Design and Development of Low Cost Auto-Profile Gas Cutting Machine

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ABSTRACT

The recent advancements in digital technology especially embedded systems, have now enabled us to make low-cost machines for Real time applications. This paper presents a simple way of designing and implementing an automatic metal sheet cutting machine using easily available low-cost micro-controllers. This machine takes shapes to be cut on the sheet in, as input a high resolution raster image via laptop and cuts the sheet accordingly. A locally developed, completely automatic and cost-effective machine for the cutting of metal sheets is the need of the hour. Such a machine would enable medium and small scale firms to increase their production capacity and produce high quality products at much cheaper rates, helping them to survive in today's competitive global market.

Keywords: *Cost-effectivemachine, Magnetic coil,Scrap material etc.*

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1. INTRODUCTION

The common methods used in cutting metal are oxygas flame cutting, air carbon-arc cutting, and plasma-arc cutting. The method used depends on the type of metal to be cut and the availability of equipment. As a Steelworker, oxygas or air carbon-arc equipment is the most common type of equipment available for our use. The oxygas cutting torch has many uses in steelwork. At most naval activities, the Steelworker finds the cutting torch an excellent tool for cutting ferrous metals. This versatile tool is used for operations, such as beveling plate, cutting and beveling pipe, piercing holes in steel plate, and cutting wire rope.

When using the oxygas cutting process, you heat a spot on the metal to the kindling or ignition temperature (between 1400°F and 1600°F for steels). The term for this oxygas flame is the preheating flame. Next, you direct a jet of pure oxygen at the heated metal by pressing a lever on the cutting torch. The oxygen causes a chemical reaction known as oxidation to take place rapidly. When oxidation occurs rapidly, it is called combustion or burning. When it occurs slowly, it is known as rusting. When you use the oxygas torch method to cut metal, the oxidation of the metal is extremely rapid and part of the metal actually burns. The heat, liberated by the burning of the iron or steel, melts the iron oxide formed by the chemical reaction and accelerates the pre heating of the object you are cutting. The molten material runs off as slag, exposing more iron or steel to the oxygen jet. In oxy gas cutting, only that portion of the metal that is in the direct path of the oxygen jet is oxidized. Then arrow slit, formed in the metal as the cutting progresses, is called the kerf. Most of the material removed from the kerf is in the form of oxides (products of the oxidation reaction). The remainder of the material is molten metal that is blown or washed out of the kerf by the force of the oxygen jet. Partial oxidation of the metal is a vital part of the oxygas cutting process. Because of this, metals that do not oxidize readily are not suitable for oxygas cutting. Carbon steels are easily cut by the oxygas process, but special techniques are required for the

cutting of many other metals. A cutting torch diverts the oxygen and mixes part of it with the fuel gas to create the preheat flame, forming the ring of flame around the cutting tip. This preheat flame will reach a temperature of 440F to 6000F, depending on the fuel gas used as well as the ratio of oxygen to fuel gas. In order to start a chemical reaction, the metal must be raised to the kindling temperature, which in mild carbon steel is approximately 1600ºF. At this point the metal will reach a bright orange color and sparks will be noticed on the top edge. When the kindling temperature is reached, the cutting oxygen lever is opened and high purity oxygen is introduced. As the oxygen chemically combines with the iron exothermically (exothermic reaction), the result is generally referred to as the "cutting jet." The cutting jet is always in the center of the tip and instantly starts a rapid oxidation of the steel through the depth of the cut. A tremendous amount of heat is liberated when the high purity oxygen unites with the steel during this reaction.

If carried through to completion, you have three balanced chemical equations as a result of this reaction:

Fe + O --- FeO + Heat (63,800 Cal) First Reaction

3Fe + 2O2 --- Fe_3O_4+ Heat (267,800 Cal) Second Reaction

2Fe + 3/2 O2 --- Fe_2O_3+ Heat (196,800 Cal) Third Reaction

The third reaction occurs, to some extent, in heavier section cutting, with the first and second predominating. Theoretically it takes 4.6 cubic feet of oxygen to oxidize one pound of steel completely to ferrous oxide. In practical cutting operations the amount of oxygen used is less because not all of the iron is completely oxidized to ferrous oxide. This set amount of oxygen is the constant required to flame cut metal no matter what fuel gas is used for the preheat function. As the iron is oxidized it starts to flow; some of the material adjacent to the iron oxides is melted and also flows, due only to the intense heat that is liberated in the chemical reaction. The removal of all the metal is based in a large part on the velocity and coherency of the high purity oxygen cutting jet.

1.1 Objectives

This project was developed to study about the profile gas cutting machine in smooth cutting using gas cutting process. The main purposes of this project are listed below.

1 To study about the influence of profile gas Cutting Parameters on mild Steel.
2 To study about the best combination of solution using gas cutting, motor and tracer, template, nozzle torch.
3 To reduce time required to generate the profile.
4 To achieve required surface finish.

1.2 Scope of the Project

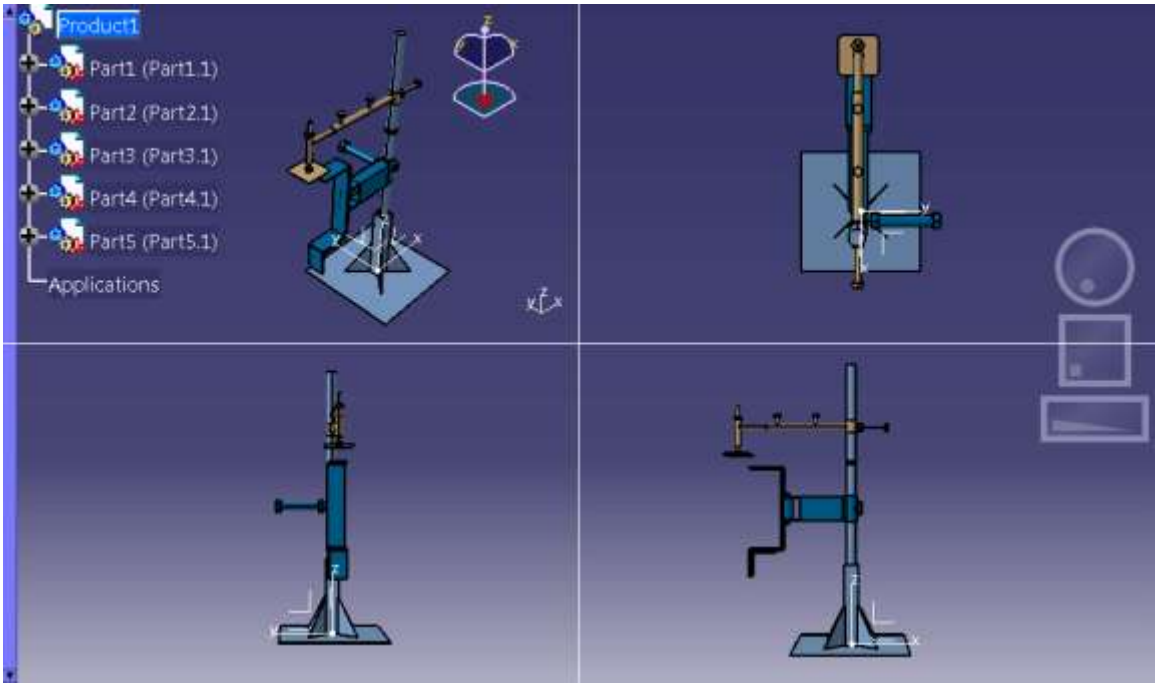
The main requirement of machine is to use in small scale workshop and for semi-skilled worker. It also helps to reduce risk of injury to worker.

- This project focuses on the optimization of cutting parameters of profile gas cutting.
- The material used to cut was mild Steel of specification AISI 1018.

2. WORKING

Gas cutting machines have become a necessity in the world of metal fabrication. Hence, there are constant improvements and developments that take place in this field. In the last couple of decades itself consumers have shifted drastically from the traditional cutting methods that used to be quite inaccurate, time consuming, and lead to high amount of wastage, to efficient and effective cutting methods like laser, oxyfuel, etc. With the use of such cutting solutions, businesses and companies have found a way to increase profitability, while reducing cost, time and wastage. Gas cutting machines have some advantages on its side as compared to laser cutting machines. Gas cutting machines are primarily reasonably priced. By searching online and doing some background checks over service and product quality, you could end up with an excellent machine that will increase the productivity of your industry by leaps and bounds. These machines are fairly easy to operate and give the kind of accuracy in the job that is needed. The machine is mostly portable and does not take up too much space. As compared to laser cutting machines, gas cutting machines can cut thicker sheets of steel or brass and other electrically-conductive metals like aluminum with fair accuracy. Profile gas cutting machine is a precision, quality constructed, hard-working gas shape cutter build for high production. Compact and simple operate; this machine excels at repetitive work, continuously producing

accurate flame cuts by following a steel template. A powerful magnetic roller smoothly guides the cutting torch around any shape, cutting steel plate up to 4 inches thick. This machine offers all the convenient features of more expensive models with all the dependability and efficiency needed for our applications. Profile gas cutting machine is small profile radial arm oxygen cutting machine. Being small in size and light weight, the machine can be easily carried to the worksite and placed directly on the plate to be cut. As the machine is mounted on four bolts, it can be moved about on the plate to be cut as per requirement. The tracing roller is magnetized by a solenoid coil or permanent magnet and driven by an electric motor follow the edge of steel template of virtually any shape guiding the cutting torch to cut the desired profile. S.C.R control ensures Table step less speed variation and smooth running. Thrust ball bearing used on rotating joints provides free and frictionless movement of arms. Efficient design of rack and pinion system ensures smooth and easy movement of cutter.



2.1 Components

1. C Shape frame

2. Arm

3. Main column (Rod)

4. Hollow pipe

5. Base

6. Bearing

7. Nozzle

8. Variac Speed controller

9. Electromagnetic coil

2.2 Advantages

1. It can be used to cut risers, rivets and gates from casting.
2. As compared to other mechanical cutting methods the cost of using this machine is rather low and cost-effective.
3. Easy setup.
4. Can be operated with unskilled worker.
5. It is portable.
6. Less maintenance

2.3 Disadvantages

1. This is method is limited to the cutting of steel and cast iron materials only.
2. The dimensional tolerances as compared to the mechanical cutting methods are poor.

2.4 Applications

Our project has wide range of applications in industries:
1. Small and medium Metal Cutting Industries.
2. Workshops

3. CONCLUSION

Thus, this work provides an alternative to the existing automatic gas cutting machine, in terms of automating the work piece entry into the cutting apparatus, eliminates power fluctuation and lesser initial investment. Time consumption is less when compared to manual cutting. This work provides the desired output for automation and fabrication.This machine is very useful for small scale industries.

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