
| 8 | 3 | 2 | 3 |
| 9 | 3 | 3 | 2 |

### 2.6 ABRASIVE WEAR TEST

The test was conducted on a machine . The sample was hold vertically on vice So that one of its face forced against the abrasive whichis fixed on the revolving disc. It tends to wearout the surface of the samples. The test was conducted using following parameters

- Load (1.5KG,3KG,5KG)
- Time (15 min each)

The table shown below gives the experimental results obtained after conducting wear test using taguchi array.

**Table 4: Experimental Results of Weight Loss (Wear)**

| Applied Load(Kg) | Sliding velocity(mm/m) | Welding current | Weight loss | Weight loss | Weight loss |
|---|---|---|---|---|---|
| 1.5 | 25 | 170 | 4.8 | 4.2 | 4.7 |
| 1.5 | 30 | 190 | 5.4 | 5.9 | 8.8 |
| 1.5 | 45 | 200 | 7.2 | 9.3 | 9.3 |
| 3 | 25 | 190 | 5.1 | 5.2 | 5.3 |
| 3 | 30 | 200 | 11.3 | 11.3 | 12 |
| 3 | 45 | 170 | 12 | 12.6 | 15 |
| 5 | 25 | 200 | 7.2 | 13.5 | 14.8 |
| 5 | 30 | 170 | 11 | 17.5 | 22 |

**Table 5: Estimated Model Coefficients for SN Ratios**

| Term | | Coef | SE Coef | T | P |
|---|---|---|---|---|---|
| Constant | | -19.7544 | 0.3023 | -65.346 | 0 |
| Applied load | 1.5 | 3.5254 | 0.4275 | 8.246 | 0.014 |
| Applied load | 3.0 | 0.4154 | 0.4275 | 0.972 | 0.434 |
| Sliding velocity | 25 | 3.3149 | 0.4275 | 7.754 | 0.016 |
| Sliding velocity | 30 | -1.1794 | 0.4275 | -2.759 | 0.110 |
| Welding current | 170 | -0.4072 | 0.4275 | -0.952 | 0.441 |
| Welding current | 190 | 1.2464 | 0.4275 | 2.915 | 0.100 |

S = 0.9069 R-Sq = 98.9% R-Sq(adj) = 95.4%

**Table 6: Analysis Of Variance For SN Ratios**

| Source | DF | Seq SS | Adj SS | Adj MS | F | P |
|---|---|---|---|---|---|---|
| Applied load (Kg) | 2 | 84.391 | 84.391 | 42.1954 | 51.30 | 0.019 |
| Sliding velocity | 2 | 50.819 | 50.819 | 25.4095 | 30.89 | 0.031 |
| Sliding velocity | 2 | 7.271 | 7.271 | 3.6354 | 4.42 | 0.185 |
| Residual error | 2 | 1.645 | 1.645 | 0.8225 | | |
| Total | 8 | 144.126 | | | | |

**Table 7 Linear Model Analysis: Means Versus Applied Load, Sliding Velo, Welding Current**

**Table 7.1 Estimated Model Coefficients for Means**

| Term | | Coef | SE Coef | T | P |
|---|---|---|---|---|---|
| Constant | | 10.5556 | 0.1982 | 54.757 | 0 |
| Applied load | 1.5 | -3.9333 | 0.2726 | -14.428 | 0.005 |
| Applied load | 3.0 | -0.5778 | 0.2726 | -2.119 | 0.168 |
| Sliding velocity | 25 | -3.3556 | 0.2726 | -12.309 | 0.007 |
| Sliding velocity | 30 | 1.1333 | 0.2726 | 3.157 | 0.053 |
| Welding current | 170 | 0.9778 | 0.2726 | 3.587 | 0.070 |
| Welding current | 190 | -1.0778 | 0.2726 | -3.953 | 0.058 |

S = 0.5783 R-Sq = 99.6% R-Sq(adj) = 98.4%

**Table 7.2 Analysis of Variance for Means**

| Source | DF | Seq SS | Adj SS | Adjms | F | P |
|---|---|---|---|---|---|---|
| Applied Load (Kg) | 2 | 108.465 | 108.465 | 54.2326 | 162.16 | 0.006 |
| Sliding velocity | 2 | 52.447 | 52.447 | 26.2237 | 78.41 | 0.13 |
| Welding Current | 2 | 6.383 | 6.383 | 3.1915 | 9.54 | 0.095 |
| Residual Error | 2 | 0.669 | 0.669 | 0.3344 | | |
| Total | 8 | 167.964 | | | | |

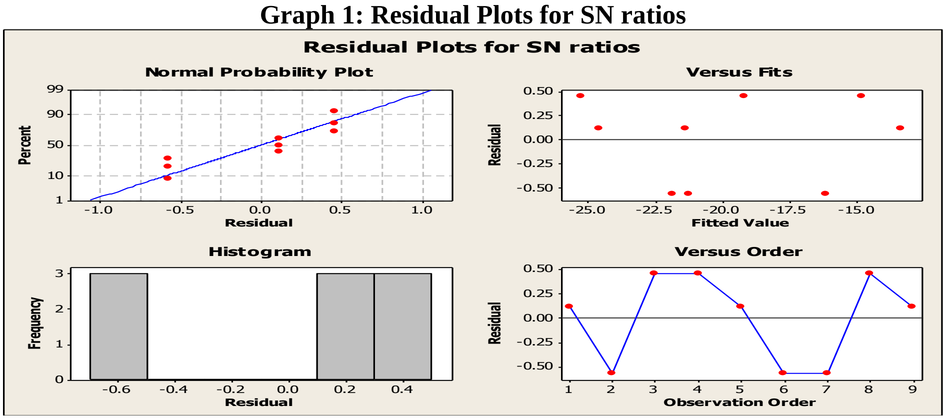
**Table 7.3 Response Table for Signal to Noise Ratios. Smaller is better**

| Level | Applied load | Sliding velocity | Welding current |
|---|---|---|---|
| 1 | -16.23 | -16.44 | -20.16 |
| 2 | -19.34 | -20.93 | -18.51 |
| 3 | -23.70 | -21.89 | -20.59 |
| Delta | 7.47 | 5.45 | 2.09 |
| Rank | 1 | 2 | 3 |

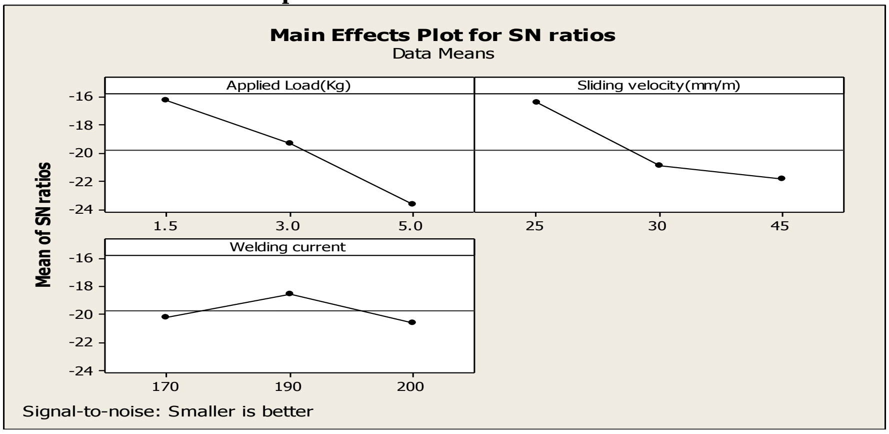
**Table 7.4 Response Table for Means**

| Level | Applied load | Sliding velocity | Welding current |
|---|---|---|---|
| 1 | 6.622 | 7.200 | 11.533 |
| 2 | 9.978 | 11.689 | 9.478 |
| 3 | 15.067 | 12.778 | 10.656 |
| Delta | 8.444 | 5.578 | 2.056 |
| Rank | 1 | 2 | 3 |

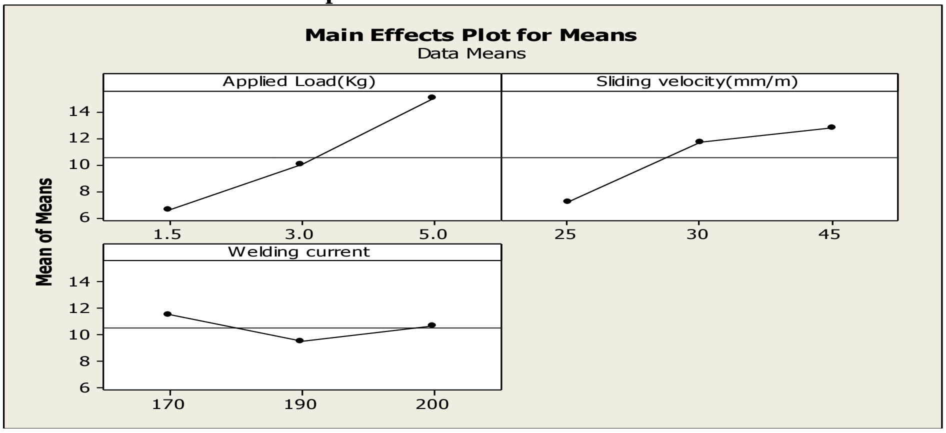
**Graph 1: Residual Plots for SN ratios**



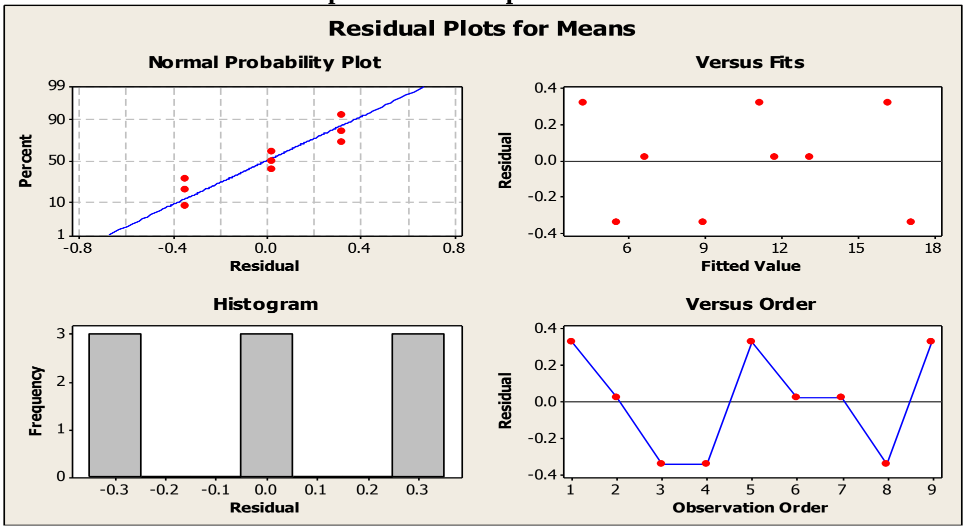
**Graph 2: Main Effects for SN ratios**




**Graph 3: Main Effects for Means**




**Graph 4: Residual plots for Means**




## III. Conclusion

a) Wear rate in valve seat was reduced.
b) Wear properties using S/N ratio gives the optimum parameters are A1, B1, and C2 at optimum conditions of Applied pressure (1.5Kgs.),Sliding Velocity (25mm/minute), and Welding current(190A)
c) Applied load has maximum effect on wear.
d) Specimen 3 shows highest value of hardness and wear resistance.

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