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# ECONOMICAL DESIGN OF METAL MELTING FURNACE

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**ABSTRACT**

*The objective of the project is to develop an economical metal melting furnace for metallic objects and creating new once. Therefore, we decided to make this furnace like oven to convert the useless metallic objects and create new objects in moulds for creation of random objects for various uses. Our design is portable, easily transportable, not having heavy structure and require less space. The purpose of project is to convert waste material in to useful.*

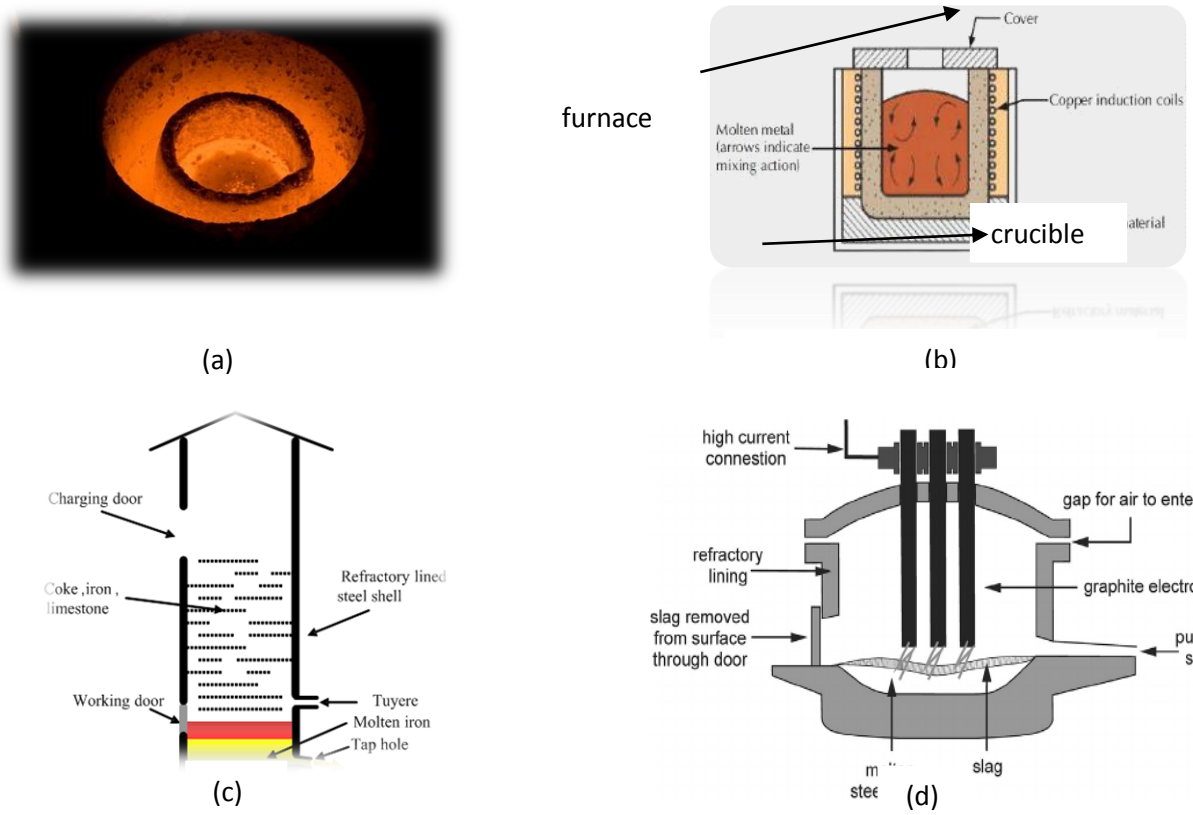
KEYWORDS:

Metal melting, Economical design, Oven, Mineral wool, Burner.

## 1.0 INTRODUCTION

Here, we are going to solve the problem considering the material waste in industries/workshops. The main purpose of our project is to "TO ELIMINATE THE WASTE OF MATERIAL BY CONVERTING IT INTO USEFUL FORM" So, we are going to make furnace which will be available at economical price. The function of the furnace is to melt the waste material which will further convert into desirable shape by casting. Recycling of material is not only saves energy but also reduces the greenhouse effect as compared to normal production processes.

In induction furnace usage in a foundry, input materials must be clean of oxidation products and some alloying elements may be lost due to oxidation. (fig.1b)). In crucible furnace first crucible going to heat by external and then material melts. So, required time is more. (fig.1(a)). In cupola furnace equipment cost is high, required more processing steps, temperature difference is difficult to maintain. (fig.1(c)). In electric arc furnace cost is high, require lots of electricity, large amount of sludge produced, would not be able to work for more quantities. (fig.1(d)).



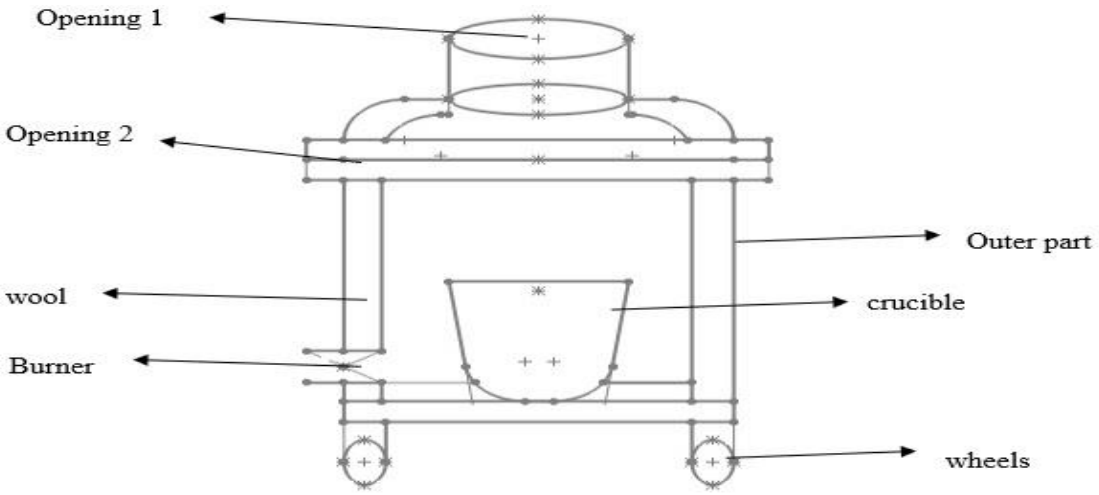

[Fig.1 (a) Crucible Furnace, (b) Induction Furnace, (c) Cupola Furnace, (d) Electric Arc Furnace]

## 2.0LITERATURE SURVEY

There are already many types of furnaces design available in market. From those, crucible furnace, cupola furnace, induction furnace and electric arc furnace are mainly used and popular. These furnaces use high power/fuel consumptions of coal, electricity etc [4]. they have heavy structure and stable structure [6]. The cost these furnaces are very high which cannot affordable by small industries. The maintenance cost is also high for such type of furnace. skilled operator is needed for operating furnace. these furnaces required huge space. Recycling 1 tonne of aluminium saves 9 tonnes of CO2 emissions, so when we consider that 1 tonne of CO2 is equivalent to driving 2800 miles [2]. The furnace is worked based on LPG which is easily available and low cost. The design is simple, portable & efficient as compared to old bulky & costly furnaces [1]. The recycling of material is easier than produce by primary process [5]. US is fulfilled its 40% demand of aluminium by recycling process [3]. The disposal of end-of-life tyres and similar products, such as oil-hydraulic piping, is a problem particularly felt in consideration of the huge amount of waste material produced every year. In this regard, it is known to mechanically treat the tyres to separate the various components and direct them to the subsequent treatments aimed at obtaining reusable material [7]. Making aluminium from crude materials is a compound process. Recycling of aluminium not only saves energy but also reduces around 95% of the greenhouse gases emission as compared to 'primary' production process [8]. Other factors related to the energy source also affect the furnace design like how the energy is transferred to the material, how combustion gases are exhausted [9].

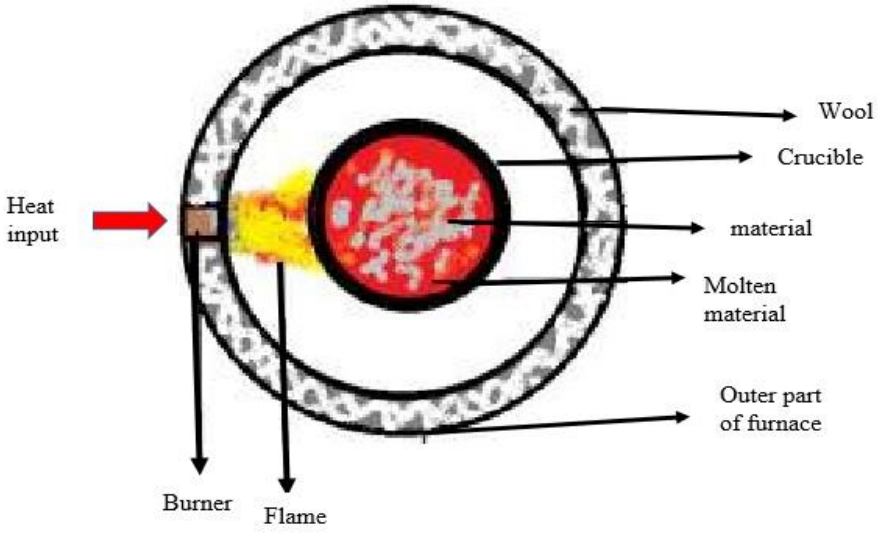
**3.0 PROPOSED SYSTEM**

**CONCEPT OF DESIGN:**




Here above shows the concept diagram of our furnace which is made by solid-works software. In that shows outer part which will be made by mild steel sheet. Crucible is shown there which is on the shaft (not shown in fig). shaft relates to base which is made of square tubes and wheels. Whole furnace is supported by square tubes and wheels arrangements. Furnace is covered with solid insulator/wool at inner part which is shown in figure. One hole shows in furnace, which is provided for burner. Opening 1 shows in fig which is provided for pouring objects/parts in furnace. Opening 2/cover shows in fig, that is parting line of furnace or cover of furnace. Here cover is provided for maintenance purpose and for easy removal of molten metal, which is joined with furnace with hinge joint. There is flange and lever arrangements which is connected with body and cover, lever is at bottom of the furnace by applying force on that cover moves upward and can rotate in 360 degrees for maintenance purpose. There is also thermometer, propane cylinder and blower/compressor but not shown in fig.

**3.2 MELTING OPERATION:**




[Fig.3 Melting Operation]

Here shows the melting operation from top view. Heat/gas entering through the hole which is Hit the crucible by flame. Due to the force of air from compressor/blower turbulence is created there because of shape of crucible and angle of burner. This turbulence of flame covers the whole furnace which helps in heating furnace fast. So,

that is the benefit of using compressor/blower. It is also makes performance efficient by providing air to propane.

## 4.0 MATERIAL SELECTION AND DESIGNING METHOD

### 4.1 MATERIAL/PART SELECTION:

Here all materials or part is selected according to availability, thermal consideration and cost. Most of part are available easily and no need to pay extra attention to any part or material.

Here list of needed parts/materials is shown below, as in this project size is not matter because you can change it according to your requirement.

1. Mild steel plate (thickness of 2mm to 3mm) or barrel
2. Wheels
3. Metal rods, metal tubes & metal angled bar
4. Flange arrangements
5. Burner assemblies
6. Propane tank
7. Thermometer (intermittent type)
8. Crucible
9. Ceramic fibre wool (1200 degree Celsius)
10. Shaft
11. Blower or air compressor or hair dryer

### 4.2 DESIGNING METHOD

Mild steel plate or barrel is for making the body and cover, we have used barrel by cutting it from top and by some finishing we made body and cover from one barrel, you can use mild steel & square tubes. By rolling and some welding you Can make body and cover. By using bar and wheels, we have made base of furnace. We have made crucible from mild steel hollow pipe by covering it from one side by heavy plate. you can get graphite crucible (1300-1400 degree Celsius) or silicon carbide crucible (2200-2300 degree Celsius) from market according to requirement. Crucible selection is done on basis of which materials you want to melt in it. If you want to melt only aluminium then better to use handmade crucible. Base and furnace joining together by welding, there is shaft between the furnace which is joined with base. Purpose of that shaft is to provide Height to crucible. On the top of the shaft thick plate of mild steel is joined for providing space to crucible. We have made assembly from round rod and square tube which is working like flange. It joined with body and cover. You can use flange assembly as same. Ceramic fibre wool is used for insulation. We have cover whole body of furnace from inside and also, we have made insulation in cover for reducing heat transfer. We have made burner by brass tube (from old gas cutting gun) and mild steel pipe or you can get locally manufactured burner in market. Others are standard parts which have used as their working phenomenon. We have used hair dryer here for providing air to propane, which made combustion better.

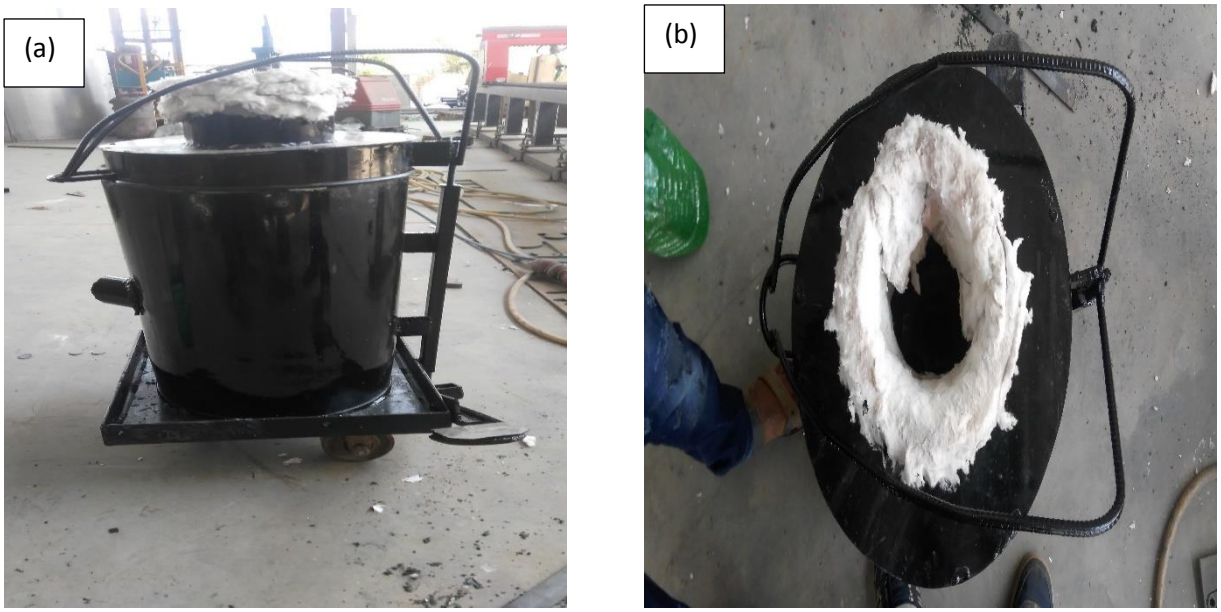
### 4.3 FEATURES OF THE DESIGN:

- The body is formed by the mild steel plate/barrel and because of insulation/wool, design is more capable for temperature.
- The burner is attached externally which directs the crucible. Because of tangential flame of burner with air force, it becomes more efficient.
- The crucible is placed in the furnace for melting the material.
- The objective of furnace cover is to improve the efficiency. That will be constructed with the same materials as the body, which reduces conduction and radiation heat loss.
- A circular opening is there to reduce internal furnace pressure, exhaust for gases and to introduce fresh oxygen into furnace for proper combustion.
- Lever with flange type arrangements is there for opening furnace from top by applying small amount of force for crucible handling and maintenance purpose.

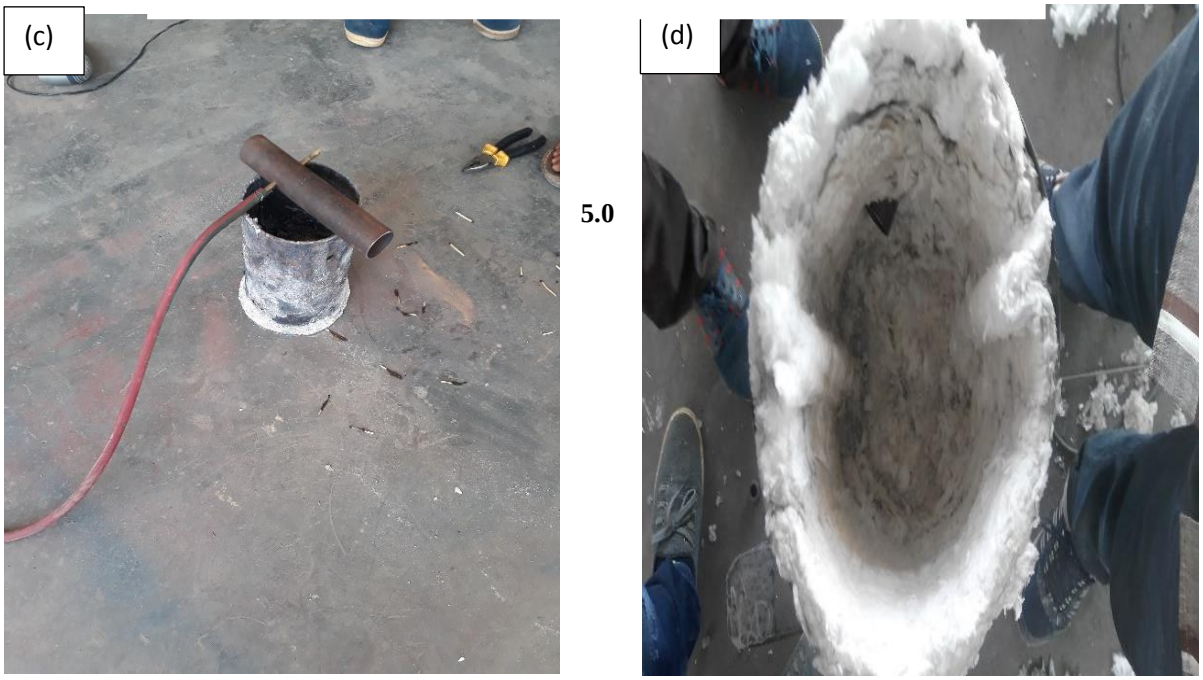
**4.4 FABRICATION PROCIDURE AND ASSEMBLY**

The barrel is formed in two-part, furnace and its cover. Whole furnace mounted on base which is made of metal bar and wheels arrangements. Shaft with metal plate on its one side, is joined with base by passing from bottom of furnace. the purpose of that shaft to provide height to crucible. Cover is joined with furnace by lever and flange type arrangements. Furnace and cover of furnace both are fully covered with Ceramic fibre wool. The burner is attached to furnace tangential at 45 degrees. The propane cylinder and burner assemblies are attached to burner. Burner is made by us with use of brass tube (from old gas cutting gun) and mild steel pipe. We have drilled 1mm hole horizontally in brass tube and have sealed by brazing from one side. That brass pipe has joined with mild steel pipe by brazing as hole focusing upward to pipe.

Actual pictures are showed here.




[Fig.4 (a) Front View, (b) Top View, (d) Burner, (e) Inner View]




**5.0**

**RESULTS & PERFORMANCE ANALYSIS**

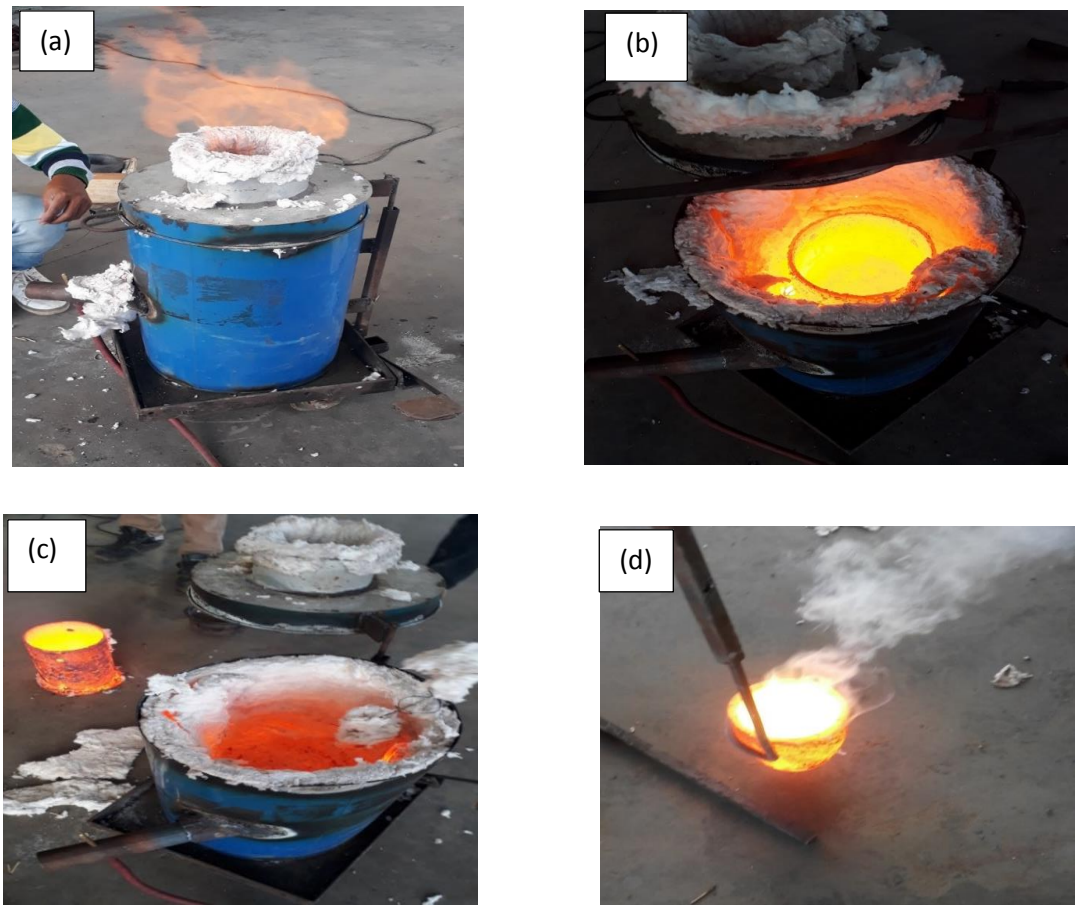
We have tested furnace for aluminium and brass. First, we select normal regulator for providing propane to burner but we cannot get good output. By replacing regulator with high pressure three key type, we get good flame. we have used hair dryer for providing air to burner, due to that we get good flame as well as turbulence of flame near crucible. You can use low power blower or compressor also for same purpose. We have performed experiments with our handmade crucible and graphite crucible.

- We have melted aluminium in 15 minutes and have melted brass in 20 minutes.

Here we have analysed two conditions for melting operation. First is without preheating, in that melting of material as normal temperature of furnace. second is with preheating, in that Melting of material as above normal temperature of furnace by heating the furnace in advance. Beneficial is to preheating of furnace. preheating is effect on time, if you have not preheated the furnace then it takes more time to complete process. In our case we have seen 5 minutes of variation in case of aluminium and 7 minutes of variation in case of brass. During experiment we have measured temperature many times. It is difficult to measure temperature nearer to crucible but we have tried our best. By covering thermocouple wire with wool, we have entered detector point in furnace from opening 1 and we have detected 1250-degree Celsius temperature which is still above the crucible. After detecting this temperature, we have controlled the flow of LPG due to the temperature limits of wool and crucible. We have done casting of aluminium and brass also.

- DRAWBACKS:

If temperature rises beyond the limit of ceramic fibre wool then wool get damaged and it becomes ruff & dry.
If temperature rises beyond the limit of graphite crucible then crucible get cracks.
Melting of stainless still is critical here. You can melt that but it affected on crucible and wool.
Actual pictures of experiment are attached here.




[Fig. 5 (a) Heat Removal from Top, (b) Process-Inner View, (c) Mild Steel Crucible-Aluminium Melting, (d) Graphite Crucible-Brass Melting, (e) Final Materials After Casting]

**6.0 FUTURE SCOPE**

- In this furnace we will use a single burner but for more heat distribution we can apply more number of burners.

- In this we will use wool as insulator, by introducing different insulator like refractory cement or combination of insulators we can get more efficient results.

- For pollution control, we can replace the LPG by CNG but, it makes changes in cost and availability.

- By replacing graphite crucible with silicon carbide crucible, you can melt materials up to 2200-2300 degree Celsius.

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