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LASER WELDING TECHNOLOGY

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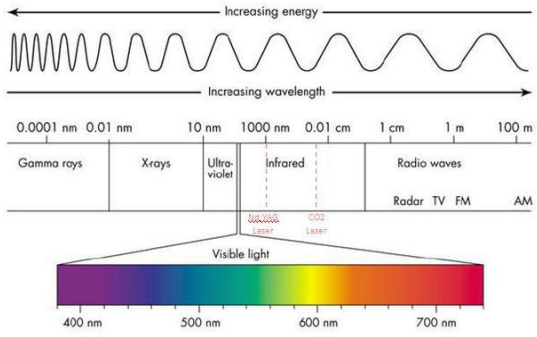
The purpose of the research is to take an up-to-date look at laser welding technology currently being utilized.

During the last decade a number of laser manufacturers in Europe and the USA have started producing laser welders, which are designed solely for a specific industry and application. This has made the technology more affordable and user friendly, and therefore contributed to a wider up take of the technology.

The focus of this paper is predominantly on laser welding equipment that is affordable and applicable to the majority of manufacturers. The paper will discuss the types of lasers currently available, laser safety, laser applications and the advantages and disadvantages of lasers.

In its basic form a laser produces intense light that can be focused to a precise spot, with enough energy to weld metals. The initial technical factors to consider when selecting a laser source are its Wavelength and Output Power. The wavelength of a laser effects how the beam will react with materials i.e. if the incorrect wavelength is used, the laser beam will just reflect off the surface and have no affect on the metal. To better understand wavelengths and where lasers fit in, we need to take a quick look at the electromagnetic spectrum:

Fig. 1. Electromagnetic Spectrum.



Nd:YAG: Refers to the type of crystal used in the laser, which produces a wavelength of 1064 nm. This wavelength is just outside the visible range of our eyes (400nm to 700nm) so we are unable to see it. However, a laser with the wavelength of 1064 nm is effectively absorbed by conductive metals, making it ideal for welding. The output powers available for Nd:YAG lasers range typically from 30W to 800 W. Nd:YAG lasers are well established technology, and are currently the most popular for laser welding applications, which require small spot or seam welds with a few millimeters penetration depth.

Due to the wavelength of Nd:YAG lasers being close to our eyes visible range, we can use the same optics to manipulate the laser beam, as for our own eyes. This benefit has resulted in a number of different Nd:YAG laser systems being available, for a range of applications.

These systems can be categorized in the following three groups:

1. Manual Laser Welding: These are usually complete systems with a small welding chamber where the operator holds the piece in their bare hands, or uses basic jigging. The operator positions the piece whilst looking through a microscope and then fires the laser via a foot peddle. They are ideal lasers for small volume production, and lower budgets. Most manual welders are classified as Class1 (the same as a DVD player), which means they require no additional safety precautions.

2. Semi-Automatic and Fully Automatic Laser Welding: Semi-automatic and automatic laser welders with built in xyz motion and optional rotation axis are used for controlled seam welds, higher volume production and/or higher precision & repeatability. The piece is moved either by a remote joystick or automation software. Often these systems can also be used in the manual mode; however in these instances it is important to ensure the system has not compromised the ergonomics. Added features of these systems are the ability to do incline laser welding, and a visible red pointer laser to aid in automation setup.

Fig. 2. Semi-Automatic and Fully Automatic Laser Welding.

3. Mobile Laser Welding: These lasers are fairly new to the market, and are used where the item to be welded is not easily moved i.e. for large tool and mould repairs. These systems are on wheels and the laser head is positioned on the end of a free moving or motorised arm, so you can take the laser to the work area. Inclined welding is possible on certain models. Due to the higher power requirements of the intended applications, these systems often require 3 phase power.

Fig. 3. Mobile Laser Welding

There are 3 main advantages most people consider when looking to invest in laser technology, which are as follows:

1. Laser technology can allow you to do a process that no other technology can achieve.

For example:

- Welding complex alloys, or dissimilar alloys
- Precise welding of small parts
- Welding in close proximity to heat sensitive components
- Repeatable welds
- Clean hermetic seals
- Solder free welds
- Contact free welding
- Welding complex structures

2. Product improvements:

- Stronger welds
- More visually appealing welds. Consistent welds with no flux used.
- Smaller heat-affected-zone, resulting in less distortion and less strain on neighboring components, increasing product life.
- Competitive advantage

3. Process improvements:

- Reduced preparation time prior to laser welding i.e. no heat treatment
- Faster welding process than alternative technology
- Reduced post welding process i.e. no cleaning of the weld or grinding
- Repeatable results from each operator
- Easy for employees to be trained on and use, no specialized skills required
- Less welding fumes in the process
- Reduced running costs i.e. no expensive solders, non contact and no mechanical wearing parts.

The main disadvantage is the Capital Cost. The cost of a laser welding system can start from just under $30000 and range up to $100000. This is less of an issue if the above advantages can be realised when manufacturing high value or high volume products.

The other disadvantage is related to mobility. There have been recent developments in making lasers more mobile, however they are still not as mobile as MIG and TIG welders.

Some people cite laser safety as a disadvantage; however for most applications there are now many laser systems that are correctly enclosed to meet Class1 classification.

In conclusion it should be noted that laser welding continues to become more widely used in our world, and in a growing range of applications.

Nd:YAG lasers are still the most popular choice in areas where small precise laser welds are needed. For applications that require larger welds and more brute force, CO_2 lasers are the preferred choice.

There is now a large range of Class1 enclosed laser welders available designed for a range of specific applications. These lasers are available as manual, semi-automatic and fully automatic systems.

The main advantage of laser welding is that it enables you to produce a product or process that was not previously possible with other technology. Other advantages are centered on improved product quality and reduced process times. The competitive advantages gained from laser welding technology can be balanced against the disadvantages when realized for manufacturing high value or high volume products.

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