

# Performance and Emission Analysis of a Diesel Engine Fueled By Biodiesel-Diesel Blends

R.Baskar<sup>1</sup>, R.Raju<sup>2</sup>, B.Santhosh<sup>3</sup>,

Assistant Professor, Department of Mechanical Engineering, TRP Engineering College, Tiruchirapalli, India<sup>1</sup>

UG Scholars, Department of Mechanical Engineering, TRP Engineering College, Tiruchirapalli, India<sup>2,3</sup>

**ABSTRACT:** Increased environmental concerns and depletion of fossil fuel resources necessitate the search for a viable alternative fuel for diesel engines. Biofuels are renewable, can supplement fossil fuels, reduce greenhouse gas emissions and mitigate their adverse effects on the climate resulting from global warming. However, further reduction in engine emission becomes one of major tasks in engine development. One promising approach to solve this problem is to add the oxygenated fuels in biodiesel. In this project work, an attempt has been made to comparative analysis of different proportions with biodiesel in a single cylinder, four stroke naturally aspirated, computerized diesel engine (5HP @ 1500rpm). The measured combustion, performance parameters are ignition delay, maximum pressure, combustion duration, brake specific fuel consumption, brake thermal efficiency, volumetric efficiency, combustion pressure, heat release, cumulative heat release rate and engine exhaust emissions of HC, CO, CO<sub>2</sub>, NO<sub>x</sub>, O<sub>2</sub> and smoke intensity. Significant improvements in combustion, performance parameters and exhaust emissions characteristics have been observed for the addition of diethyl ether and ethanol blends with biodiesel.

**KEYWORDS:** Biodiesel, rice-bran oil methyl ester, combustion characteristics, P- diagram, burn rate, heat release

## I. INTRODUCTION

Biodiesel is a renewable substitute fuel for diesel made from vegetable oils or animal fats. It can be used as a mixture with alcohol as blends as it has similar characteristics but it has lower emissions. Using biodiesel results in large reductions in overall carbon dioxide emissions. In fact when biodiesel is manufactured from vegetable oil the fuel is almost carbon neutral i.e. the CO<sub>2</sub> released during combustion and manufacture is offset by CO<sub>2</sub> consumed during the growth of the crops that are used to produce the raw oil. Biodiesel seamlessly integrates with current engine technology and fuelling infrastructure. It is the first clean fuel that does not require fleet operators to purchase new vehicles or construct new facilities.

### A. RICE BRAN OIL

Due to clean emission profile, ease of use and other benefits biodiesel quickly become one of the fastest growing alternative fuels in the world. The future of biodiesel lies in the world's ability to produce renewable feedstock such as vegetable and animal oils, to keep the cost of biodiesel competitive with petroleum. The rice bran oil is extracted from the rice bran, which is a byproduct obtained during the grinding of paddy. Since rice is the staple food in a large part of south Asia, there is a huge potential to produce and utilize rice bran oil. India is the second largest producer of paddy. Hardly 50% of the bran is utilized for producing rice bran oil and 19% of edible grade rice bran oil is consumed for cooking, hence Rice bran oil is commercially feasible for biodiesel production. Rice bran oil is a byproduct obtained from outer layers of brown rice kernel during milling operation to produce polished rice. Rice bran has 16 wt% to 32 wt% oil (lipids) and nutraceutical compounds are depending on the rice variety and degree of milling. Crude RBO is difficult to refine because of its high free fatty acid contents, dark color, and a large amount of unsaponifiable matter. *CO<sub>2</sub> laser*

CO<sub>2</sub> lasers emit the infrared laser radiation with a wavelength of 10.6 μm and possess overall efficiencies of

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Special Issue 8, May 2016

approximately 10 to 13%. The laser-active medium in a CO<sub>2</sub> laser is a mixture of CO<sub>2</sub>, N<sub>2</sub> and He gases, where CO<sub>2</sub> is the laser-active molecule. The stimulation of the laser-active medium is accomplished by electrical discharge in the gas. During the stimulation process, the nitrogen molecules transfer energy from electron impact to the CO<sub>2</sub> molecules. The transition from energetically excited CO<sub>2</sub> molecules (upper vibrational level) to a lower energy level (lower vibrational level) is accompanied by photon release leading to emission of a laser beam. The CO<sub>2</sub> molecules return to the ground state by colliding with the helium atoms, which comprise the major share of the gas mixture, and the CO<sub>2</sub> molecules in the ground state are then available for another cycle. The stimulation of the electrical gas discharge in the gas mixture is accomplished by either direct current or radio frequency stimulation. In direct current stimulated lasers, gas discharge between electrodes allows the electrical energy to be directly coupled into the laser gas while the radio frequency stimulated lasers are characterized by capacitive in coupling of the electrical energy needed for gas discharge. There are different designs of the CO<sub>2</sub> laser that use different modes of gas flow and cooling enabling effective beam delivery over a wide range of output power. The CO<sub>2</sub> laser technology includes the following designs: Transverse flow (cross-flow) laser, Fast-axial flow laser, Diffusion-cooled slab laser and Sealed-Off laser. They can be operated in either the CW mode or pulsed mode. The beam power and beam quality of the transverse flow (cross-flow) CO<sub>2</sub> laser (multi-mode) are favorable for laser welding applications. The CO<sub>2</sub> laser designs that are used for cutting applications are discussed in the following sections.

## II. LITERATURE REVIEW

**S.SIVALAKSHMI, et al (2012)** analysed an experiment on, "performance and emission characteristics of a diesel engine fuelled by neem oil blended with alcohols", Alcohols up to 20% (by volume) are blended with neem oil by manual mixing at room temperature. No phase separation is observed with all the fuel blends. The brake thermal efficiency is improved with the use of neem oil-alcohol blends with respect to those of neat neem oil. The smoke intensity is significantly reduced with the use of neem oil-alcohol blends with respect to that of neat neem oil. The NO<sub>x</sub> emission is very slightly reduced with the use of neem oil-alcohol blends except for the neem oil-ethanol blend compared with that of neat neem oil. The CO and HC emissions with neem oil-alcohol blends are observed to be lower with respect to those of neat neem oil at higher loads. **G.BALAJI, et al (2012)** proposed an paper on, "experimental investigation to mitigate exhaust emissions in a single cylinder engine fuelled with methyl ester of neem oil using tocopherol acetate", For MENO200T mixture, NO<sub>x</sub> emissions reduce by 22.41 % compared to pure biodiesel at full load conditions. For MENO100T mixture, HC emissions reduce by 48.81 % compared to pure biodiesel at full load conditions. For MENO200T mixture, Smoke Intensity reduces by 9.59 % compared to pure biodiesel at full load conditions. There is no significant variation in CO, CO<sub>2</sub> emissions, BTE and BSFC. Based on the present experimental analysis, antioxidant (□-Tocopherol Acetate) addition with neem biodiesel reduces NO<sub>x</sub>, HC and smoke intensity. **DR.RATHOD PRAVIN, et al (2007)**, "The performance of multi cylinder diesel engine fuelled with blend of diesel and neem oil biodiesel" and he concluded that "Neem oil biodiesel has comparative properties to diesel. Neem oil biodiesel has 11.81 % lower energy content than diesel. B20 fuel has 2.36% lower energy content than diesel. Maximum power produced using blend of Neem oil biodiesel with diesel can be less compared to diesel because of lower calorific value. B20 has 25% higher kinematic viscosity compared to diesel. Neem oil biodiesel to attain lesser diameter droplet. Brake thermal efficiency with B20 fuel is 30.50%, which are higher compared to 29.89% of diesel. Maximum brake thermal efficiency with B10 and B30 fuels are found 27.97% and 28.45% respectively, which are lower compared to 29.89% with diesel. The higher kinematic viscosity of B30, results in larger droplet diameter and hence in lower brake thermal efficiency. Minimum BSEC for B20 fuel is 11.80 MJ/KW-h. B20 fuel has the lowest BSEC followed by B10, B30 and diesel fuels. Lowest BSEC for B10, B30 and Diesel fuels are 12.87 MJ/KW-h, 12.65 MJ/KW-h and 12.04 MJ/KW-h respectively. Lowest BSEC for B10, B30 and Diesel fuels are approximately 16%, 17% and 11% higher compared to lowest BSEC for B20 fuel. Maximum EGT measure for diesel, B10, B20 and B30 fuels are 305.68 °C, 223.52 °C, 238.07 °C and 240.10 °C respectively at full load. EGT increased from no load to full load for all fuels. Minimum emission of CO with diesel, B10, B20, and B30 fuels are 0.022 %/Vol., 0.02 %/Vol., 0.018 %/Vol. and 0.021 %/Vol. respectively at brake power of 4.3 KW. Among all compared fuels CO emission for B20 is lowest followed by B10, B30 and diesel. At maximum brake power of 9.4 KW, emission of CO with diesel, B10, B20, and B30 fuels are 0.032 %/Vol., 0.025 %/Vol., 0.022 %/Vol. and 0.023 %/Vol. respectively. Minimum amount of CO

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Special Issue 8, May 2016

emission is achieved for diesel and B20 fuels are 0.022 %/Vol. and 0.018 %/Vol. respectively at brake power of 4.3 KW”.

**S.SRAGIT, et al (2010)** analysed on,” Optimization of neem methyl ester from transesterification process and fuel characterization as a diesel substitute”, Based on the observations of the ester recovery and kinematic viscosity, it was found that filtered neem oil at 6:1 M ratio (methanol to oil) preheated at 55 °C temperature and maintaining 60 °C reaction temperature for 60 min in the presence of 2 percent KOH and then allowed to settle for 24 h gave lowest kinematic viscosity (2.7 cst) with ester recovery (83.36%). The lowest viscosity is considered better for engine performance in internal combustion engine in this research study. The density, flash and fire points of neem methyl ester gave good results but calorific value was slightly less as compared to diesel.

### III. METHODOLOGY

The methodology adopted is outlined below in step by step manner.

- Selection of suitable vegetable oil.
- Preparing the esterified rice bran oil by the transesterification process.
- Developing an experimental setup with necessary instrumentation to study the performance and emission characteristics of the diesel engine fuelled with rice bran oil.
- Conducting experiments with rice bran oil and study the performance and emission characteristics.
- Conduct the experiments on Single cylinder diesel engine in various blends.

On the basis of reading and the result come from the experiment conclusion was drawn.

### BIODIESEL PRODUCTION

Biodiesel production is the process of producing the biofuels, biodiesel, through either transesterification or alcoholysis. It involves reacting vegetable oils or animal fats catalytically with a short-chain aliphatic alcohol. The major steps required to synthesize biodiesel are as follows:

#### FEEDSTOCK PRE-TREATMENT:

If waste vegetable oil (WVO) is used, it is filtered to remove dirt, charred food, and other non-oil material often found. Water is removed because its presence causes the triglycerides to hydrolyze, giving salts of the fatty acids (soaps) instead of undergoing transesterification to give biodiesel.

#### Determination and treatment of free fatty acids:

A sample of the cleaned feedstock oil is titrated with a standardized base solution in order to determine the concentration of free fatty acids (carboxylic acids) present in the waste vegetable oil sample. These acids are then either esterified into biodiesel, esterified into bound glycerides, or removed.

#### 3.2.2 Reactions:

While adding the base, a slight excess is factored in to provide the catalyst for the transesterification. The calculated quantity of base (usually sodium hydroxide) is added slowly to the alcohol and it is stirred until it dissolves. Sufficient alcohol is added to make up three full equivalents of the triglyceride, and an excess of usually six parts alcohol to one part triglyceride is added to drive the reaction to completion.

## International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Special Issue 8, May 2016



Fig 1 Esterification unit separation flask



fig 2 Gravity

### 3.2.3 Product purification:

Products of the reaction include not only biodiesel, but also by products, soap, glycerine, excess alcohol, and trace amounts of water. All of these by products must be removed, though the order of removal is process-dependent. The density of glycerine is greater than that of biodiesel, and this property difference is exploited to separate the bulk of the glycerine by product. Residual methanol is typically removed through distillation and reused, though it can be washed out (with water) as a waste. Soaps can be removed or converted into acids. Any residual water must be removed from the fuel.

### 3.3 Transesterification process:

Animal and plant fats and oils are typically made of triglycerides which are esters of free fatty acids with the trihydric alcohol, glycerol. In the transesterification process, the alcohol is deprotonated with a base to make it a stronger nucleophile. Commonly, ethanol or methanol is used. As can be seen, the reaction has no other inputs than the triglyceride and the alcohol.

Normally, this reaction will proceed either exceedingly slowly or not at all. Heat, as well as an acid or base are used to help the reaction proceed more quickly. It is important to note that the acid or base are not consumed by the transesterification reaction, thus they are not reactants but catalysts.

Almost all biodiesel is produced using the base-catalyzed technique as it is the most economical process requiring only low temperatures and pressures and producing over 98% conversion yield. However, biodiesel produced from other sources or by other methods may require acid catalysis which is much slower. Since it is the predominant method for commercial scale production, only the base-catalyzed transesterification process will be described.

## IV. RESULT AND DISCUSSION

The below response was analysed with the help of above instruments and following the graphs and mathematical equations are obtained.

## International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

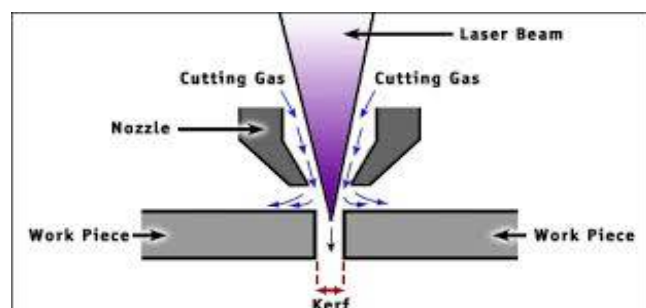
Vol. 5, Special Issue 8, May 2016

TIME	KERF WIDTH	MEAN HARDNESS
2.312	1.035	65.25
5.398	0.86	89.75
3.687	0.405	93.5
4.283	0.305	74.75
2.596	0.435	82
4.95	0.46	71.5
3.605	0.56	84.75
2.544	0.485	82.5
4.409	0.51	59.75
4.545	0.525	72.75
4.816	0.57	92.75
3.501	0.53	81.75
4.908	0.62	86.25
4.318	1.06	68.5
3.908	0.8	60.75
4.498	0.54	63.75

Response Values for the experiment

### Kerf Width (Kw)

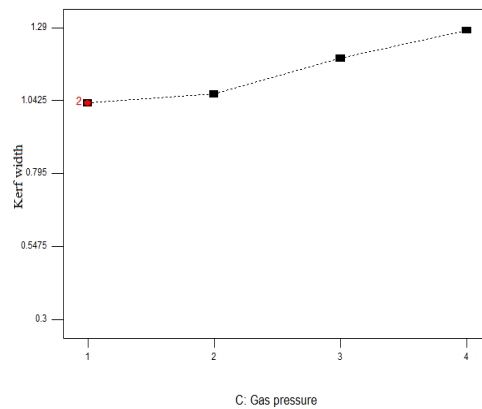
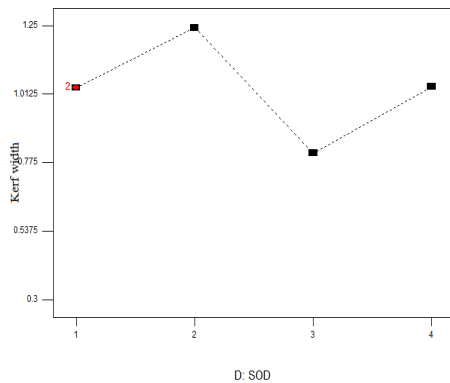
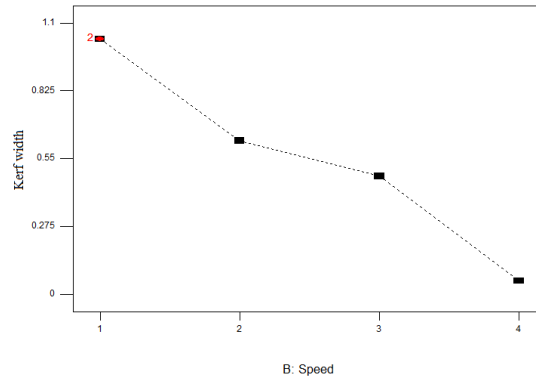
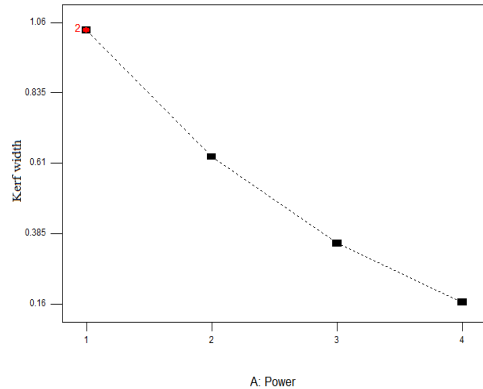
The **width** of a saw cut, which depends on Several factors: the **width** of the saw blade; the set of the blade's teeth; the amount of wobble created during cutting; and the amount of material pulled out of the sides of the cut.



## International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Special Issue 8, May 2016



From the above graph of kerf width it is observed that

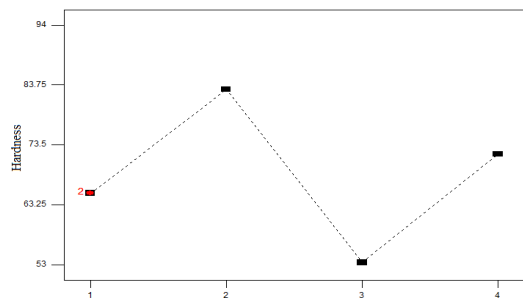
1. The power increases, the value of the kerf width gradually decreases.
2. The value of the speed increases which results in reduction of kerf width gradually
3. The assist gas pressure increases the value of the kerf width increases. Thus the pressure of assist gas should be low for minimizing the kerf width.
4. The stand of distance increases the, value of the Kerf width gradually increases and decreases at the certain point.

# International Journal of Innovative Research in Science, Engineering and Technology

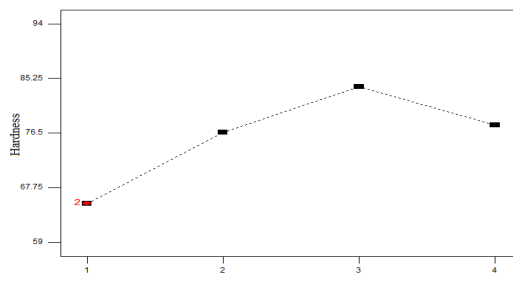
(An ISO 3297: 2007 Certified Organization)

Vol. 5, Special Issue 8, May 2016

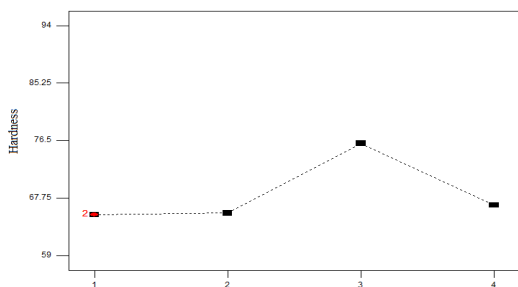
## MEAN HARDNESS



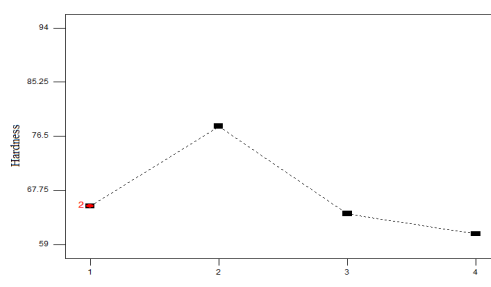
A: Power



B: Speed



C: Gas pressure

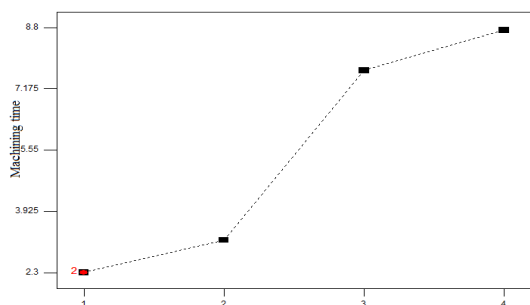


D: SOD

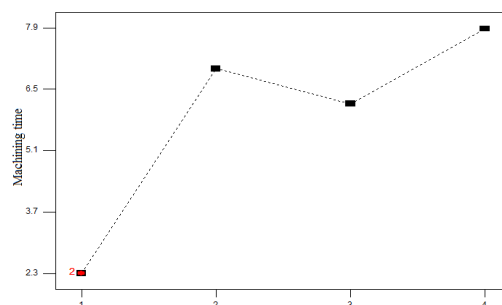
We observed from the graph that,

- Power increases, the value of the surface hardness has both sudden increase and decreases to a certain level of point.
- The value of the speed increases, the value of the surface hardness gradually increases and after a certain point it starts to decrease.
- Gas pressure increases, the value of the surface hardness remains constant for a particular gas pressure and then results in sudden increase and decrease of hardness.
- The value of the Stand of distance increases the value of, the surface hardness suddenly increases and then gradually decreases to a certain level.

## MACHINING TIME:



A: Power



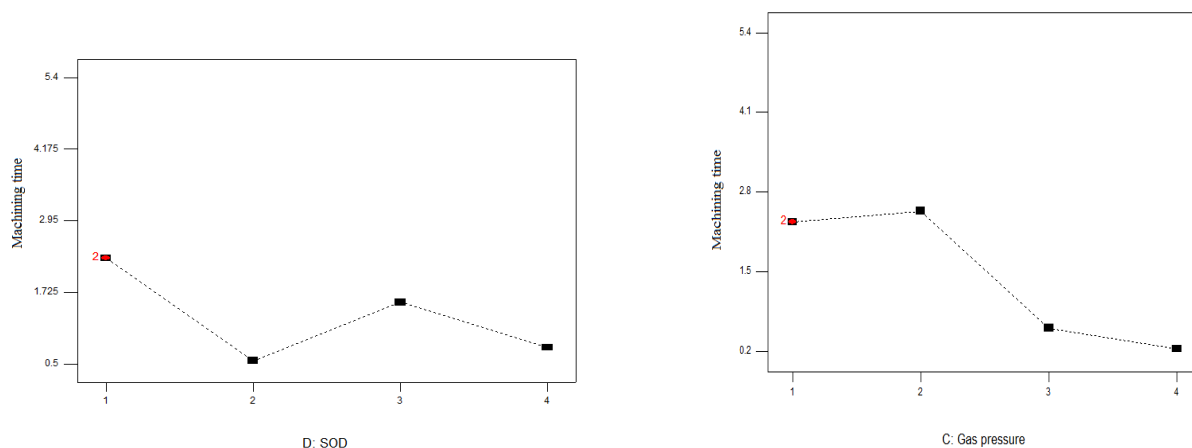
B: Speed



# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Special Issue 8, May 2016



It is shown that from the graph above given are

- Power increases the value of the machining time also gradually increases from point to point to a certain level.
- The value of speed increases, the value of the machining time gradually increase and decrease in nature.
- The value of the gas pressure increases the value of the machining time gradually decreases to a certain level
- The SOD increases the value of the machining time suddenly decreases and then increases to a certain point.

## V. CONCLUSION

The experiment presented here is an overview of research work carried out in laser cutting process. From the above discussions it can be concluded that:

- Increase in value of power results in gradual decreases in kerfwidth, machining time simultaneously increases for every point and there is a sudden increment and decrement in hardness value.
- Machining time and kerfwidth are inversely proportional, since increase in the value of speed decreases their values, and hardness gradually increases and all of sudden decreases.
- There is an increment in the value of hardness and kerfwidth, when the value of pressure increases and machining time reduces. At some point hardness remains constant and reduces.
- Standoff distance has a similar impact on all kerfwidth, machining time and hardness. Since both increment and decrement happens when SOD increases.

Thus the relationship between the various values of input parameters and their corresponding response is studied for CO<sub>2</sub> Laser cutting of stainless steel plate of 3mm thickness. The scope of this project can be increased by optimizing the value of the input parameters for better quality of cut, in future.

## REFERENCES

1. Dhaval P. Patel, Mrugesh B. Khatri, —Optimization of High Power Co2 Laser Machining Centre's Machining Parameters by Experimental Analysis, International Journal of Engineering Research and Applications (IJERA), Vol. 2(Issue 2), 2012, 1190-1196.
2. Ahmet Cekic et al. (2014)- 25th DAAAM International Symposium on Intelligent Manufacturing and Automation, DAAAM2014 Definition of Mathematical Models of High-Alloyed Steel 1.4828 in CO<sub>2</sub> Laser Cutting.
3. A.M. Orishich, A.G. Malikov, V.B. Shulyatyev,\*, A.A. Golyshev-Experimental comparison of laser cutting of steel with fiber and CO<sub>2</sub> lasers on the basis of minimal roughness 8th International Conference on Photonic Technologies LANE 2014
4. Jun Hu, Zhuoxian Zhang, Jingwen Luo, Xiaojun Sheng. —Simulation and experiment on standoff distance affecting gas flow in laser cutting, Journal of Applied Mathematical Modeling, Vol 35, 2011, 895–902.
5. Sivarao, Ammar, T.J.S. Anand, Shukor, —Stochastic Modeling and Optimization of Laser Machining by Response Surface



## International Journal of Innovative Research in Science, Engineering and Technology

*(An ISO 3297: 2007 Certified Organization)*

**Vol. 5, Special Issue 8, May 2016**

Methodology, International Journal of Engineering & Technology, Vol 10(04), 13-21.

6. MilosMadic, MiroslavRadovanovic and LaurentiuSlatineanu, —SurfaceRoughness Optimization In Co2 Laser Cutting By Using Taguchi Method", U.P.B. Sci. Bull., Vol. 75(Iss. 1), 2013, 97-106.

7. H.A. Eltawahni ,M.Hagino , K.Y.Benyounis , T.Inoue , A.G.Olabi- Effect ofCO2 laser cuttingprocessparametersonedgequalityand operating costofAISI316L

8. Sundar,A.K.Nath, D.K.Bandyopadhyay, S.P.Chaudhuri, P.K.Dey,D.Misra, —Effect of process parameters on the cutting quality in lasocutting of mild steell, International Journal of Advanced Manufacturing Technology, Vol. 40, 2009, 865-874.

9. K.A.Ghany, &M.Newishy, —Cutting of 1.2mm thick austenitic stainless steel sheet using pulsed and CW Nd:YAG laser.I Journal of MaterialProcessing Technology, Vol 168, 2005, 438–447.

10. B.S.Yilbas, —Laser cutting quality assessment and thermal efficiency analysisI, Journal of Materials Processing Technology, Vol(155-156), 2004, 2106-2115.