Laser Based Manufacturing

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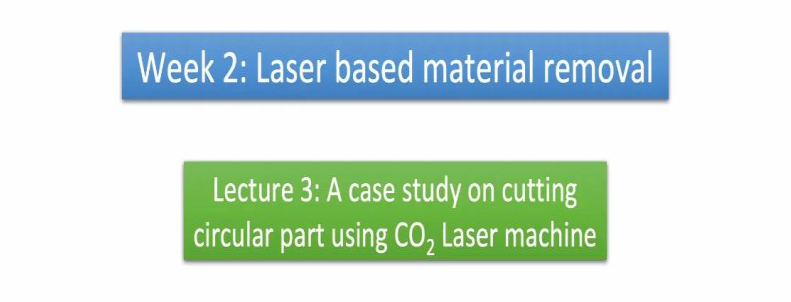
Module # 02

Lecture # 06

A Case study on Cutting a Circular Part Using CO_2 Laser Machine

Hello everyone. I welcome you all to the Lecture 3 of Week 2.

(**Refer time: 00:34**)



In this lecture, we will be looking at a case study on how to cut a circular work part by using CO_2 laser machine.

(**Refer time: 00:42**)

- Recap of previous lectures
- A tour of CO_2 Laser machine: its parts
- Cutting of a circular part of diameter 30 mm on a 2 mm thick mild steel sheet

Let us begin the Lecture 3 of Week 2. As I mentioned we will be using the gas laser that is the CO_2 laser machine and we will be cutting the circular part of about 30 mm using this machine.

(**Refer to the Video which starts at 01:01**)

Let us start the journey. This is the CO_2 machine. We have seen the electrical panel and this is the resonator where laser is getting generated. This is an industrial machine, this is the machine

bed where we are fixing our work part. This is laser head and the laser head has the nozzle through which we are getting the assist gas and laser beam.

We can write the program online, we can control by using graphic user interface based control system. This is the keypad. Now, let us see how to fix up the work part; for that we have to design and develop our work piece fixture. Here you can see the work piece fixture in which we have fixed up the work part.

This is the assembly above the nozzle: we are having the focusing lens through which the laser beam is getting focused on the work part. This operation of focusing would be done automatically by the laser machine. This is pressure gauge helping us to control or to monitor the pressure of the assist gas which is being used during the operation. The temperature of the system is quite high, so, we need cooling water to cool down the temperature of the laser head.

Focusing would be done initially. This is the chiller unit or the cooling unit: here the chilled water will get generated and that would be used for the chilling the system. Dust collector: whatever the dust is getting generated that would be collected by using this equipment.

This is the CO_2 gas cylinder that is the losing gas cylinder. It has the proper proportion of the losing gas and through this losing gas only we are generating the laser beam. Now the CO_2 gas will be transferred to the resonator through a pipe as we have seen the resonator located beside the table. The resonator is generating the CO_2 gas and through the conveyance pipes it will be transferred to the location of its application through a set of mirrors that we call the bending mirrors. These mirrors are highly reflective. This particular beam or box kind of structure which is there on your screen through which the laser beam will be transmitted at the location.

Now we need the assist gas. This black colour cylinder is the oxygen cylinder and the white cylinder with black shoulder is the nitrogen cylinder. Oxygen we will be using for the assist gas, this is nitrogen gas as I mentioned.

Now this entire system is generating quite lot of heat. We have to control the environment by applying the air conditioner, we have to control the temperature and the safety has to be there.

Now, this is the column through which we are getting the laser beam at our intended location on our work part.

This is the focusing lens through which we are getting the laser beam on the work part.

Now, let us see how to write the program. Every CNC based machine tool has a graphics user interface and a keypad through which we have to do the programming online or we can do the programming offline by using CAD-CAM softwares and then we can transfer that to the machine control unit. During all CNC operations we have to set the part zero, we have to communicate the location of the part which is there located on the machine bed to the control unit.

And based on that location of the one part then the control unit will sent the signals to the machine that at what location the controller has to approach to carry out to further machining operation.

Here XYZ is the focus point on the work part and these XYZ coordinates we have to communicate through our program to the machine control unit and that XY coordinate which we have entered here that will be taken as the part zero (0, 0).

And with respect to that part zero, the further thing would be carried away. The machine tools they do have the standard program settings and we can retrieve one of them. Here we are using the setting number 6021 which is having the standard settings of some of the process parameters such as the focusing lens that is about 7.5 inches.

Then we require the oxygen for the cutting as well that will also be set.

Here you can see 7.5 lens that is the focusing lens and according to this parameter given the machine will automatically adjust the focusing distance.

Now, this particular program has been said to cut 2 mm sheet metal sheet and our work part is mild steel of about 2 mm and it has all the prior settings such as the gas pressure which you can see here the 25, the power of the electrical field that we are applying is around 1,500 watt.

Speed is also predefined that is a 4,700 and the frequency is also decided that is about 2,000. It is a fast-cutting mode that we are using. If the user has to change the parameters that can be changed. We can have the medium cutting parameters, so on and so forth.

Now, after retrieving or after setting the process parameters, now we have to give the information about the geometry.

As I mentioned there is a part zero setting that we have to do. Here the command G920 and the G920 coordinates which are entered are X 1873 and Y 225. These are being taken from the display which is there on your screen there it is showing X 1869 times, but grossly it has been taken 1873, its minor adjustment is fine and Y is 225 that is as is taken. There should not be any gross deviation or you can say significant deviation, minor deviations are okay.

We have to set the program zero. Here there is no other requirement to set the program zero.

For demonstration purpose we have taken just a sample point on the work part. Now, we are carrying out the actual machining operation. As per the program given here, we have to just set up the radius that is 15 mm and X0 Y0. X0 Y0 with respect to the program zero and already the program zero is known to the machine tool. The machine tool will come to X 1873 and Y 225 and that it will be considered as (0,0) and about that point, circular part will be cut of diameter 30 mm.

The focusing would be done once again, before that even we can do. The dry run or graphical simulation. All the CNC machine tools have the facility to carry out the graphical simulation. It is must to carry out the graphical simulation.

Now we are starting the flow of the oxygen - the assist gas for actual cutting. Here you can see that the cylinder nozzle is getting operated and the flow will be started.

Let us start the cutting. Now the laser will cut the work part in fraction of seconds. The laser head will come down, the energy will be applied. We just noticed the cutting yes cutting has been started done. Within seconds the cutting has been completed on 2 mm mild steel.

Let us look at the job which has been done - perfect. We got a very good quality circular laser cut on a mild steel 2 mm thick steel plate. This is the top view where the laser was applied. Now, let us observe the exit. At the exit we got some sort of deposition or some sort of dross which are there which can be removed by using grinding operation.

Overall, the quality of the laser cut was fantastic and that is the capability of the laser-based process. Further, you can carry out the micro structural studies, HAZ of all these things. Lot of students are working: M.Tech students, B.Tech students and PhD students are working in this area: to improve the machining accuracy, to reduce the heat affected zone during the CO_2 laser based laser cutting.

(**Video Ends: 12:02**)

Now, with this I thank you all for watching this video.

In the next lecture or in the next week we will be studying the laser welding operations. Till then good bye. Thank you.