A PROJECT REPORT

ON

"DESIGN AND FEBRICATION OF INFRARED OVEN"

Submitted by

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In partial fulfillment for the award of the Degree

Of

BACHELOR OF ENGINEERING

IN

MECHANICAL ENGINEERING

UNDER THE GUIDANCE

Of

Prof. SURESH VINAYAK RANADE

DEPARTMENT OF MECHANICAL ENGINEERING

ANJUMAN-I-ISLAM

KALSEKAR TECHNICAL CAMPUS NEW PANVEL,

NAVI MUMBAI – 410206

UNIVERSITY OF MUMBAI

ACADEMIC YEAR 2017-2018

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CERTIFICATE

This is to certify that the project entitled

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To the Kalsekar Technical Campus, New Panvel is a record of bonafide work carried out by him under our supervision and guidance, for partial fulfillment of the requirements for the award of the Degree of Bachelor of Engineering in Mechanical Engineering as prescribed by **University Of Mumbai**, is approved.

Internal Examinar
(Prof.____________)

External Examiner
(Prof.____________)

Head of Department
(Prof. __________)

Principal
(Dr.____________)

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APPROVAL OF DISSERTATION

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(Internal Examiner) **(External Examiner)**

___________________ ___________________

Date: ________

ACKNOWLEDGEMENT

After the completion of this work, we would like to give our sincere thanks to all those who helped us to reach our goal. It's a great pleasure and moment of immense satisfaction for us to express my profound gratitude to our guide **Prof. SURESH VINAYAK RANADE** whose constant encouragement enabled us to work enthusiastically. His perpetual motivation, patience and excellent expertise in discussion during progress of the project work have benefited us to an extent, which is beyond expression.

We would also like to give our sincere thanks to **Prof. Zakir An**sari, Head Of Department and **Prof. Riwan Shaikh**, Project co-ordinator from Department of Mechanical Engineering, Kalsekar Technical Campus, New Panvel, for their guidance, encouragement and support during a project.

I am thankful to **Dr. Abdul Razak Honnutagi**, Kalsekar Technical Campus New Panvel, for providing an outstanding academic environment, also for providing the adequate facilities.

Last but not the least I would also like to thank all the staffs of Kalsekar Technical Campus (Mechanical Engineering Department) for their valuable guidance with their interest and valuable suggestions brightened us.

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ABSTRACT

This project is designed to improve Electrical versus Thermal efficiency. Nowadays electrical heating system converts 65% of the electrical power into thermal power. We have introduced infrared penetration heating system to improve efficiency up to 95% thermal efficiency and 100% electrical efficiency.

We are going to construct a oven model to improve our system. A real fabrication model is to analyze IR heating

system. The capacity of infrared lamps used inside the oven will be about 500watts. IR lamps will be used to provide heat.

From the OVEN, the temperature is sensed by the thermocouple, which is based on the principle of Seeback effect. The function of a thermocouple is to convert heat energy to mill voltage and it is fed to a signal conditioner to improve the sensitivity and also to improve the non-linear Property of thermocouple. Temperature acquired from the thermocouple is indicated on the screen of the computer. The computer will also compare the temperature acquired with the set temperature and control action if any will be done by the solid-state relay that avoids instantaneous heating. The infrared (IR) heating has the potential to be used for solution zing of metal forgings with benefits of reduced energy consumption, increased productivity, and improved microstructure and mechanical properties.

In our project, we have integrated heat treatment, annealing, oven and oven operations are done in a single device. So that the cost of equipment for each process and time taken are reduced.

Chapter 1

BASIC INTRODUCTION

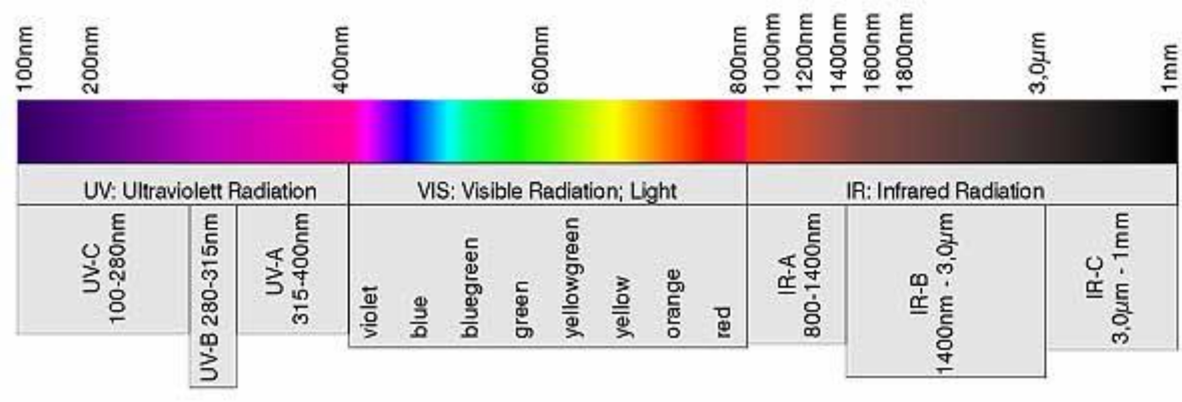
1.1 INTRODUCTION

This project is designed to improve Electrical versus Thermal efficiency. Nowadays electrical heating system converts 65% of the electrical power into thermal power. We have introduced infrared penetration heating system to improve efficiency up to 95% thermal efficiency and 100% electrical efficiency.

High energy (short wavelength) IR is characterized by bright visible light which is also emitted. Most of the energy is transmitted through the coating to be absorbed by the substrate. This type of cure is therefore best suited for complex part shapes (non line-of-sight heating) where it is used to heat the substrate. The fastest heat up rate is possible with high energy IR.

Medium energy (medium wavelength) IR is the most widely used for curing because the energy is absorbed directly by the coating. This type of oven works best with simple or symmetrical parts and frequently the parts are rotated for uniform exposure. Also, the oven configuration must match the shape of the part, e.g. ceiling and floor mounted emitters assist in illuminating the top and bottom of cylindrical parts.

Low energy (long wavelength) IR is not effective for cure. Much of the energy generated is lost to inefficient convection heating. The fraction of IR energy which does reach the coating is absorbed at the surface, resulting in possible “skin formation” or other defects.



We are going to construct a Oven model to improve our system. A real fabrication model is to analyze IR heatingsystem. The capacity of infrared lamps used inside the Oven will be about 750watts. IR lamps will be used to provide heat.

From the Oven, the temperature is sensed by the thermocouple, which is based on the principle of Seeback effect. The function of a thermocouple is to convert heat energy to mill voltage and it is fed to a signal conditioner to improve the sensitivity and also to improve the non-linear Property of thermocouple. Temperature acquired from the thermocouple is indicated on the screen of the computer. The computer will also compare the temperature acquired with the set temperature and control action if any will be done by the solid-state relay that avoids instantaneous heating. The infrared (IR) heating has the potential to be used for solutionizing of metal forgings with benefits of reduced energy consumption, increased productivity, and improved microstructure and mechanical properties.

In our project, we have integrated heat treatment, annealing, oven and oven operations are done in a singledevice. So that the cost of equipment for each process and time taken are reduced.

1.2: PROBLEM DEFINITION

- Conventional heaters work indirectly by heating the air in a Oven which in turn heat the objects in it. This type of convection heat not only wastes energy by having to heat the air first before the heat is felt, but you also don't feel the benefits of the heater as soon as it is turned on. It might take quite a few minutes for a Oven to heat up before you feel heat.
- Infrared heat on the other hand is a radiant heat which heats you and the objects in the Oven directly at the speed of light and is not dependent on heating the air first in order for you to feel heat. You feel the heat almost instantly once the heater is turned on. This principle makes infrared heaters far more efficient than conventional heaters.
- IR heating if applied object will improve the efficiency of the heating system as comparing to forced air heating.

1.3: AIM:

Heating the object by infrared radiation: In our project we intend using Infrared Heating. Heating process is attained through infrared lamps. At a wavelength of 680nm of the infrared lamp, the heating effect starts. We are applying a wavelength of 980 nm. This method offers following advantages over the conventional heating:

- 90% of energy is transmitted as infrared
- Lamp lifetime 5000 hours
- Instant, accurately controllable radiant heat
- Easy installation
- Simple, safe and clean heat source
- High-efficiency, low energy costs

Chapter 2

LITERATURE SURVEY/ MARKET SURVEY/ MATERIAL SURVEY

2.1: LITERATURE SURVEY

1: Research papers by "(1: Mr. AmalorpavaDass.J, 2: Mr.Mohanraj.N 3: Mr. Senthil Vel.C, Mr.Gugan raja.PL)" "HIGH SPEED INFRA RED OVEN "

2: Information broacher of "INFRATECH & ALTOTECH COMPANIES".

2.2: MATERIAL SURVEY

COMPONENTS USED:

- INFRA RED TUBES
- THERMOCOUPLE
- DIGITAL DISPLAY
- INSULATOR MATERIAL
- FRAME
- SHEET METAL

2.3: MARKET SURVEY

COMPONENT	PRICE	QUANTITY
INFRARED TUBE	Rs 1200/- tube	3 TUBES
THERMOCOUPLE	Rs 750/-	1
DIGITAL DISPLAY	Rs 1200/-	1
INSULATOR MATERIAL	Rs 45-77/kg	5 Kg
FRAME	Rs 80/kg	5 Kg
SHEET METAL	Rs 800	SWG 20
MISCELLINOUS	Rs 500	-

Chapter 3

PRINCIPLE OF IR TUBE

3.1: PRINCIPLE OF IR TUBE

Infrared energy is a form of radiation, which falls between visible light and microwaves in the electromagnetic spectrum. Like other forms of electromagnetic energy, IR travels in waves and there is a known relationship between the wavelength, frequency and energy level. That is, the energy (temperature) increases as the wavelength decreases.

Unlike convection, which first heats air to transmit energy to the part, IR energy may be absorbed directly by the coating. It may also be reflected or transmitted to the substrate. When the equipment is properly matched with the application either absorption (to heat the powder) or transmission (to heat the part) may become the primary method used to achieve cure. Because the energy is radiant (in the form of radiation), IR cure is known to have limitations based on line of sight. That is, the energy only travels in a straight line, to be absorbed by sections of the part facing the source, much like a flashlight illuminating an area of the part.

Since the thermal conductivity of metals is excellent, some energy may be selectively transmitted to the substrate resulting in cure of hidden areas via a conduction mechanism. This allows cure to be achieved on the inside of a steel tube, for example. Also, in some cases IR may provide some degree of convection heating, which also helps to achieve non line-of-sight cure. IR systems are usually described as high, medium or low intensity. This refers to the energy level of the source.

3.2: WORKING REGION

Infrared can be subdivided into multiple spectral regions, or bands, based on wavelength; however, there is no uniform definition of each band's exact boundaries. Infrared is commonly separated into near-, mid- and far-infrared. It can also be divided into five categories: near-, short-wavelength, mid-, long-wavelength and far-infrared.

The near-IR band contains the range of wavelengths closest to the red end of the visible light spectrum. It is generally considered to consist of wavelengths measuring from 750 nm to 1,300 nm -- or 0.75 to 1.3 microns. Its frequency ranges from about 215 THz to 400 THz. This group consists of the longest wavelengths and shortest frequencies, and it produces the least heat.

The intermediate IR band, also called the mid-IR band, covers wavelengths ranging from 1,300 nm to 3,000 nm -- or 1.3 to 3 microns. Frequencies range from 20 THz to 215 THz.

Wavelengths in the far-IR band, which are closest to microwaves, extend from 3,000 nm to 1 mm -- or 3 to 1,000 microns. Frequencies range from 0.3 THz to 20 THz. This group consists of the shortest wavelengths and longest frequencies, and it produces the most heat.

3.3: ADVANTAGES

Infrared heaters produce heat that is similar to the heat produced by the sun. The infrared rays emitted are easily absorbed by the items in your home, which gently increases the temperature of their surroundings. As cool surfaces heat up, infrared heaters raise the ambient temperature of the room. Besides warming up your home, infrared heaters provide many other benefits.

1. Infrared Heaters & Safety

When purchasing a space heater, safety is a main concern. The core temperature of infrared heaters never get as high as a conventional heater's temperature. A protective metal sheath usually covers the heating elements as well. This means animals and children can touch the surface of an infrared heater without being burned.

2. Minimal Maintenance

Nobody wants to be burdened with a bunch of maintenance tasks. Because infrared heaters have no moving parts, maintenance is minimal. There are no motors to wear out, air filters to replace or lubrication required. Your infrared heater will need periodic cleaning of the reflectors and replacement of the heat source to ensure optimal performance.

3. Quick Heat Recovery

Some space heaters require a long cool-down time between being turned off and being turned back on. Infrared heaters will still provide the same strong, penetrating heat no matter how long it's been after being turned off.

4. Infrared Heaters Heat Silently

When in noise-sensitive environments such as bedrooms or studies, finding a heater that doesn't operate loudly is important. There are no moving parts or fan blades whirring on infrared heaters, therefore they deliver heat silently.

5. Comfortable, Gentle Heat
Infrared heaters can make you comfortable indoors no matter what the temperature is outdoors. Inside the heater, a hot coil is wrapped into a circle so that all of the heat can be transferred evenly. The heat produced is reflected by a special polished metal, a reflector, and the heat can be felt several yards in front of the heater. Also, infrared heaters aren't affected by drafts or wind.

6. Infrared Heaters Provide Instant Heat

Instead of warming the air like other conventional heaters, infrared heaters heat objects directly in their paths. Heating the air wastes energy and the benefits of the heat aren't felt immediately. The rays produced by infrared heaters penetrate and warm you beneath the skin. The infrared rays radiate outward, heating all nearby objects, producing a widespread effect. This all happens immediately, with no need to wait for the heat to buildup.

7. Cost Effective

The benefit of any space heater is zone heating. With an infrared heater, heating only the parts of your home that you're using at any given time is possible. When you aren't heating your entire home, you'll save money on your heating bill. Infrared heaters can save you up to 30-50% on heating costs. Actual savings vary depending on insulation, ceiling height, type of construction and other factors.

8. Environmentally Friendly

This day in age, the earth's resources must be used responsibly. Infrared heaters operate without any carbon combustion, no toxic by-products of combustions, no open flame, and no fuel lines to leak. They add nothing to the air and take nothing away from the air, making them environmentally friendly.

9. Energy Efficient

Infrared heaters use a substantially lower amount of energy than conventional heaters. Some infrared heaters can operate on as low as 300 watts of electricity and 800 watts is enough power to provide heating to a room. The reflective metal used in its design transfers almost 100 percent of the heat created. Also, there's no need to turn on the heater in advance to pre-heat the room because heat is delivered instantly.

10. No Dry Heat

Unlike conventional heaters that draw moisture out of the air as a part of their heating process, infrared heaters don't produce dry heat. This way you can avoid uncomfortable side effects such as itchy eyes and throat.

3.4: DISADVANTAGES

Infrared Waves, Skin Damage and Lasers

Large doses of infrared waves can also damage skin and tissues. Infrared radiation waves are the same as heat waves. Laser beams are composed of highly amplified electromagnetic radiation (visible light, microwaves, infrared and others). These lasers can be strong enough to burn a hole through metal and so could certainly damage flesh. Extremely powerful lasers are even being developed by the military for use as weapons.

Infrared Waves and Greenhouse Effect

Infrared waves are involved in the greenhouse effect. The earth's surface and the clouds above it absorb radiation from the sun's rays and re-emit it as infrared radiation back out into the atmosphere. When the air above the earth's surface has a high concentration of water vapor, as well as elements such as sulfur and nitrogen and chemicals such as chlorofluorocarbons, the infrared radiation becomes trapped near the ground. This causes elevated temperatures and changes in weather patterns that can be harmful to people and animals.

Chapter 4

CURING AND DRYING OF PAINTS

4.1: CURING OF PAINTS

As we all know, a paint consists of various ingredients and is a mixture of liquids and solids, finely ground into a free flowing fluid consistency. The ingredients, which leave the paint after application are volatile liquids. (Solvents / Thinners / Reducers). Incidentally the thinners and Reducers are the same. While the thinners thin the paint, the reducers also do the same job of reducing the consistency of a paint. (Please also read Quora : What is the difference between solvent and paint thinner?). The other free flowing component is the Binder of the paint, which actually gets converted into the hard film of the finish.

There are three terms used for the transition of a paint coating from the fluid stage,

to that of a completely cured film of paint. They are the Drying, Hardening and Curing.

Drying : This is the stage when all the solvents and thinners in the paint, on application evaporates into the atmosphere.

Hardening : After the drying of the paint, Hardening of the paint commences and the other liquid portion of the paint (The Binders) hardens into a solid film.

Curing : This term actually denotes the action of both the above terms taken together. Curing = Drying + Hardening.

Curing of Lacquers : In the case of lacquers, they dry by the evaporation of solvents alone. For eg : the NC Lacquer paints or nail polish. The binder used in these formulations are Thermoplastic Polymers.

Curing of Enamels and Latex Wall Paints : These paints form the paint film on application in two stages. The first is the Drying, when all the solvents or thinners evaporate. The second stage is the Hardening Stage, when the binder, cross links with atmospheric oxygen to form a 3D network of interlinked Thermosetting Polymers. They are said to have cured, when the Polymerization is complete. (Please read Quora : What is an enamel paint and how is it made ? and also How does cross-linking relate to synthetic polymer emulsion paint ?).

Thus an Enamel Paint or Latex Paint cures first by the evaporation of solvents and thinners and later hardens into a solid film.

Drying of paints

The process of drying a paint made of a dispersion of a polymer in a solvent is experimentally and theoretically studied at various constant temperatures. The diffusion of the solvent through the paint and evaporation from the surface is considered, as well as the subsequent shrinkage. From measurements made at the beginning and at the end of the drying operation on the kinetics of drying, the diffusivity is found to largely depend on the solvent concentration. An exponential relationship of the diffusivity versus the concentration is thus found and successfully tested for the whole process of drying, the diffusivity increasing with the solvent concentration.

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4.3: TYPES OF PAINTS

Standard primers Standard grey primers are generally provided as alkyd paints. At Canam-Buildings, the grey primer applied to joists either by dipping or with a paint gun is normally an alkyd paint. These one-component primers are easy to apply and economical but offer limited protection against rust. They are designed to provide temporary protection during transportation and erection and provide a uniform appearance. The Canadian Institute of Steel Construction (CISC) and Canadian Paint Manufacturers Association (CPMA) standards CISC/CPMA 1-73a and CISC/CPMA 2-75 require that primed steel used in non-corrosive environments must be protected from rust for a maximum period of six and twelve months, respectively. Note that the 2-75 standard specifies that the steel must be prepared before painting in compliance with SSPC standard SP7-63 Brush-off Blast Cleaning . Alkyd primers are usually grey but may also be available in red and white. Contrary to universal alkyd finishes, standard alkyd primers cannot be top coated with highperformance paints such as epoxy or polyurethane. However, they can be used in combination with additional coats of alkyd primer, enamel, water-based acrylic paints and certain types of intumescent coatings. Ideally, the application of a top coat should be done on the job site to minimize touchups from impacts that occur during transportation. Specialty paints Finishes other than the standard grey alkyd primers described above are commonly referred to as specialty paints. Compared with standard primers, these paints, which require much more care during the application process, are more costly but provide enhanced protection against corrosion. These types of specialty paints are discussed in the following paragraphs.

1. Zinc: - Zinc rich primers are divided into two categories: organic and inorganic. Both types offer cathodic protection against rust since the zinc, which serves as a "sacrificial metal", acts as an anode to protect the steel from corrosion . When inorganic zinc primers are used in one-coat applications, the resulting rust protection is similar to that obtained with galvanization. Organic zinc primers are generally used in multiple coat systems. Note that zinc primers must be applied 2 in compliance with the SSPC-SP6/NACE No. 3 standard for surface preparation, which specifies a minimum surface profile of two mils. In certain cases, zinc primers can meet Class B requirements for friction coefficient in connections.

2. Epoxy:- Epoxy coatings are two-component paints that offer much greater rust protection than standard primers, but less than zinc primers. Epoxy paints, which create a protective barrier that seal the metal surface, are very effective in humid environments such as arenas and pools. Specific epoxy paints are even used to coat the interior of fresh water and saltwater tanks. These coatings cost twice as much as standard primers due to their higher retail price and the thicker coats required.

3. Polyurethane:- Polyurethane paints are usually applied as a finish coat on the zinc primer or epoxy . Several types of polyurethane paints can also be applied directly to steel without the use of primers. These finishes, which are characterized by their color retention and gloss, are generally not required for interior environments.

4.4:VARIOUS CURING PROCESSES

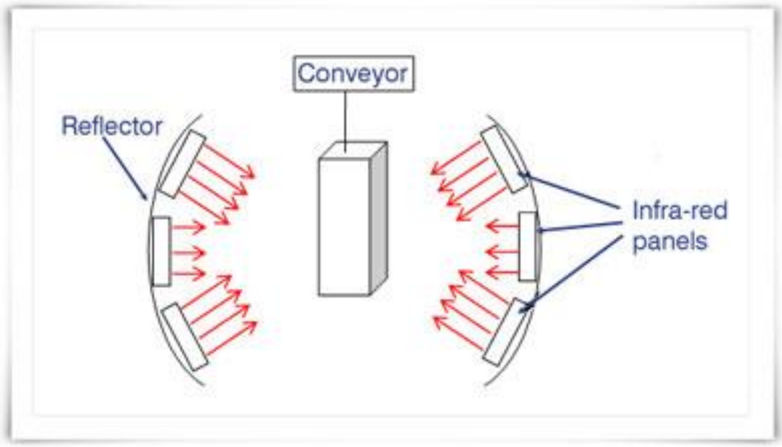
Convection Curing

If the painted items are placed within the confines of an oven, the extra energy transmitted to the coating will speed up the curing process enormously. Coatings that typically take 8 hours to through dry can be cured in 20 minutes or less at a temperature of 120°C.

The energy transfer takes place by conduction, the heated air molecules give up a portion of their energy to the (usually) metal which slowly heats up to match the air temperature. Large metal masses eg castings absorb huge amounts of energy before equalizing with the air temperature. It is important that when setting or following recommendations for stoving conditions, that it is understood that the temperature quoted on information sheets is that of the metal, not of the air. A heavy casting placed in an oven set at 120°C can take an appreciable time to reach that temperature (sometimes several hours!) and the paint film temperature will rise at roughly the same rate as the metal temperature.

Infra-Red Curing

The coated articles are passed in front of a series of infra red panels, which can be either gas or electrically powered. The energy is transmitted as radiant energy (as a domestic grill) and travels in straight lines only. It is essential that parts of the object are not shielded by any other part, as they will receive less energy and be under-cured. To help overcome this effect, the panels are usually arranged in front of a curved polished reflector to re-direct any radiation that misses the object.



Because of the high energy levels, short curing times can be achieved. As the energy is transmitted by radiation, there is no heating of the surrounding air or the substrate up to curing temperature, which enables much shorter curing periods (typically 10 minutes) to be achieved. As the heating takes place as a surface effect, the method is more suitable for heavy fabrications than convection.

Dark colours absorb infra red radiation better (and hence cure faster) than do pale colours, (the reason why black objects get hotter than white objects in the sun) and matt finishes absorb more than glossy finishes.

4.5 VARIOUS DRYING PROCESSES

1:-Convection drying (temperature, RH, air velocity speed)

Convection drying is known as the most used drying technique for water borne coatings. Due to air speed, relative humidity, temperature and time, the water evaporates. Several models for this drying process were found . However, they do not take into account the effects of salts, surfactants and co-solvents which are often present. After the first evaporation step in water borne acrylics, the capillary pressure is the driving force resulting in a water flow from the lower part of the film to the upper part . After this, the particles approach each other and wet sintering or coalescence of the binder particles starts, resulting in a polyhedric structure. When all water is evaporated, the autohesion takes place . The polymeric chains diffuse into each other resulting in a continuous and homogeneous film which is influenced by the intrinsic polymer character as its Tg, the cross-linking density and the temperature of film formation .

A study into the drying of water borne primers for joinery industry and film performance after several drying conditions was reported . This study elaborated the minimum conditions and ‘forced’ drying conditions in production locations. The method used was derived from studies according to EN 927-5 with omission of the leaching procedure. This method evaluates the degree of film formation by measuring the water uptake.

In this study, paints in various colours were investigated and it was demonstrated that some colours show high early water uptake due to a large amount of dispersants (surfactants) and different pigment-binder ratios present in specific colorants.

Because drying conditions affect film formation of water borne coatings, the water uptake of coated spruce panels was measured after various conditions of drying. With incomplete film formation, a closed film is not formed and therefore, the water uptake will be large. Drying of water borne coatings is slowed down by a high relative humidity: it prevents evaporation of water. If the relative humidity in the factory is low but ventilation is absent, a thin layer of high humidity will be present above the direct surface of the coating. Therefore, the evaporation speed of water is slowed down.

Laboratory tests such as water uptake according to the primer system (longer and better drying and leaching of hydrophilic components) do not investigate the early film performance but the behaviour on long term. Therefore, laboratory tests were performed to obtain information about the early resistance of the water borne coating to water in the building phase. Similar to the test described in this was tested by floating coated spruce panels for a period of 72 hours on water. The panels had previously been sealed on its sides and end grains. Before the water uptake, the coating was dried according to the so-called minimum 'Quick Scan' drying conditions: 48 hours at 15 °C and 85% R.H. with 0.5 m/s air circulation.

Results showed that longer drying times or drying with ventilation (so-called 'forced drying') resulted in less water uptake and no blistering compared to drying after 'Quick Scan' conditions. It was demonstrated that the formulation of the paint influenced the performance after drying.

To evaluate the technical feasibility for switching to water borne primers, a discriminating test such as water uptake after minimum conditions of drying ('Quick Scan') should be used. This test is believed to simulate the severe conditions on the construction site for many cases.

Generally water borne coatings do not build up a water barrier as quickly as solvent borne ones, especially if relative humidity is high, the temperature is low and air ventilation is absent. However by lowering RH, increasing temperature and air speed the film formation process and hence the protection against water can be strongly improved.

Convection drying tunnels in joinery and furniture applications can be summarised.

2-Infrared drying

The advantage of drying with infrared (IR) is fast heating up of the surface. At the same time, the substrate is not heated.

IR drying can be split into short, medium and long wave infrared spectrum. Short wave (Near-InfraRed, NIR) operates from 0.75 to 2.0 µm, medium wave from 2.0 to 4.0 µm and long wave operates from 4.0 to 15 µm. At short wave lengths, the intensity of the radiation is high and high temperatures on the surface can be reached without heating the substrate.

Within short time the lamps reach maximum output. Medium wave length is known to be very effective to irradiate water and solvents and therefore enhances drying of both water and solvent borne coatings.

Often, IR emitters are combined with convection drying to enhance drying further by incorporation of air velocity. These dryers are combinations of jets or air knives for high throughput flat panel lines or are applied in a tunnel for large 3D objects.

IR emitters can be operated by electricity (Carbon Emitters, Tungsten Emitters) or by heating up a ceramic plate by combustion of gas.

4.6 Infrared heating for drying and curing

Today's finishes require precise control of color, gloss, texture and surface finish. Cured organic coatings must perform well in the environments where the product will be used. Infrared curing and drying can provide these properties consistently, with easy operator control, fast curing times, precise control, low maintenance costs, and over 50% less floor space.

Infrared radiation can be used in a variety of different applications from drying and curing to preheating before a convective oven. Whether infrared radiation is used in the finishing process of organic coatings on products such as light fixtures, hot water tanks, shelving units, or insulated doors, line speeds can be drastically increased and cost savings can be realized. How a convective oven differs from an infrared oven is like night and day.

At night, if a car remains outside in a driveway, it eventually becomes the same temperature as the surrounding air. The air slowly exchanges energy with the outside of the car body during molecular collisions of the air molecules with the surface of the car. During the day the air temperature could be exactly the same, however, the car rapidly heats up well beyond the air temperature 1 because the sun's radiation can heat the car body faster than the air can cool it.

Curing Powder Coating on Specialty Lighting Fixtures. With the change from a solvent-based paint spray system to modern powder coating technology, the manufacturer wished to update an old gas fired convective oven that could not handle the higher energy requirements necessary for curing powder.

A tunnel oven was designed using flat panel medium-wavelength emitters within an insulated enclosure. The oven fully cured the powder coating on the outside and inside of the fixtures in just over two minutes. The system used approximately 120 KW of power at line speeds of up to ten feet per minute and now produces in two days the production that once required a full week. Drying Paint on Hot Water Tanks. Applying a high solids, solvent-based paint, the company wished to increase the speed of the paint line. Existing equipment was a 60-ft-long, gas fired convection oven, with a production speed of three feet per minute.

A two-section infrared oven was designed, utilizing two types of infrared heaters. The first section quickly raised the temperature of the paint and started the solvent evaporation. Medium-intensity quartz tubular heaters were chosen. The second section help the product at the final bake temperature, ensuring good flow and cure.

The system was 13 ft long and consumed 85 kw/hr of electrical energy. Through the use of infrared radiation, the company saved over 45 ft in production space and increased line speed over 100 pct. Unit operating costs were slightly less than with the original oven.

Preheat to Convective Oven for Curing Powder Coating on Shelving Units, Commercial supplier of shelving units needed a 40% increase in line speed to keep up with production orders. Existing equipment included a electrostatic powder coating booth with a 100 ft long gas fired convective oven, Line speed was 10 ft per minute and an increase to 14 ft per minute was necessary.

A 8 ft. infrared section was added in front of the existing unit to meet the requirement. An additional 288 kw of energy was needed to power the flat panel medium-wavelength emitter preheat unit.

An infrared preheat to a convective oven can be used to gel a powder coating, preventing blow-off. Once the powder has gelled, the air velocity in the convective oven can be increased yielding higher efficiencies.

Dry and Cure High Solids Water-Based Coating on Insulated Doors. New V.O.C. reduction requirements forced the factory to replace solvent based coating with high-solids water-based finish. The new paint needed more energy than available from the existing long-wave infrared oven system.

A system was designed to meet the higher energy requirements of the water-based coating. The upgraded infrared system had medium-intensity medium-wavelength quartz tubular emitters installed within an insulated enclosure and a blower to provide exhaust for the released water vapor.

The quartz tubular emitters were selected for their ability to headwater-based coatings efficiently. The quartz tube surrounds the emitter coil and allows air flow around the heaters without cooling the emitter.

Chapter 5

METHODOLOGY

5.1: MATERIAL SELECTION

The proper selection of material for the different part of a machine is the main objective in the fabrication of machine. For a design engineer it is must that he be familiar with the effect, which the manufacturing process and heat treatment have on the properties of materials. The Choice of material for engineering purposes depends upon the following factors:

1. Availability of the materials.
2. Suitability of materials for the working condition in service.
3. The cost of materials.
4. Physical and chemical properties of material.
5. Mechanical properties of material.

The mechanical properties of the metals are those, which are associated with the ability of the material to resist mechanical forces and load. We shall now discuss these properties as follows:

1. Strength : It is the ability of a material to resist the externally applied forces
2. Stress: Without breaking or yielding. The internal resistance offered by a part to an externally applied force is called stress.
3. Stiffness: It is the ability of material to resist deformation under stresses. The modules of elasticity of the measure of stiffness.
4. Elasticity: It is the property of a material to regain its original shape after deformation when the external forces are removed. This property is desirable for material used in tools and machines. It may be noted that steel is more elastic than rubber.
5. Plasticity: It is the property of a material, which retain the deformation produced under load permanently. This property of material is necessary for forging, in stamping images on coins and in ornamental work.
6. Ductility: It is the property of a material enabling it to be drawn into wire with the application of a tensile force. A ductile material must be both strong and plastic. The ductility is usually measured by the terms, percentage elongation and percent reduction in area. The ductile materials commonly used in engineering practice are mild steel, copper, aluminium, nickel, zinc, tin and lead.
7. Brittleness: It is the property of material opposite to ductile. It is the property of breaking of a material with little permanent distortion. Brittle materials when subjected to tensile loads snap off without giving any sensible elongation. Cast iron is a brittle material.

8. Malleability: It is a special case of ductility, which permits material to be rolled or hammered into thin sheets, a malleable material should be plastic but it is not essential to be so strong. The malleable materials commonly used in engineering practice are lead, soft steel, wrought iron, copper and aluminium.
9. Toughness: It is the property of a material to resist the fracture due to high impact loads like hammer blows. The toughness of the material decreases when it is heated. It is measured by the amount of absorbed after being stressed up to the point of fracture. This property is desirable in parts subjected to shock an impact loads.
10. Resilience: It is the property of a material to absorb energy and to resist rock and impact loads. It is measured by amount of energy absorbed per unit volume within elastic limit. This property is essential for spring material.
11. Creep: When a part is subjected to a constant stress at high temperature for long period of time, it will undergo a slow and permanent deformation called creep. This property is considered in designing internal combustion engines, boilers and turbines.

5.2: COMPONENT USED

INFRA RED LAMP:

Industrial manufacturing processes are becoming more and more rationalized. Automation increases and production rates rise. To gain the competitive edge, industry today demands innovative, effective heating solutions that will optimize cost of ownership. Infrared heat is transferred from the heat source to the object to be heated without any intermediary.

In our project we have used two Infra-Red Lamps each having a capacity of 500 Watts. They transfer heat on to component by means of radiation heat transfer as described in the operation section of our project.

Features:

- 90% of energy is transmitted as infrared
- Lamp lifetime 5000 hours
- Instant, accurately controllable radiant heat
- Easy installation

THERMOCOUPLE

Two strips of dissimilar metals joined to form junction called thermocouple. If the junction is heated and a millivoltmeter is connected across the free ends away from the junction, there will be found a voltage present. This voltage is caused by the different work -function of the metals forming the junction and is dependent upon both the temperature and the types of metals used.

INSULATING MATERIAL

The insulator used in the oven is glass wool. This is a very effective insulator. It is similar to mineral wool but more effective. Insulator material is packed in between the outer and inner mild steel cabins.

This insulator is so effective that when the inner cabin is at a temperature of around 350°C, the outer surface of the cabin remains only slightly higher than the room temperature.

DIGITAL TEMPREATURE CONTROLLER

The Select TC513 is a sophisticated auto tuning PID controller or on/off controller with selectable thermocouple, RTD up to two outputs. Versions are available with different relay and SSR outputs. The controller can be configured as on/off or PID control and alarm outputs, or as 2 on/off or PID controls (heat/cool) plus 1 alarm output. It has a large dual 3 digit LED display to show the set point and the process value and is suitable for use with power supplies of 85 to 270 VAC

Features

- Single display, 3 digit, 7 segment LED
- TC / RTD inputs
- PID, ON/OFF control
- Single set point
- °C / °F selectable
- Field selectable control output (Relay or SSR)
- Easy to use

5.3: MACHINE USED

ABRASIVE SAW-

An abrasive saw, also known as a cut-off saw or metal chop saw, is a power tool which is typically used to cut hard materials, such as metals. The cutting action is performed by an abrasive disc, similar to a thin grinding wheel. Technically speaking this is not a saw, as it does not use regularly shaped edges (teeth) for cutting. The abrasive saw generally has a built-in vise or other clamping arrangement, and has the cutting wheel and motor mounted on a pivoting arm attached to a fixed base plate.

They typically use composite friction disk blades to abrasively cut through the steel. The disks are consumable items as they wear throughout the cut. The abrasive disks for these saws are typically 14 in (360 mm) in diameter and 7⁄64 in (2.8 mm) thick. Larger saws use 410 mm (16 in) diameter blades. Disks are available for steel and stainless steel. Since their introduction, portable metal cut-off saws have made many building site jobs easier. With these saws, lightweight steel fabrication previously performed in workshops using stationary power band saws or cold saws can be done on-site. Abrasive saws have replaced more expensive and hazardous acetylene torches in many applications, such as cutting rebar.

DRILLING MACHINE-

Drilling is a cutting process that uses a drill bit to cut or enlarge a hole of circular cross-section in solid materials. The drill bit is a rotary cutting tool, often multipoint. The bit is pressed against the workpiece and rotated at rates from hundreds to thousands of revolutions per minute. This forces the cutting edge against the workpiece, cutting off chips (swarf) from the hole as it is drilled. Exceptionally, specially-shaped bits can cut holes of non-circular cross-section; a square cross-section is possible.

WELDING MACHINE-

Welding is a fabrication or sculptural process that joins materials, usually metals or thermoplastics, by causing fusion, which is distinct from lower temperature metal-joining techniques such as brazing and soldering, which do not melt the base metal. In addition to melting the base metal, a filler material is often added to the joint to form a pool of molten material (the weld pool) that cools to form a joint that can be as strong, or even stronger, than the base material. Pressure may also be used in conjunction with heat, or by itself, to produce a weld. Although less common, there are also solid state welding processes such as friction welding or shielded active gas welding in which metal does not melt.

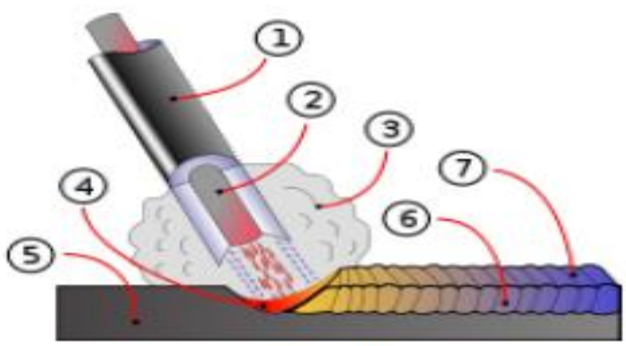


FIGURE- ARC AND WELD IN SHEILDED METAL ARC WELDING

1. Coating Flow
2. Rod
3. Shield Gas

4. Fusion
5. Base metal
6. Weld metal
7. Solidified Slag

Some of the best known welding methods include:

Shielded metal arc welding (SMAW) also known as "stick welding or electric welding", uses an electrode that has flux around it to protect the weld puddle. The electrode holder holds the electrode as it slowly melts away. Slag protects the weld puddle from atmospheric contamination.

Gas tungsten arc welding (GTAW) also known as TIG (tungsten, inert gas), uses a non-consumable tungsten electrode to produce the weld. The weld area is protected from atmospheric contamination by an inert shielding gas such as argon or helium.

Gas metal arc welding (GMAW) commonly termed MIG (metal, inert gas), uses a wire feeding gun that feeds wire at an adjustable speed and flows an argon-based shielding gas or a mix of argon and carbon dioxide (CO_2) over the weld puddle to protect it from atmospheric contamination.

Flux-cored arc welding (FCAW) almost identical to MIG welding except it uses a special tubular wire filled with flux; it can be used with or without shielding gas, depending on the filler.

Submerged arc welding (SAW) uses an automatically fed consumable electrode and a blanket of granular fusible flux. The molten weld and the arc zone are protected from atmospheric contamination by being "submerged" under the flux blanket.

Electro slag welding (ESW) a highly productive, single pass welding process for thicker materials between 1 inch (25 mm) and 12 inches (300 mm) in a vertical or close to vertical position.

Many different energy sources can be used for welding, including a gas flame, an electric arc, a laser, an electron beam, friction, and ultrasound. While often an industrial process, welding may be performed in many different environments, including in open air, under water, and in outer space. Welding is a hazardous undertaking and precautions are required to avoid burns, electric shock, vision damage, inhalation of poisonous gases and fumes, and exposure to intense ultraviolet radiation.

Until the end of the 19th century, the only welding process was forge welding, which blacksmiths had used for centuries to join iron and steel by heating and hammering. Arc welding and oxy-fuel welding were among the first processes to develop late in the century, and electric resistance welding followed soon after. Welding technology advanced quickly during the early 20th century as the world wars drove the demand for reliable and inexpensive joining methods. Following the wars, several modern welding techniques were developed, including manual methods like SMAW, now one of the most popular welding methods, as well as semi-automatic and automatic processes such as GMAW, SAW, FCAW and ESW. Developments continued with the invention of laser beam welding, electron beam welding, magnetic pulse welding (MPW), and friction stir welding in the latter half of the century. Today, the science continues to advance. Robot welding is commonplace in industrial settings, and researchers continue to develop new welding methods and gain greater understanding of weld quality.

GRINDING OPERATION-

Grinding is an abrasive machining process that uses a grinding wheel as the cutting tool.

- A wide variety of machines are used for grinding:
- Hand-cranked knife-sharpening stones (grindstones)
- Handheld power tools such as angle grinders and die grinders
- Various kinds of expensive industrial machine tools called grinding machines
- Bench grinders often found in residential garages and basements

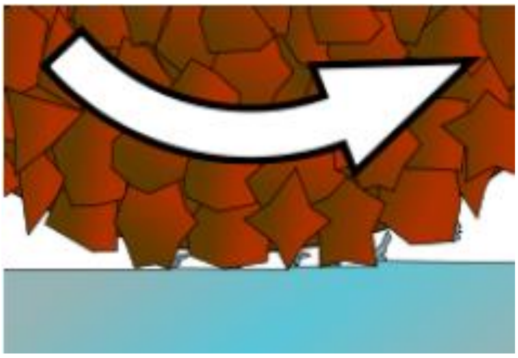


FIGURE- WORKING OF ABRASIVE PARTICLE FROM THE METAL

Grinding practice is a large and diverse area of manufacturing and tool making. It can produce very fine finishes and very accurate dimensions; yet in mass production contexts it can also rough out workpiece large volumes of metal quite rapidly. It is usually better suited to the machining of very hard materials than is "regular" machining (that is, cutting larger chips with cutting tools such as tool bits or milling cutters), and until recent decades it was the only practical way to machine such materials as hardened steels. Compared to "regular" machining, it is usually better suited to taking very shallow cuts, such as reducing a shaft's diameter by half a thousandth of an inch or 12.7 μm.

Grinding is a subset of cutting, as grinding is a true metal-cutting process. Each grain of abrasive functions as a microscopic single-point cutting edge (although of high negative rake angle), and shears a tiny chip that is analogous to what would conventionally be called a "cut" chip (turning, milling, drilling, tapping, etc.). However, among people who work in the machining fields, the term cutting is often understood to refer to the macroscopic cutting operations, and grinding is often mentally categorized as a "separate" process. This is why the terms are usually used in separately in shop-floor practice.

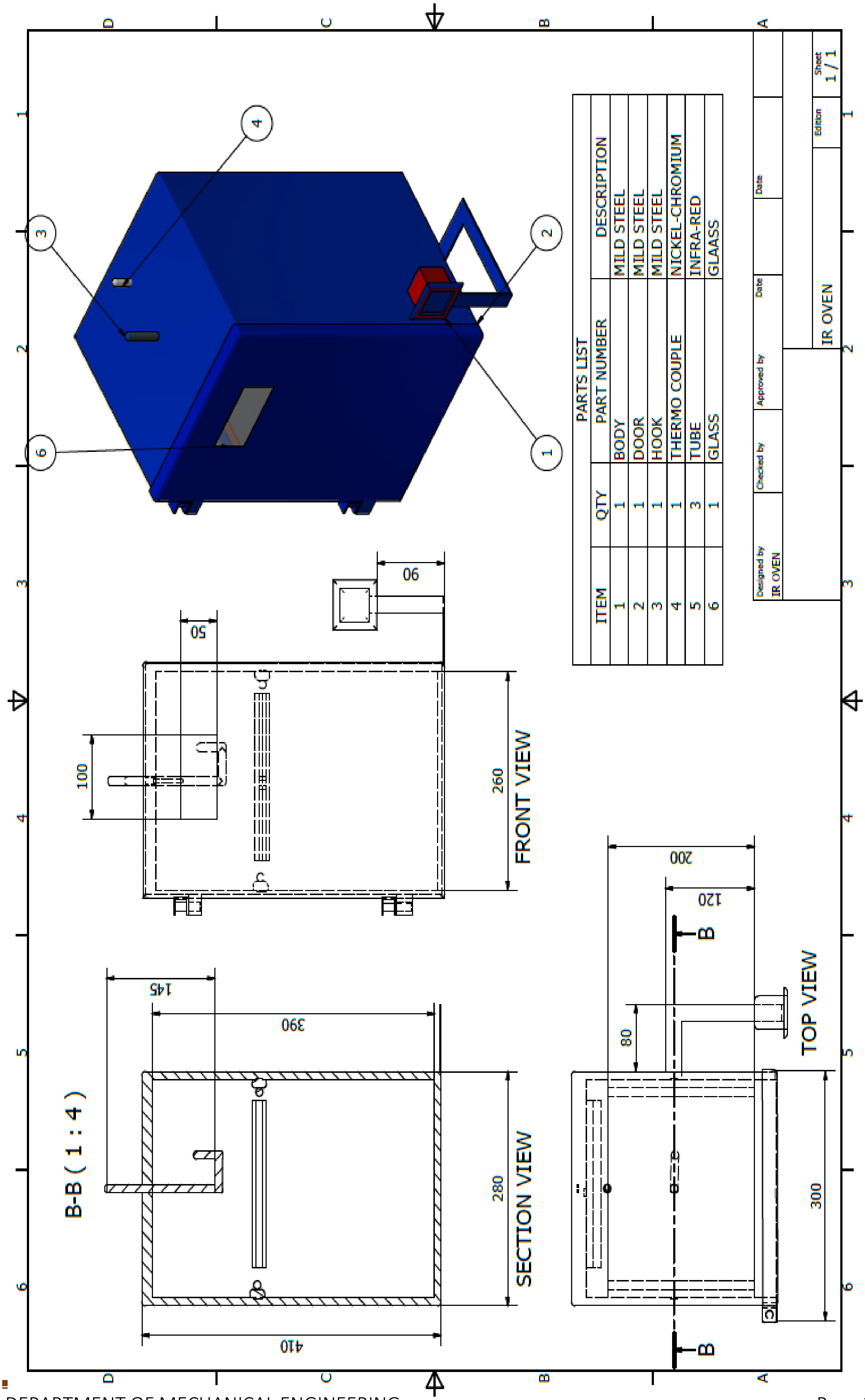
SPRAY PAINT-

Aerosol paint can. Propellant in the top of the can pressures down on the paint propellant mixture in the bottom. The paint mixture is pushed up through the dip tube when the valve is opened.

FIGURE-SPRAY PAINT

Spray paint (scientific name aerosol paint) is a type of paint that comes in a sealed pressurized container and is released in a fine spray mist when depressing a valve button. Spray paint leaves a smooth, evenly coated surface, unlike many rolled or brushed paints. Standard sized cans are portable, inexpensive and easy to store. Aerosol primer can be applied directly to bare metal and many plastics.

DESIGN OF INFRARED OVEN



PARTS LIST

ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	BODY	MILD STEEL
2	1	DOOR	MILD STEEL
3	1	HOOK	MILD STEEL
4	1	THERMO COUPLE	NICKEL-CHROMIUM
5	3	TUBE	INFRA-RED
6	1	GLASS	GLASS

Chapter 6

RESULTS AND CONCLUSION

6.1 OBSERVATION TABLE:

RANGE (°C)	STIME REQUIRED (SEC)
UPTO 50	**15**
50-60	**27**
60-70	**39**
70-80	**48**
80-90	**57**
90-100	**65**
100-110	**74**
110-120	**83**
120-130	**92**
140-150	**110**
150-160	**120**
160-170	**132**
170-180	**150**
180-190	**162**
190-200	**175**

CONCLUSION

We have designed and fabricated a prototype of an infrared Oven in which heat radiated from infrared Tubes is used to achieve quicker and effective heating. Thus we have developed a method to improve the heat treatment process and at the same time decrease the cost of production. Moreover, the life of the oven and components is also increased. The electrical circuit is also accurate and durable hence reducing the cost of maintenance and repair which is a problem with the existing oven.

Chapter 7

FUTURE SCOPE

7.1 FUTURE SCOPE

It has industrial application like on manufacturing industry, it is required to melts the objects and remoulding it and making same object or new objects. By using this kind of oven, they can make tremendous amount of new or same jobs or objects at very fast rate in minimum time because of fast heating process.

In our college itself, students those who are part of ATV or GOKART or something like that, they required to heat parts of automobiles to bend it according to require shape and size. They first heat it in simple oven up-to red hot condition & it takes too much time, we saw them. Sometime they used to do it on the stove to heat it. The same parts can be heat at faster rate in minimum time by using this kind of oven. It's nothing but future scope in college itself.

REFRENCE

- Research papers by "(1: Mr.AmalorpavaDass.J, 2: Mr.Mohanraj.N 3: Mr. Senthil Vel.C, Mr.Gugan raja.PL)" "HIGH SPEED INFRA RED OVEN ".
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