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Investigating ND-YAG Laser Cutting of SS Sheets Experimentally with Different Parameters

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***Abstract* - Although metal cutting operations traditionally employ mechanical or manual processes, laser cutting can be a viable, effective, and cost-efficient option for metal fabrication. Laser equipment is distinct from other cutting machines in both design and application. For example, laser cutters do not make direct contact with material, rely on high-energy power sources, have tighter cutting tolerances, and are generally automated to maximize precision. A laser device fires a concentrated stream of photons onto a precise area of the work piece in order to trim excess material and shape the work piece into a specific design. These machines are highly effective in cutting various grades of steel, such as stainless and carbon steel. However, lasers are less efficient on light-reflective or heat- conductive metals, like aluminum or copper, and require specific modifications to shape these materials. The material being cut often dictates the type of laser used in fabrication, making it important to match equipment specifications with forming stock.**

This project deals with the cutting parameter of Nd-yag laser cutting of stainless steels. steel sheets to be cut satisfactorily by a pulsed Nd: YAG laser at the optimum process parameter ranges. In this project we will be made three attempts for made test pieces to predict the surface quality and dimensional accuracy of Nd-yag laser cutting for getting maximum best mechanical properties and min HAZ with various gases pressure. The responses considered are the heat-affected zone (HAZ) and mechanical properties analysis. The effect of the process parameters on the output responses is also investigated through mechanical properties and micro structural analysis.

***Index Terms*— Kitchen Waste, Chemical Fertilizers, Buzzing System, Liquid Fertilizer Soil Compost.**

I. INTRODUCTION

A laser is a machine that uses optical amplification based on the stimulated emission of electromagnetic radiation to produce light. Light Amplification by Stimulated Emission of Radiation is what the term "laser" originally stood for. Applications like laser cutting and lithography are made possible by spatial coherence, which enables a laser to be focused to a precise location. Applications like laser pointers are made possible by spatial coherence, which also enables a laser beam to remain narrow across extended distances (collimation). In addition to having an extremely narrow spectrum—that is, just emitting one color of light—lasers can also have excellent temporal coherence.

In 1917, Albert Einstein put forth the notion of stimulated light emission. Einstein demonstrated that light was made up of photons, which are little packets of wave energy, with the wavelength varying with the energy.

Lasers emit light coherently, which sets them apart from other light sources. Because the photons in laser light have the same frequency, wavelength, and phase as regular light, they are also different. Therefore, laser beams are more directed, have a higher power density, and have greater focusing properties than regular light. These special qualities of the laser beam are helpful when treating materials. Cutting, drilling, micromachining, labeling, welding, sintering, heat treatment, and other manufacturing operations all make extensive use of laser beams.

There are numerous significant uses for lasers.

II.COMPONENTS OF LASER

The three basic components of a laser are:

•Lasing material (crystal, gas, semiconductor, dye, etc.)

•Pump source (adds energy to the lasing material, e.g. flash lamp, electrical current to cause electron collisions, radiation from a laser, etc.)

•Optical cavity consisting of reflectors to act as the feedback mechanism for light amplification

III.PROBLEM STATEMENT

In the industry sector, they are various ways to cut materials. One of them is using laser machine that is Laser Beam Cutting. This project is to help the industry to cut the various type of material that is used in the industry by using laser machine. By using this method, they can cut any shape that they want easily where it is hard to use another machine or method to cut it. So practically, this method can help the industry in cutting their materials.

There were some problems that need to be tackled such as using the Microsoft Excel Software to analysis data or to find pattern in data. Besides that, the type of materials that need to use in this project also has to determine and have to produce the finest and the most quality of cut.

There are some parameters that have to consider such as laser power, type and pressure of assist gas, cutting materials thickness and its composition, cutting speed, and mode of operation (continuous or pulsed) on process performance. All of these parameters have to be determined before doing an experimental study of laser beam cutting.

IV.PROJECT OBJECTIVE

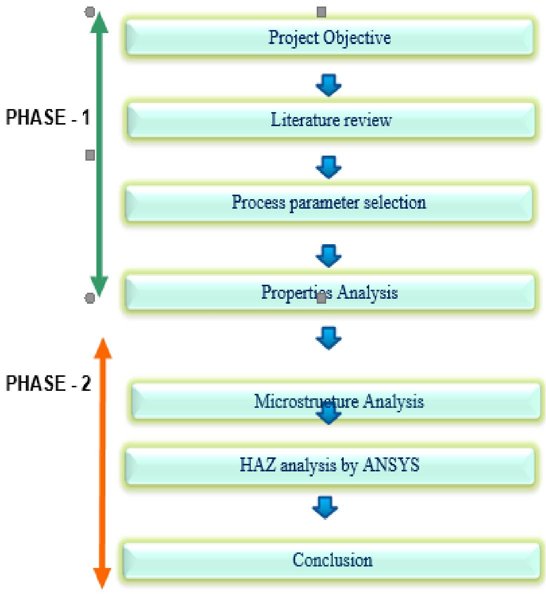
The aim of this project is generally to:

• To study the Laser Beam Cutting (LBC) on Stainless steel Sheet.

• To find the best parameters that can produce the finest and most quality of Cutting quality on stainless steel sheets by analysis using ansys.

• Parameter optimization.

V. PROJECT METHODOLOGY



VI. PROCEDURE MICRO-INDENTATION HARDNESS TESTER

This section provides a step-by-step procedure. A description of the machine is provided in Figure. The indenter tip and optics are located on a 3stage swivel, with the indenter occupying the center location, the coarse objective to the right and the fine/measurement objective to the left.

o Turn the power on

o Place specimen in self-leveling stage and lock the specimen in place with the thumbwheel such that the specimen just touches the leveling fingers. Do not over tighten, as this will either damage the sample or the stage.

o Move the coarse objective at the center point of the indenter/optics swivel.

o Focus on the sample with the coarse objective. This will place the specimen surface at the appropriate distance from the indenter tip. Set the lamp intensity such that features are distinguishable, as too high an intensity reduces bulb life and induces eyestrain.

o Adjust the eyepiece diopter until the micrometer filaments are sharply in focus (Figure 2).

o Bring the two measurement _laments together until no light passes through the two lines by rotating the left and right thumbwheels on the eyepiece. Hold set for 2 seconds so that the DRO reads 0 for both d1 and d2.

o Select the appropriate dwell time by pressing dwell, followed by set. The standard dwell time for creep-resistant materials is 10 seconds.

o Locate the position on the specimen in which you wish to place an indent using the stage micrometers. Note that these micrometers are in imperial units, with each division equal to 0.001", or 25.4 _m. Ensure that the position does not produce interference between the indentation tip and the _ne/measurement objective.

o Select the desired load by rotating the load knob.

o Ensure that the DRO is displaying HV (Vickers) and not HK (Knoop).

o Move the indenter into the center location, and press start. The Loading LED will illuminate as the test proceeds. Do not move the specimen stage or the indenter while this LED is illuminated as the indenter/sample will be damaged.

o Once the loading cycle is complete and the loading Loading LED is no longer lit, move the fine objective into place.

o Using the measurement _laments, measure the indent by first orienting the eyepiece such that the filament is completely perpendicular to the diagonal to be measured. This is shown in Figure 3. Pressing the read button on the eyepiece will pass the value to the DRO under d1/d2. Alternatively, manually record the measurement. Repeat for the other diagonal.

o If values were passed to the DRO, the hardness value according to the mean of the two diagonals is displayed in the measurement window.

VII. TESTING RESULTS

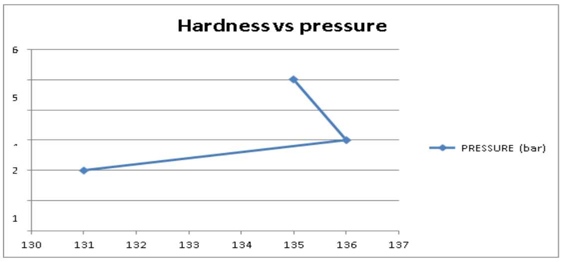
1. BEFORE TESTING

LOCATION	OBSERVATION
A	146
B	141
C	139

2. AFTER TESTING

LOCATION	OBSERVATION
A	135
B	136
C	131

3.GRAPH



a.Hardness vs pressure

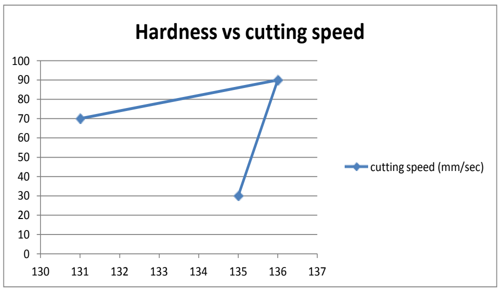
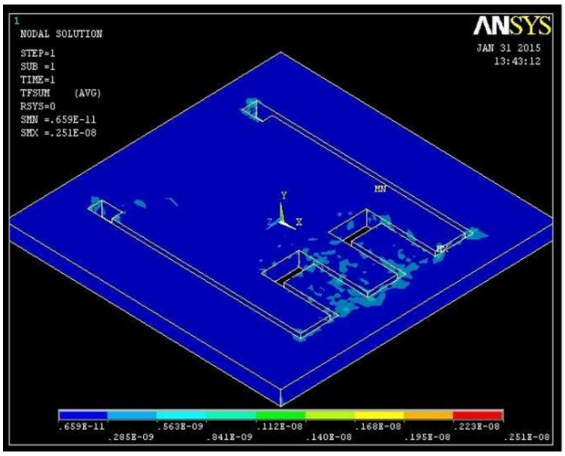


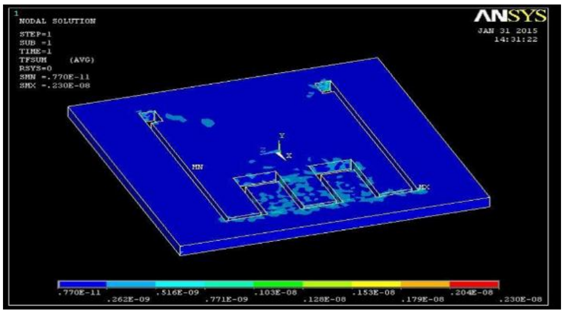
Fig no : 5.3.2 Hardness vs cutting speed

3.1 TEMPERATURE DISTRIBUTION

1.HEAT FLOW-TEMPEARTURE-1700



2. HEAT FLOW-TEMPEARTURE-1750



VIII. MICROSTRUCTURE

SAMPLE – I-500 x Magnification

The photomicrograph at left was made at 500X near the high carbon surface. It shows martensite plus retained austenite. The austenitization temperature was high enough to put most of the carbon into solution in the austenite, so the martensite start temperature was above room temperature

IX.MERITS OF THE PROPOSED SYSTEM

The main aim was to design the proposed on-line monitoring system, which differs from the existing ones because of the following.

- Time consumption prediction is major criteria
- Improve the productivity.
- Improve Safety and minimize environment pollution.
- Reduce the effect of human health impacts.
- Costs are lower.

X. CONCLUSION

The various parameters have to be selected for Nd-Yag laser machining. The work piece will be planned with various parameters like gas pressure and cutting speed. In order to achieve to high degree cutting surface as well as minimum nodes and minimum heat affected zone these machining parameters will be used. Along with that compare the micro structure and cut quality properties and material hardness. Thermal distribution also analyzed by using ansys.

Thus cutting stainless steel by pulsed and CW Nd:YAG laser, it was shown that the laser cutting quality depends mainly on the cutting speed, cutting mode, laser power and pulse frequency and focus position. The cutting parameters that provided dross-free and sharp cut surface during pulsed laser mode were: power=25W, cutting speed 90mm/sec, gas pressure =3 bar, time duration 20 min. The maximum hardness value obtained after machining in terms of Vickers hardness number is 136HV.

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