# *Manufacturing Lines Process Optimization: Tissue Cutter*

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***Abstract*** *— A medical devices company manufactures small tissue cutters. In this process, two pieces must be welded, grinded and straightened. The tissue cutter must be grinded because of imperfections formed in the metal welded. The heat applied in the welding process causes distortion in the tissue cutter, and that is why it must be straightened. To regulate the gas mixture and heat applied, a step in the manufacturing process is removed. On long term, the productivity increases 33 % by eliminating one machine of the process. In terms of cost, it eliminates two operators and lowers cost per unit.*

***Key Terms*** *— Productivity, waste, cost, gas mixture, heat.*

## INTRODUCTION

"Metal fabrication is the process of building machines and structures from raw metal materials. The process includes cutting, burning, welding, machining, forming, and assembly to create the final product" [1]. A company has a process to manufacture tissue cutters used in surgeries. The company is looking to find optimizations in the process so they can be more productive. In their process analysis, it was found the there is too much rework on the tissue cutter being manufactured. An area of opportunity has been found so it must be studied thoroughly and determine if the process can be optimized. Figure 1 shows the process of manufacture of the tissue cutter.

Small tissue process is automatic; therefore it only depends on the machines, and for each machine there are two operators. Following is an explanation of the steps of the process:

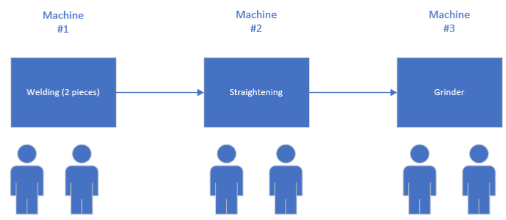


**Figure 1**
**Manufacturing Tissue Cutter**

- First the process starts with the welding of two small pieces which go through Machine #1. One operator aligns the two pieces and puts it in the plasma welding machine. Another operator is removing it from the machine and preparing the pieces (already welded) for the next process. The welding gas used in the process is 93% Argon and 7% Hydrogen, the welding machine parameters (amperage) is given in the WPS (Welding Procedure Sheet) by design from corporates office.
- Secondly is the straightening of the pieces already welded. Straightening involves applying controlled torque to a deformed part of steel cycles until the metal completely straightens to 180 degrees in Machine #2. One operator receives the two pieces welded from the Machine #1 and it's passed to Straightening machine. While another operator is removing it from the machine and preparing it for next process, which is to grind the piece.
- Grinding, an abrasive machining process that uses a grinding wheel as the cutting tool, it can make precision cuts and producing very fine finishing. In Machine #3, one operator receives the two pieces straightened from the Machine #2 and passed to Grinder machine. While another operator is removing it from the

machine and pieces are ready for finish good product.

The intent of this project is to determine where in the process is an opportunity of reducing cost and increase the productivity. Viewing the process there are three steps (Machine #1, Machine #2 and Machine #3) with six operators in total. The approach for this project was:

- Determine if the machine #1 can be eliminated.
- Determine if by changing the welding gas, productivity can be reached.
- If project is successful, economic analysis on savings.

## LITERATURE REVIEW

On the metals, the heat affects the structure molecules of the metal, changing the shape of them, hence distorting the metal. Applying a plasma arc, which is of approximately 28,000 C* affects the shape of the tissue cutter. A plasma is a gas which is heated to an extremely high temperature and ionized so that it becomes electrically conductive. "The plasma arc welding process uses this plasma to transfer an electric arc to a work piece. The metal to be welded is melted by the intense heat of the arc and fuses together" [2].

Argon/hydrogen is the best welding gas for this process. "Hydrogen-enhanced gas blends produce faster travel speeds and let you do more welding, with less distortion in less time" [3].

Specified for Plasma Arc Welding, since it's the welding process used in the manufacturing of the tissue cutter. This welding process is by fusion. This means that there is no filler metal applied, only heat that temporarily melts the metal and it fuses the two pieces [4].

## ANALYSIS PROCESSES

Optimization in manufacturing of medical tissue cutter: A medical devices company manufactures small tissue cutter. In this process, two pieces must be welded, grinded and straightened. By changing the welding gas & parameters the straightening process can be eliminated and the production increased.

First Major Task: Determine Optimum Gas Mixture for process. Three mixtures of gas where used to weld 60 tissue cutters (20 tissue cutters per Mixture) to determine the best gas for the process. Using an angle meter to determine if the unit passed or failed (Pass: If angle meter 0.1 $\geq$ 180◦ Fail: If angle meter 0.1 < 180◦)

The mixtures used were the following:

- Argon 93%/ Hydrogen 7% Mix
- Argon 95%/ Hydrogen 5% Mix
- Argon 97%/ Hydrogen 3% Mix

Determine Optimum Amperage for the process: After not having a 100% pass in the results of the first major task, the amperage had to be manipulated in order to reach the "100% pass" in the units. So, the amperage was changed three times (37, 35, 33 AMPS). Also, an angle grinder was used to inspect the unit. 20 units were welded for each AMP set, meaning a total of 60 units were used in this task.

## RESULTS

Tables 1 to 3 present the overall results.

**Table 1**
**Result of Trial of Gas Mixture**

| Mixture | Result |
|---|---|
| **Argon 93%/ Hydrogen 7% Mix** | All units Fail |
| **Argon 95%/ Hydrogen 5% Mix** | All units Fail |
| **Argon 97%/ Hydrogen 3% Mix** | 80% Pass |

**Table 2**
**Result of Trial of Amperage**

| Amperage | Result |
|---|---|
| **37 AMP** | 80% Pass |
| **35 AMP** | 90% Pass |
| **33 AMP** | All units Pass |

**Table 3**
**Operation of Cost include; Material Cost, Facility and Labor Cost**

| | | |
|---|---|---|
| | **Operational Cost** | |
| | **Material Cost** | |
| Stainless Steel (150 units used) | $1.00/unit | $ 150.00 |
| Gas Cost ( 3 Cylinders used) | $150/Cylinder (Supplier: Praxair) | $ 300.00 |
| | | |
| | **Facility** | |
| Voltage per Machine | 240 | |
| AMPS | 33 | 7.92 kWh |
| kWh x $21.02 | $166.48 | |
| Total cost for 20 hours | $ 3,329.57 | |
| | | |
| | **Labor (2 operator)** | |
| 5 Days (4 Hours/Day) | 20 hours of total work | |
| 2 Operators with $15/hr salary | $600.00 | |
| | | |
| | | $ 4,379.57 |

## Conclusion

The objectives of this project were completed. The process was found to have an opportunity for optimization. The process productivity was increased by 33% and the costs were reduced by two operators. Also, by increasing productivity, because of fixed costs, a big cost reduction is being applied on the unit cost.

Not much work is needed for the project to be implemented. Only a change in gas which is the same cost and a change in parameter. Of course, a new process of validation must take place in order to change the actual process.

## References

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