The future of laser cutting

Out of six various applications of laser in engineering - marking, micro-machining, cutting, cladding, welding, and hardening, 'laser cutting' is one of the proven, productive and cost effective applications of lasers in material processing in either prototyping or in mass production of sheet metal component or blanks abroad and now in India too...

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Laser cutting is used in cutting a variety of materials such as metals as well as non-metals. It is a very flexible process giving fine quality cuts. Choosing a right laser cutting machine is not a simple task as there are several kind of lasers like Nd:YAG , CO_2 , fibre , disc etc, positioning systems, rack & pinion, ball screw, linear motors, among others and CNC control systems. The optimum choice depends on the material, its thickness, geometry and the shape-quality required for the finished cut. Moreover, the wavelength, power, beam quality and spot size are some of the parameters that determine the cutting dynamics.

At present, CO_2 laser cutting system is well accepted in the market for sheet metal cutting application but the invention of fibre laser cutting technology is a big challenge to CO_2 Lasers.

Fibre laser

At the heart of the fibre lasers is a specially designed optical fibre that is doped with a rare-earth element (ytterbium, erbium or thulium) and pumped by high-power laser diodes. The fibres have a multiple-cladding design to withstand the high pump powers passing through them and optimise the interaction with the dopant. A device may be made from coils of ytterbium-doped, multi-clad fibre with an emission wavelength of 1.07 to 1.08 microns. Alternately, it may be thulium doped with a wavelength of 1.8 to 2.0 microns or erbium doped with a wavelength of 1.54 to 1.56 microns. The diode pump energy is delivered to the active medium via multimode fibres that are spliced to the multi-clad coil. The laser cavity is created directly in the active fibre. The laser emission exits the fibre laser through a passive single-mode fibre typically with a core. The resulting laser beam is essentially diffraction limited and, when outfitted with an integral collimator, produces a beam that is extremely parallel with very less divergence.

Since the inception of the fibre laser, large gain and continuous lasing has attracted many laser source manufacturers and integrators. Fibre laser represent a technology threat to the established Nd:YAG and high-power CO_2 lasers,

Advantage of fibre over conventional laser cutting technology

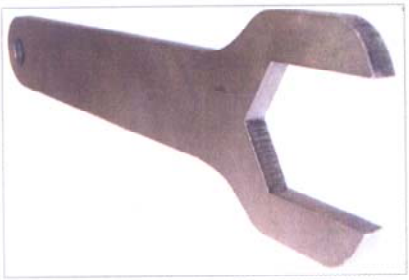
Details	Fibre Laser	CO_2 Laser	Advantage Fibre
Operating wavelength	1070	10060	1070 nm wavelength of fibre is well absorbed by all metals so faster cutting as well as higher depth cutting is possible with the same power option Moreover, smaller wavelength leads to lesser beam spot and hence the kerf width is less as well as HAZ.
Power options	100 kW	40 kW	Versatility in options and applications
Cutting speed	2.5 to 5 X	X	4 kW fibre laser can achieve cutting speed of 135 m/min achieved for car body steels with a thickness of 1 mm: result achieved in R&D by one Institute
Cutting thickness	2 Y	Y	2 kW CO_2 laser can't go more than 10-12 mm MS. Whereas 2 kW fibre laser will cut more than 17 mm mild steel So, 1 kW fibre = 2 kW CO_2
Beam properties	Excellent	Good	Fibbers of 50 µm dia can achieve a power output of 4 kW and deliver a beam quality of better (ie less) than 2 mm* mrad CO_2 fundamental mode lasers with a beam quality of →3.4 mm*mrad The high mode quality and small spot size of the fibre laser with optimised pulses facilitate cutting of intricate features in thin material Minimal slag and HAZ, which are very critical
Power stability	Excellent	Good	Fibre laser cut quality is better than CO_2 because of good power stability
Compactness	Z	3Z	Fibre laser foot print is three times smaller than CO_2
Warm up time	Rapid	20 min approx	Faster operation: high productivity
Cooling system	Air / water	Water	Easy system for maintenance
Maintenance	Very less	Required	There is no beam delivery mirrors and optics in resonator. Moreover, no heavy maintenance parts like high-pressure turbo flow compressors are there in fibre laser. Hence, the maintenance cost is really low
Upgradation	Yes	No	Fibre can be easily upgradeable due to its modular design whereas in up gradation CO_2 it is not possible
Consumable	Very less	More	Optics and gas are consumable which is quite significant in CO_2 laser In fibre laser, only cutting gas is consumed
Operating cost	Approx 2 -2.5 times less	More	1 kW fibre: $ 6.6/hr 1 kW CO_2: $ 11.86/hr 2 kW CO_2: $ 16.37/hr 1 kW fibre = 2 kW CO_2: ie $ 6.6 Vs $ 16.37

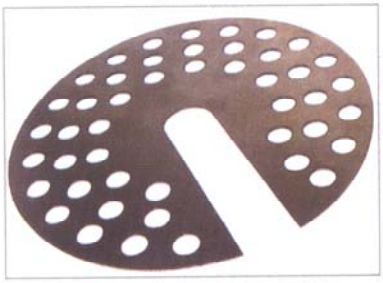
especially in the areas of metal processing. Lasers of this range are mainly used for the cutting or welding of aluminium or steel, and are anticipated to become widely deployed in cutting as well as welding application.

Previously, the laser cutting machine users were sceptical about the performance of high power fibre laser technology. But now by introducing fibre laser cutting in their manufacturing processes, leverage their superior competitive advantages.

The advantages

Fibre lasers are publicised as having the capability to displace other lasers currently used in industrial applications. In the fabricated metal products industry there is a possibility that the fibre laser could replace CO_2 lasers in flat sheet cutting operations. In the history of laser business, there has always been new technology that carves out very nice niches, but the old technology is still there. Fibre lasers will also find areas that they fit well, but they can't totally obliterate the competition of CO_2 laser cutting technology. Until 2000, CO_2 lasers were well accepted in the market for sheet metal cutting application. But thereafter, fibre laser technology has shown a lot of potential in producing cost





effective high-power lasers ranges from 1kW – 40 kW. Fibre lasers hold great promise for a wide range of applications because they are truly solid-state with a minimum of exposed optical interfaces, have very high efficiency, and are capable of exceptional beam quality. The already low cost and high reliability of CO_2 lasers may limit the growth as CO_2 laser replacements, but high beam quality and the ability to both cut and weld with the same fibre laser could pose a challenge to CO_2 down the road.

Gaining popularity

The highly competitive laser cutting market in India and Asia continues to capture attention with emerging customer needs and novel applications. That induces the company to offer appropriate technology that suits customers stated and implied needs for the present and future.

The price one must pay for this technology will continue to decrease, further expanding the use of the technology in manufacturing plants worldwide. The acquisition costs of high-power fibre lasers are currently substantially below diode- and lamp-pumped Nd:YAGs and are said to be approaching the levels of CO_2. If we consider the initial capital investments, undoubtedly CO_2 lasers are economical than fibre laser. However, when all factors-floor space, chillers, maintenance and so on-are accounted for these lasers should be more cost effective than equivalent power CO_2 lasers. Considering the operational savings such as electrical power and their increased production capabilities, the value proposition for fibre lasers becomes even stronger.

In one to two years fibre laser prices will be able to compete with CO_2 lasers. This is already happening for cutting applications. Industry experts say that in metal cutting for example, fibre lasers have a great chance to completely win in 3-5 years time.

Fibre laser will get more acceptance in industrial sheet metal fabrication for 2D profile cutting, medical stent cutting, automotive rapid prototyping and blanking and cutting, aerospace component manufacturing, and electronics industry will be the prime target segments. Some novel applications with the high power multimode fibre lasers include 3-D cutting of automotive body parts such as hydro form tubes, high temperature steels. Cutting riveting holes in alloys of aluminium and titanium for aerospace applications, cutting thick plates for the shipbuilding and steel industries.

An innovative feat

During IMTEX 2007, Sahajanand Laser Technology Ltd launched first time in India - Fibre laser based sheet metal processing system BRAHMASTRA F-Series which also got FIE awards for 'technical innovation'.

The main component of this machine is the laser source. This laser source is of Ytterbium fibre lasers operating at the 1070 nm wavelength and are perfect for laser cutting. Apart from laser, the company uses world class CNC controller and the fastest XYZ movement technology supported by Internet based service strategy. MMT

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