CHAPTER – 7

Calculation of SCT, NBT and CT

Introduction

Short-circuiting and burning is a cyclic process of welding, one welding cycle is one short-circuiting plus one burning. The welding process stability can be known form computing the Short-Circuiting Time (SCT) and Burning Time (BT) [47].

Using WSA software, time taken for one short-circuiting and burning and its cycle time, can be computed for any desired range of samples. The mode value of the samples taken for investigation is considered as reference or threshold voltage and is used for finding SCT, BT, NBT and Cycle Time (CT).

Short-Circuiting Time (SCT) is the time elapsed between the welding voltage equals the threshold voltage, the occurrence of welding and the welding voltage again recovering back to the threshold voltage.

Voltage spike is any sudden increase in short circuiting voltage for a duration not exceeding 12millisecond.

Net Burning Time (NBT) time elapsed between the starting of the ‘fusion of metals and the welding electrode’ and the completion of that cycle of welding process [start of the next short circuiting phenomena].

Cycle Time (CT) Cycle time is the sum of short circuiting time and burning time.

Short circuiting takes place when welding voltage is less than threshold in that duration the welding current is high.

Burning takes place when welding voltage is above the threshold voltage during that time the welding current is low.
7.1 SCT, NBT and CT

Fig. 7.1.1 shows the Short Circuiting Time (SCT), Net Burning Time (NBT) and Cycle Time (CT) of a 12millisec. The function of the program, its algorithm and flow chart is shown in fig. 7.1.2 for computing SCT, NBT and CT are discussed below.

![Weld Voltage Signature](image)

**Fig.7.1.1 SCT, NBT & CT in welding voltage signature**

There are two flags used in this program. One is the SCT flag and another is BT flag. These flags are used to check whether it is burning time event or short circuiting time event that occurs for the first time. During the start of the program both the flags are disabled. After both the events occur for the first time both the flags are enabled. As soon as the short circuiting starts, the SCT flag is disabled then the weld voltage value is continuously checked whether it is greater than threshold. Once the weld voltage value is lesser than threshold, it signifies the end of short circuiting time.

The total short circuiting time is calculated by using the SCT start time and SCT end time. As soon as the burning starts, the BT flag is disabled. The BT Start count and BT End count are obtained. Each time the weld voltage value is compared with the threshold value.
The end of burning time is signified when the weld voltage value goes below the threshold value. The count at which the weld voltage value goes below the threshold value is the BT End count.

The BT Total is calculated by using the BT Start count and BT End count.

The cycle time is equal to the sum of short circuiting time and burning time

7.2 Algorithm for Computing SCT and NBT

NBT- Net Burning time

SCT- Short Circuting time

Step 1: Start the program

Step 2: Get the data

Step 3: check whether the value is greater than the threshold value. if it is greater than or equal to the threshold value then continue or else go to step 10

Step 4: check whether the BT flag has been enabled or not. If it is enabled go to step 5 or else go to step 6

Step 5: disable the BT flag and calculate BT start, BT end and BT total time.

Step 6: check for SCT flag. If it is disabled go to step 7 or else go to step 8

Step 7: enable the SCT flag and get the SCT start count.

Step 8: increment the count

Step 9: go to step 2 and continue the process

Step 10: check whether the SCT flag has been enabled or not. if it is enabled got to step 11 or else go to step 14

Step 11: disable the SCT flag and check whether the count is greater than spike .if it is greater than the spike go to step 12 or else go to step13
Step 12: store SCT start count, SCT end count

Step 13: calculate SCT total

Step 14: check for BT flag. If it is disabled then go to step 15 or else go to step 16

Step 15: Set the BT flag and get SCT start count

Step 16: increment the count and go to step 2

Flow Chart for computing of SCT and NBT

Fig. 7.1.2 Flow chart of SCT, NBT & CT calculation
7.3 SCT and NBT of Welding Signature in 30-35sec. of Test – 01

Voltage setting made on the welding machine is 23V

Mode value of 5000 voltage samples [30millisec.to 35millisec] = 23.4V

Voltage signature of test -01 and its number of SCT are shown in fig.7.3.1 & fig.7.3.2 and details of SCT and NBT are shown in table-7.3.1.

![Reference Welding voltage signature of Test - 01 in 30 -35 sec. duration](image1)

**Fig.7.3.1** welding voltage signature of test – 01 in 30 -35sec.

![Short Circuited Time of Reference welding voltage signature in 30-35sec.](image2)

**Fig. 7.3.2** PI chart of test – 01 [Short Circuit Time and Burning Time]

<table>
<thead>
<tr>
<th>Total number of Count</th>
<th>No. Cycles</th>
<th>Total No. Short circuiting</th>
<th>Total No. Net burning</th>
<th>Total no of spikes</th>
<th>Spikes time in millisec. Total</th>
<th>Total NBT in millisec.</th>
<th>Total SCT in millisec.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5000</td>
<td>45</td>
<td>26</td>
<td>45</td>
<td>19</td>
<td>38</td>
<td>3105</td>
<td>1895</td>
</tr>
</tbody>
</table>

Table 7.3.1 Details of SCT and NBT

The net burning time is more than that of the short-circuiting time hence the welding process is good.
7.4 SCT and NBT of Welding Signature in 30-35sec. of Test -02

Voltage setting made on the welding machine is 20V instead of 23V.

The mode value of 5000 voltage samples [30millisec.to 35millisec] = 20.7V

Voltage signature of test -02 and its number of SCT are shown in fig.7.4.1 & fig.7.4.2 and details of SCT and NBT are shown in table-7.4.1.

![Welding voltage signature of Test - 02 in 30 -35sec. duration](image1)

**Fig. 7.4.1** welding voltage signature of test – 02 in 30 -35sec.

![Short Circuiting Time of Welding Voltage Signature of Test - 02 in 30-35sec.](image2)

**Fig.7.4.2 PI Chart of test – 02 [Short Circuiting Time and Burning Time]**

<table>
<thead>
<tr>
<th>Total number of Count</th>
<th>No. Cycles</th>
<th>Total No. Short circuiting</th>
<th>Total No. Net burning</th>
<th>Total no of spikes</th>
<th>Spikes time in millisecc. Total</th>
<th>Total NBT in millisecc.</th>
<th>Total SCT in millisecc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5000</td>
<td>46</td>
<td>22</td>
<td>46</td>
<td>24</td>
<td>45</td>
<td>3096</td>
<td>1662</td>
</tr>
</tbody>
</table>

Table – 7.4.1 Details of SCT and NBT in 30 – 35sec. of test – 02

More spikes occurred in the welding process due to lack of fusion and net burning time is more than that of the short-circuiting time hence the welding process is good.
7.5 SCT and NBT of Welding Signature in 30-35sec. of Test -03

Voltage setting made on the welding machine is 30V instead of 23V.

The mode value of 5000 voltage samples [30millisec.to 35millisec] = 30.7V

Voltage signature of test -03 and its number of SCT are shown in fig.7.5.1 & fig.7.5.2 and details of SCT and NBT are shown in table-7.5.1.

![Welding voltage signature of Test -03 in 30-35sec duration](image1)

**Fig. 7.5.1** welding voltage signature of test – 03 in 30-35sec.

![Short Circuited Time of Welding Voltage Signature of Test -03 in 30-35sec](image2)

**Fig.7.5.2** PI Chart of test – 03 [Short Circuiting Time and Burning Time]

<table>
<thead>
<tr>
<th>Total number of Count</th>
<th>No. Cycles</th>
<th>Total No. Short circuiting</th>
<th>Total No. Net burning</th>
<th>Total no of spikes</th>
<th>Spikes time in millisec. Total</th>
<th>Total NBT in millisec.</th>
<th>Total SCT in millisec.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5000</td>
<td>48</td>
<td>18</td>
<td>48</td>
<td>30</td>
<td>44</td>
<td>2273</td>
<td>1861</td>
</tr>
</tbody>
</table>

Table – 7.5.1 Details of SCT and NBT of Test - 03

- Though, number of cycles and spikes are more, but the net burning time is more than that of short circuiting time which indicates the welding process is good.
7.6 SCT and NBT of Welding Signature in 30-35sec. of Test -04

Welding has been carried out without shielding gas with voltage setting made on the welding machine is 23V.

The mode value of 5000 voltage samples [30-35sec.] = 17V

The voltage signature of test -04 and its number of SCT are shown fig.7.6.1 & fig.7.6.2 and details of SCT and NBT are shown in table-7.5.1.

Fig.7.6.1 welding voltage signature of test-04 in 30-35sec.

Fig.7.6.2 PI Chart of test – 04 [Short Circuiting Time and Burning Time]

- The welding voltage signature and chart indicates the short-circuiting time and burning time are equal because of insufficient heat.
- Welding done without CO₂ develops porosity.
7.7 Conclusion

In this chapter, method for calculating of SCT, BT and CT are discussed. Algorithm for computing SCT, NBT and CT and its flow chart are also explained. SCT, NBT and CT have been calculated for different voltage settings and their results are obtained.