



Analysis of Percentage of Dilution in GMAW

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Abstract-The welding characteristics are dependent on weldment formed after welding. These are generated and depend on gap between plates, types of materials, filler rod, and voltage, current, wire feed rate, and the skill of the operator. These parameters should be greatly investigated and should be controlled for the required joint. So, these are to be evaluated by conducted tests and plotting graphs. For the processes of welding, GAS METAL ARC WELDING (GMAW) is preferred, where it is conducted under the shielding of CO₂ gas which is cheapest and freely available with fewer effects. The project pertains to mainly on percentage of dilution of the parent material, where the joint occurs with the mixture of parent material and electrode. This observation and investigation on this welded joint gives the percentage of dilution of base metal fused with the electrode. The profiles can be obtained by using profile projector which projects the joint on the screen and this can be used for the calculation.

Keywords-Stainless steel pieces, Gas Metal Arc Welding equipment, Profile projector

I. INTRODUCTION

All joining process involving atomic bonding is of permanent nature. In mechanical bonding, strength of the joint is less than the obtained strength of the original members. However, in atomic bonding, the situation is not necessarily so. Classification according to the joint composition:

1. Autogenously: In this process, no filler material is added during joining.

Eg: all types of solid phase welding and resistance welding.

2. Homogeneous: In this process, the filler material used to provide the joint is the same as the parent material.

Eg: Arc welding, Gas welding, and Thermit welding belong to this category.

3. Heterogeneous: In this process, a filler material is different from the parent material.

Eg: Soldering and Brazing.

A. Welding

Welding is a process that joins materials, usually metals. This is often done by melting the work pieces and adding a filler material to form a pool of molten material that cools to become a strong joint. Many different energy sources can be used for welding, including a gas flame, an electric arc, an electron beam, friction and ultrasound.

Application of welding: there are many applications in different fields.

1. Air craft
2. Railways
3. Pressure vessel
4. Ship Building
5. Structures
6. Bridges.

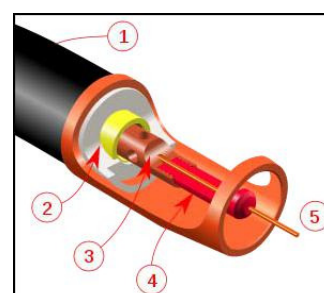
Gas Metal Arc Welding: Gas Metal Arc Welding (GMAW), sometimes referred by its sub types, Metal Inert Gas (MIG) welding (or) Metal Active Gas (MAG) welding. It is a semi- automatic (or) automatic arc welding process in which a continuous and consumable wire electrode and a shielding gas are fed through a welding gun. A constant voltage direct current power source is most commonly used with GMAW.



Fig(1)

GMAW can be applied to steels because it allowed for lower welding time compared to other welding processes. GMAW is the most common industrial welding process, preferred for its versatility, speed and the relative ease of the process to robotic automation.

To perform a Gas Metal Arc Welding, the basic necessary equipment is a welding gun, a wire feed unit, power supply, an electrode wire, and a shielding gas supply.





1. Torch handle
2. Molded phenolic dielectric (shown in white) and threaded metal nut insert (yellow)
3. Shielding gas diffusion
4. Contact tip
5. Nozzle output face

The typical GMAW welding gun has a number of key parts – a control switch, a contact tip, a power cable, a gas nozzle, an electrode and a gas hose. The wire feed unit supplies the electrode to the work, provides the wire at a constant feed rate, but more advanced machines, can vary the feed rate in response to the arc length and voltage. Some wire feeders can reach feed rates as high as 30.5 m/min (1200 in/min) but feed rates for semi-automatic GMAW typically range from 2 to 10 m/min (75-400 m/min).

B. Electrode

Electrode selection is based primarily on the composition of the metal being welded, the process variation being used, joint design and the material surface condition. Electrode selection greatly influences the mechanical properties of the weld and is a key factor of weld quality. In general, the finished weld metal should have material properties similar to those of the base material with no defects such as discontinuous (or) porosity within the weld. Depending on the process variation and base material being welded the diameter of the electrodes used in GMAW, typically range from 0.7 to 2.4 mm but can be as large as 4mm. Shielding Gas: Shielding gas are necessary for gas metal arc welding to protect the welding area from atmospheric gases such as nitrogen and oxygen, which can cause fusion defects, porosity. This problem is common to all arc welding processes, for example, in the Solid Metal Arc Welding process (SMAW), the electrodes are coated with a solid flux, which evolve a protective cloud of carbon dioxide when melted by the arc. In GMAW, however, the electrode wire does not have a flux coating, and a separate shielding gas is employed to protect the weld.

The choice of shielding gas depends on several factors, most importantly the type of material being welded and the process variation being used

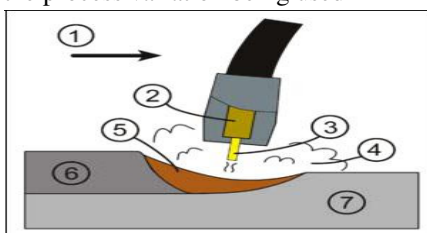


Fig (3)

1. Direction of travel
2. Contact tube
3. Electrode
4. Shielding gas
5. Molten weld metal
6. Solidified weld metal
7. Work piece.

C. Stainless Steel

The major components of stainless steel are Iron, Chromium, Carbon, Nickel, Molybdenum and Small quantities of other metals. On the basis of its crystalline structures, stainless steel can be broadly categorized into four different types. It is to be noted that iron is always the main constituent and the rest of the chemical substances are present in varying properties in each type of stainless steel.

D. COMPOSITION

Element	%weight
C	0.15
Mn	7.5-10.0
Si	1.00
Cr	17.0-19.0
Ni	4.0-6.0
P	0.06
S	0.03
N	0.25

E. Grades of Stainless Steel

Category	Steel
Class	Stainless steel
Type	Austenitic standard
Common Names	Chromium-Manganese-Nickel steel
Designations	United States: ASTM A276 , ASTM A314 , ASTM A412 , ASTM A429 , ASTM A473 , ASTM A666 , FED QQ-S-763 , FED QQ-S-766 , FED STD-66 , SAE 30202 , SAE J405 (30202) , UNS S20200

II. EXPERIMENTAL PROCEDURE

There are different types of weld joints.

They are

1. Butt joint
2. Corner joint
3. Edge joint
4. Lap joint
5. Tee joint



In this experiment we have preferred the lap joint. To obtain the lap joint, two pieces were placed one over another. The pieces of stainless steel have been considered. These pieces were arranged to form the lap joint and the welding process was carried out by using the Gas Metal Arc Welding equipment. The values were noted and tabulated and finally the dilution calculations were done.

Table 1:

S. No.	Wire feed m/min	Gas pressure in lit/min	Weight of welded joint in gm	Weight of base plates in gm	Parts of base plate in %	Parts of welded joint in %	% dilution
1	3.5	14	535	485	89.2	10.58	12
2	4	14	552	485	87	13	14.9
3	4.5	14	563	485	86	14	16.2
4	3.5	18	541	485	89.81	10.19	13
5	4	18	556	485	87.1	12.9	15
6	4.5	18	559	485	86.1	13.9	16.3
7	3.5	22	541	485	89	11	13
8	4	22	560	485	86.6	13.4	15.5
9	4.5	22	569	485	85	15	17.6

Table 2:

S. no	Setting	Current in amps	Voltage in volts	Wire feed m/min	Time in sec	Gas pressure in lit/min	Horizontal distance in mm	Vertical distance in mm
1	4-4	150	30	4.5	60	14	10.19	7.2
2	4-4	140	27	4	66	14	10	7.18
3	4-4	130	25	3.5	70	14	7.8	7.05
4	4-4	150	30	4.5	56	18	13.05	7.95
5	4-4	140	26	4	64	18	12.42	6.12
6	4-4	130	27	3.5	75	18	10.43	5.72
7	4-4	150	30	4.5	40	22	15.1	6.95
8	4-4	140	24	4	45	22	12.68	5.93
9	4-4	130	25	3.5	50	22	9.18	5.81

III. DILUTION CALCULATION

$$\begin{aligned}\text{Parts of the base metal} &= \frac{\text{Wt of base metal}}{\text{Wt of weld metal}} \\ &= 485 / 569 \\ &= 85 \%\end{aligned}$$

$$\begin{aligned}\text{Parts of weld joints + parts of base metal} \\ &= 100 \%\end{aligned}$$

$$\begin{aligned}\text{Parts of weld joints} &= 100 - \text{parts of base Metal} \\ &= 100 - 85 \\ &= 15 \%\end{aligned}$$

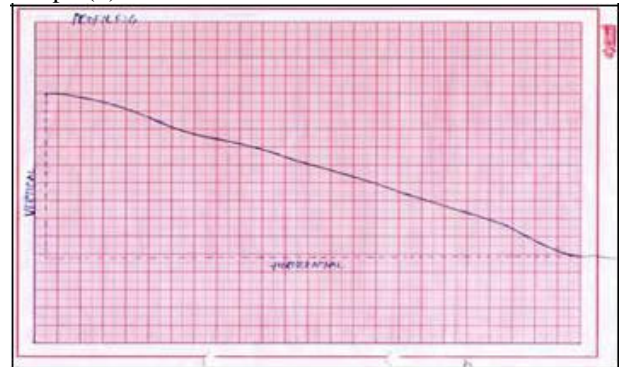
$$\begin{aligned}\text{Percentage (\%) of dilution} &= \frac{\text{parts of weld Metal}}{\text{parts Of base metal}} \\ &= 15 / 85 \\ &= 0.1767 \\ &= 17.67 \%\end{aligned}$$

IV. WELDING PROFILES

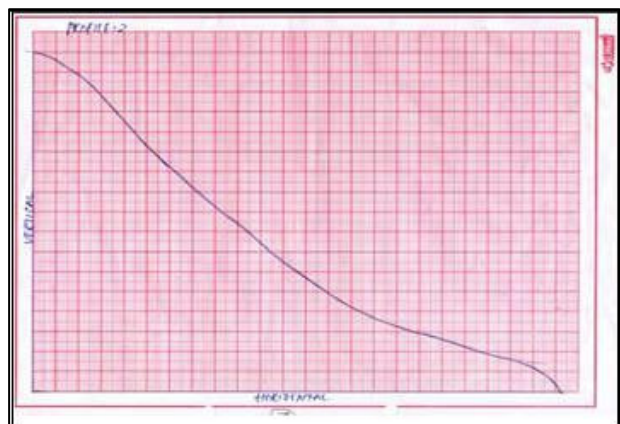
The following graphs represent the profile of the weld joint.



Graph (1)

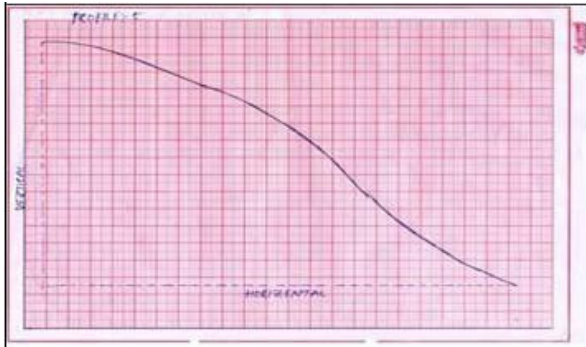


Graph (2)

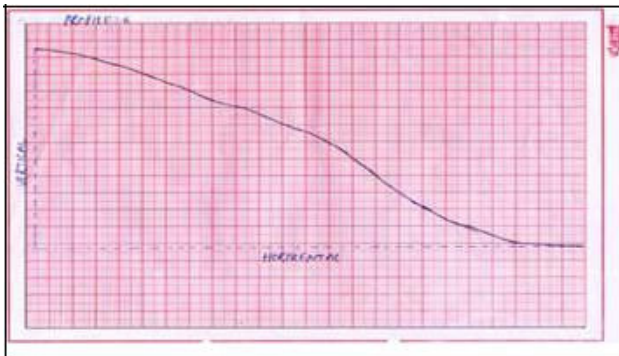




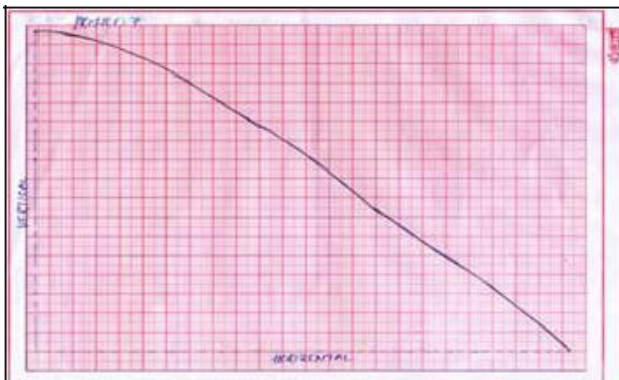
Graph (3)



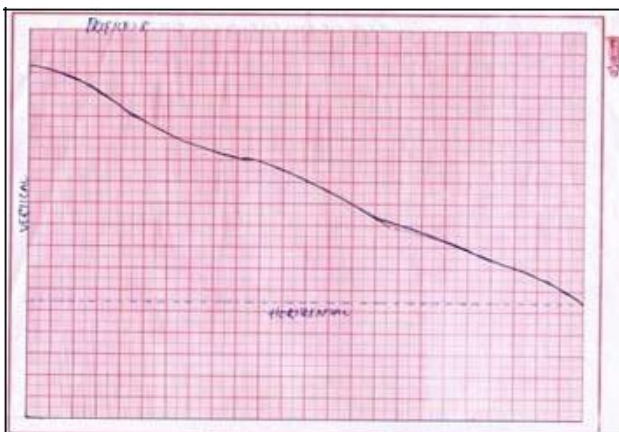
Graph (4)



Graph (5):



Graph (6)



V. CONCLUSION

Finally it is concluded that whenever the current, wire feed rate increases the percentage of dilution also increases which results an increase in strength of the weld.

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