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LASER BEAM WELDING: A REVIEW PAPER

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ABSTRACT

Laser beam welding is regarded as one of the most advanced welding techniques which is unknown to most of people, so in this paper laser beam welding process is discussed in great details so that reader must have actual knowledge of laser beam welding process. In later section laser beam welding process application is discussed and its edge upon other welding process is highlighted so that those who actually want to compare laser beam welding process with other welding process can now be able to plot a difference between laser beam welding process with other conventional welding process. Future scope of laser beam welding process is also discussed so that limitation of laser beam welding process can be minimized and it can be used for larger application.

KEY WORDS

In this paper the analysis is basically focused on the method of laser beam welding process, applications, limitation, future scope so that its limitation can be minimized.

INTRODUCTION

First of we must know what is laser then it actually means Light Amplification by Stimulated Emission of Radiation is basically is very high coherent and concentrated beam which is projected upon any surface to achieve desired results, it is basically monochromatic beam of light with very high energy so that it can produce thermal agitation in metal or any other surface. Talking about difference between normal light and laser light then normal light (white) light consist of several color which are of different wavelength and frequency so it is very difficult to produce high energetic beam from normal white light or it impossible to collimate white or ordinary light without any appreciable loss of its energy or intensity.

Reason for using monochromatic beam of light because all the waves are of single wavelength and are coherent , the basic principle of laser emission is that light is amplified by stimulated emission of radiation, coherency helps the light concentrate on the particular surface and its energy can be improved by using optical lenses. The laser beam is very energetic beam of light

use to melt the surface of metal so that metal can fuse together to produce laser beam welding of very high accuracy and precision and high surface finish, normally it is regarded as far better than any other conventional welding process.

LASER BEAM WELDING WORKING PROCESS

In laser beam welding process there are two types of laser that are widely used and they are Carbon dioxide laser and Nd:YAG laser light because laser light of this two laser are most efficiently absorbed by the work piece to raise the temperature of metal so that heat produce use to fuse the metal and produce high quality of weld.

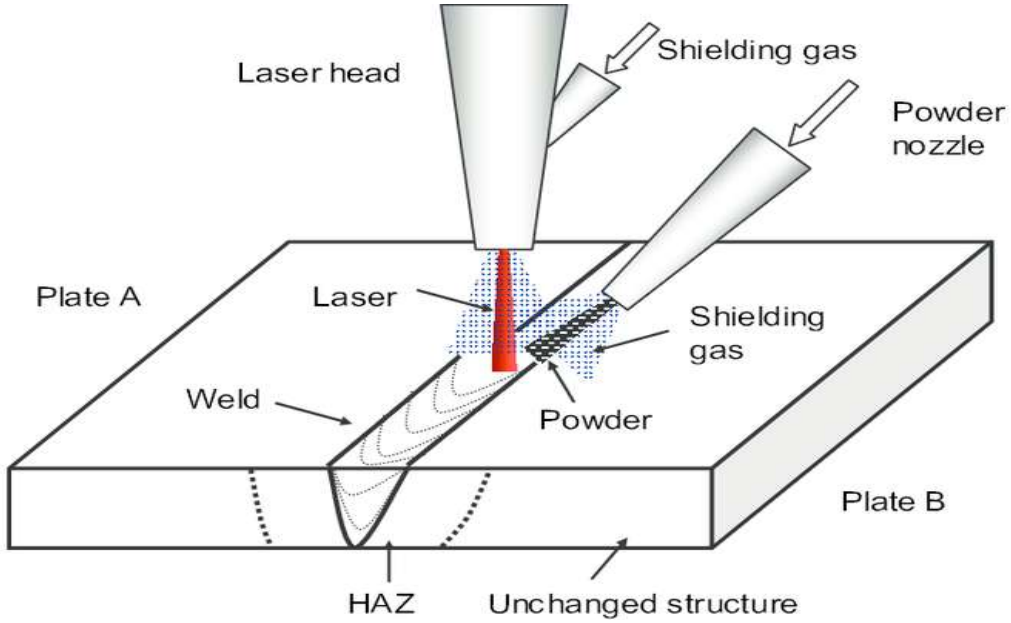

Fig.1.schematic of laser beam welding process (Pic courtesy researchgate.net)

In the laser which uses solid state medium, light is emitted from mono or single crystal is basically doped with suitable medium to produce coherent beam, similarly when the normal whit light is intrude or impinge on the metal surface the electron of higher shell go to state that is meta stable. In the returning process they emit light by stimulation in the form of packet called photons. In this process the energy is provided to atom at lower state by the means of other laser light so that they can absorb the light and raise itself to higher energy level for further laser operation. The output of laser can be continuous or may be in the form of pulse, but output is preferred over the continuous output light because it is more energetic then continuous output light. Power rating of laser may be different but laser used for welding process have output range from 2-2.5kW.

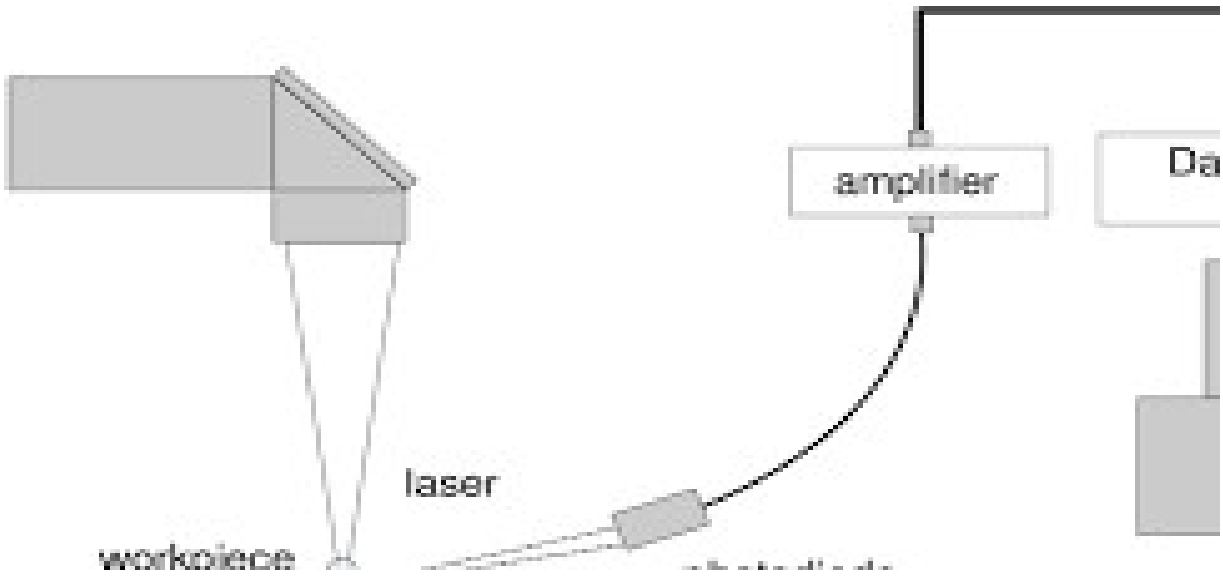

Fig.2. laser welding setup (Pic courtesy researchgate.net)

In the case of gas laser welding process such as carbon dioxide laser the operation principle is quite similar as solid state and liquid state laser , firstly light from other source such as other laser is impinged on the molecules which are at lower energy level and after absorbing light molecules are excited to the higher energy level and after spending time in metastable state it return to lower energy level, during returning to lower energy level light is emitted which is highly coherent and monochromatic. This emitted light is use as energy source for welding process.

If low output power laser is used as welding source(less than 1 KW) then incomplete fusion of metal will occur which do not produce desirable weld, incomplete penetration results incomplete fusion, but this difficulties can be removed by increasing the power output of laser and by this large coherency is obtained and sufficient density is obtained and this cause metal situated centrally to laser jet to vaporize after forming keyhole which is quite similar to electron beam welding. Keyhole temperature can be reach enormously high such as 25000 degree Celsius and this high temperature will give rise to very high penetration as show in fig.1. Instead heat is conducted in downward direction from the metal surface ,otherwise heat is conducted in radially outward direction from keyhole surface, in this way it form molten region surrounded by the vapor surface. The laser beam moves in right direction at particular velocity (shown in fig.2) molten metal fills the cavity and after the solidification of molten pool it form weld. Speed of laser torch can be adjusted to obtain faster welding and to obtain larger weld in low time.

With the help of suitable optics techniques it is possible to obtain suitable spot sizes with the diameter range as mall as possible (.023mm), carbon dioxide laser has starting or initial

reluctance about 85 – 94 % for majority of metals and proper care must be taken while using this gas laser and optics must be kept in mind while operation.

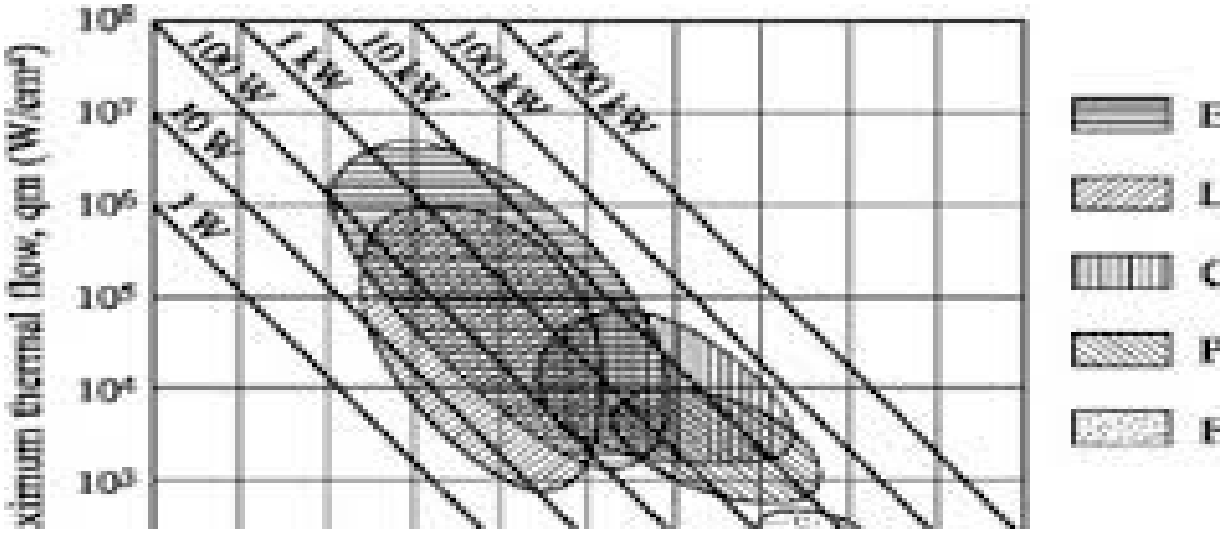

Fig.3.cmparison between different welding techniques (Pic courtesy globalspec.com)

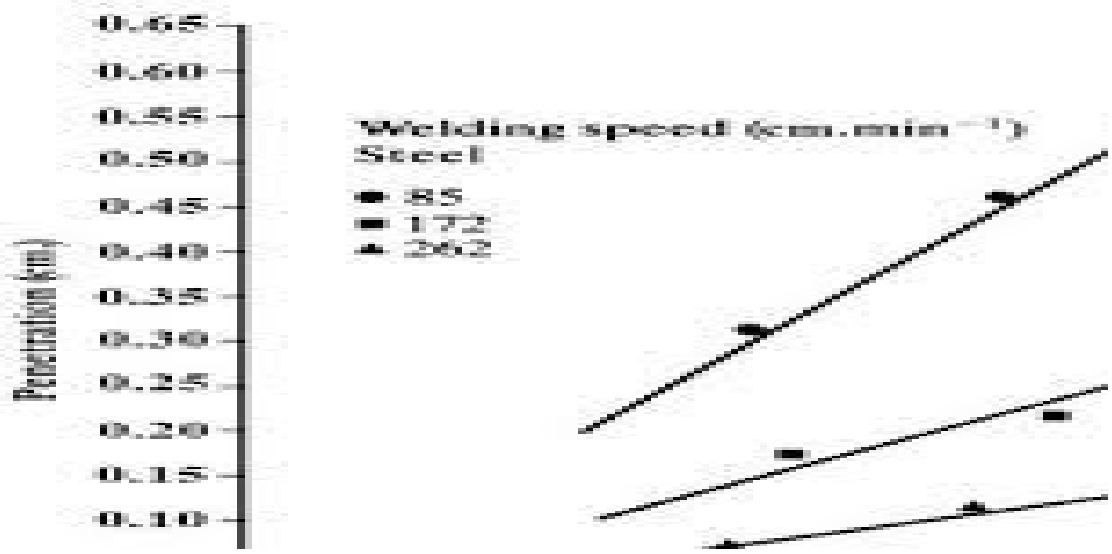

Fig.4.penetration vs power of laser beam welding (Pic courtesy open edu)

In the Nd:YAG laser power output varies from 450-500 watt but carbon dioxide laser setup power output about 10KW or more so carbon dioxide laser is mostly preferred. Those metals which has low boiling point capable of producing large metal vapor and it initiate the breakdown of gas and generate plasma where beam intensity is quite high slightly above working metal surface. Plasma by absorbing the high laser energy block the passes of beam and produce bubble

at the bottom or root of weld. Viscosity plays an important role because if viscosity is high the bubbles cannot be able to escape till the molten metal solidifies, in most of the cases the melting point of metal do not have remarkable affect weldablity, thus it can be said that metal with lower melting temperature easy to weld and metal which posses higher melting point is little bit difficult to weld.

ADVANTAGES

1. Laser welding is where faster welding is required.
2. Laser welding process can weld magnetic materials.
3. Laser welding process has higher uptimes and shorter cycle.
4. Laser welding process can reach to remote or inaccessible locations.
5. In laser welding process no filler metal and flux is required.
6. Lesser distortion is seen in laser welding process.
7. It produces two-side single pass welding.
8. It is regarded as non conventional welding process because there is no contact between work piece,

FUTURE WORK

So far laser welding process is regarded as one of the most efficient welding technique even though it has some limitation which must be reduced so that it can be used in most of welding and fabrication techniques. Laser welding techniques is costly than other conventional welding techniques and due to this its application is made limited. Laser welding output gives a different scope so that it can be used where great tolerance and high dimensional accuracy is required but due to it installation cost manufacturer are not willing to adopt this laser welding techniques but our task is accept this challenge and find new way so that laser welding process can be applied in most of manufacturing fields.

CONCLUSION

In this paper the analysis was mainly focused on the laser beam welding technique that is quite different from conventional welding techniques which produce welding which is high in quality and greater dimensional tolerance. Laser welding method is quite costlier than other techniques but due to its precision and accuracy it is one of the top priority of the manufacturer but due to high skilled labor is required its application is reduced but in future its application may going to be wide and it can be used in most of the manufacturing field to produce products which are dimensional accurate and capable of producing desirable result.

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