Laser Based Manufacturing

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Module # 03

Lecture # 10

A Case Study on Welding of Mild Steel Sheets Using 2.5 kW CO_2 Laser Machine

Hello everyone. I welcome you all to the last lecture of Week 3. In this week, we are learning the laser welding. We have seen the fundamentals of laser welding, mechanisms of laser welding, we have also studied what are the various process parameters which are affecting the laser welding performance and weld quality. We have also seen the weld defects or the defects which are getting generated during the laser welding operation.

In this lecture we will be looking at a video which is recorded for a case study and this case study is on joining of two mild steel plates of 2 mm thickness by using laser welding operation. Let us begin our case study.

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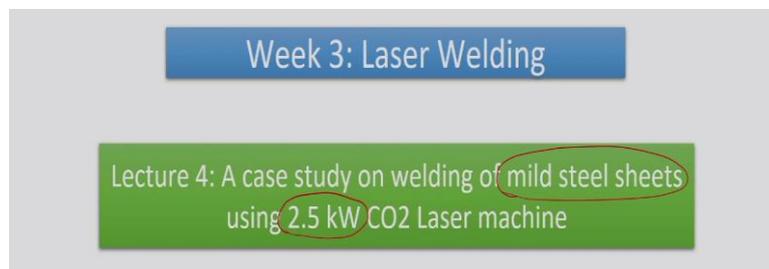
As I mentioned, we will be joining two mild steel sheets by using a 2.5 kilowatt laser machine. The same machine we had also used for machining operation, on the same machine we will also carrying out the welding operation.

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On your screen you can see there are two plates. This is plate 1 and this is plate 2 and these are of mild steel and thickness is 2 mm. Let us begin our video.

(**Video Starts: 02:01**)

We can see that two mild steel plates are joined together and we are going for the butt joint here. We have seen that in the butt joint the two plates are kept in the same plane and there is a gap between the two plates and we are applying the laser beam based heat energy to melt the work material and get solidified together to have the joining operation done.

(**Video Starts: 02:29**)

Here let us begin these two plates that we have taken. This is the machine bed and now are using the fixture to hold, to clamp or to fix the two plates on the machine bed, this is a laser bed or you can say the machine bed. We have to ensure that the two pieces are joined together, they are aligned in a proper manner. Now, in our previous class we have seen that we are writing the G and M code **(Video Ends: 03:16)** for the work that to be done.

In our previous class we have seen that for cutting a circular work part of 30 mm we have made a CNC code by using the readymade functions which are available on the CNC laser machine. In this case we have to program a path for joining the two plates, it is just the linear path that we have to program. Again the laser machine is having all its readymade functions embedded inside the controller, we have to choose the appropriate function, we have to choose appropriate settings for the required operation and that appropriate setting will enable us to actuate or to execute the program as per our requirement.

The CNC laser machines are also helping us to focus the laser beam automatically and then to provide the dry run or we can say the simulation of the laser over the work part. After confirming, after due assurance whether we are getting the intended application, intended feature to be machine or to be worked out on the work part then only we have to go for the actual laser based operation maybe welding or cutting.

Let us begin. Here this is the part, the focusing operation is going on. Here you can see the focusing is being carried out. The focusing would be done and afterwards we have to start the actual welding. Now, the focusing operation or the process has been done. Now we are going for the programming, as we have seen in our previous week as well. We have to choose the process conditions, the readymade functions, we have to even input the program 0 and by using the program 0, here you can see there are readymade operations which are given here that is the welding. We have to choose that setting number, two settings number are given. 7924 and 7925, these are for the welding operation. Similarly for simple heating there are certain operations settings are there, for cutting there are some other operations are there. 7926 is for cutting and 24 and 25 are for the welding.

That operation number will be chosen and will be applied. We have to again give the part 0 or program 0 or the workpiece point from where we have to actually start the laser welding operation. This point in the work volume, in the working zone of the laser machine has to be specified and then accordingly the controller will take the action.

These parts are programmed based on your local zero setting, local coordinate system, part coordinate system, but the machine coordinate system is different. We have to give the offset, we have to provide the relationship between the machine zero setting and the part 0 setting and based on that the machine will compute the locations of various features on the work part.

That operation is being carried out over here. These are the X, Y, Z locations. These we have to record and manually enter.

After programming, now we have to simulate whether the intended feature that is the straight line whether it is getting done or not. Here the simulation would be carried out first and when we assure or when we confirm that part is okay, the feature is okay and after that we can go for the actual operation.

The program is till half way. We have to edit it. Deliberately we have kept it minimum to ensure that the machine is informing us the proper values. Now, we are trying to give the exact value so that is programmed.

Now, here the actual welding is started now. You can notice that the welding is carrying on. We had given a certain length of welding and that has been done. Let us look at the weld quality. Till half-way we found that the welding was okay, for certain zone there was a gap and this gap was the limitation of the laser welding when the other end is not clamped properly. During the formation of vapours, that vapour pressure is applying the pressure on the two walls of the work parts and there is a separation which got occurred and due to that there was a little gap was produced during the laser welding operation.

This is the final part which is produced. Now, let us remove that final part. The way we have done the butt welding, in a similar way we can also do the other types of welding such as lap welding, edge welding, corner welding.

Now the part is removed and approximately the 80% of the weld was done, but there was a gap for the 20% weld and it is quite obvious. There is the separation of the two plates, maybe due to the vapour pressure which is being applied or the preheating of that part. Due to pre-heating as well there is increase in temperature, local temperature and then there is more vaporization of the work part rather than melting. (**Video Ends: 11:43**)

The last portion if you just notice for 20% there is more temperature was generated and the vapour pressure was also high. Due to more temperature generated there was vaporization, but no sufficient melting and due to that, weld was not happened and due to vapour pressure the plates got little bit separated. These kinds of things are to be properly tackled during the laser welding operation. Here we have taken a simple case study for the butt joint. To have the proper welding operation, the fixtures must be designed, we can use the modular fixtures during our operations.

With this small video and the discussion, we can say that we can certainly weld two metal parts by using laser welding operation. Now, let me tell you about the various process parameters which are used for this laser welding operation.

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The parameters are laser power of 1800 watt, the scan speed was about 500 meters per minute. There was a lasing gas CO_2 and assist gas was O_2 that is oxygen, the stand-off distance was about 15 mm and the assist gas pressure was 25 bar.

With these settings, we could successfully weld two mild steel parts of 2 mm thickness. However, further, we can do the optimization, detailed experimental studies to have proper welding operation.

With this I would like to stop for this particular case study on laser welding of mild steel sheets of 2 mm thickness using 2.5 kilowatt laser.

Thank you for watching this video. With this, we are ending the Week 3 of this course Laser Based Manufacturing. In the next week that is Week 4, we will be learning about an interesting application of laser that is in material forming, that is laser forming we will be studying in detail in Week 4 of this course till then good bye. Thank you.