Induction Billet Heating for Ferrous/Non-Ferrous

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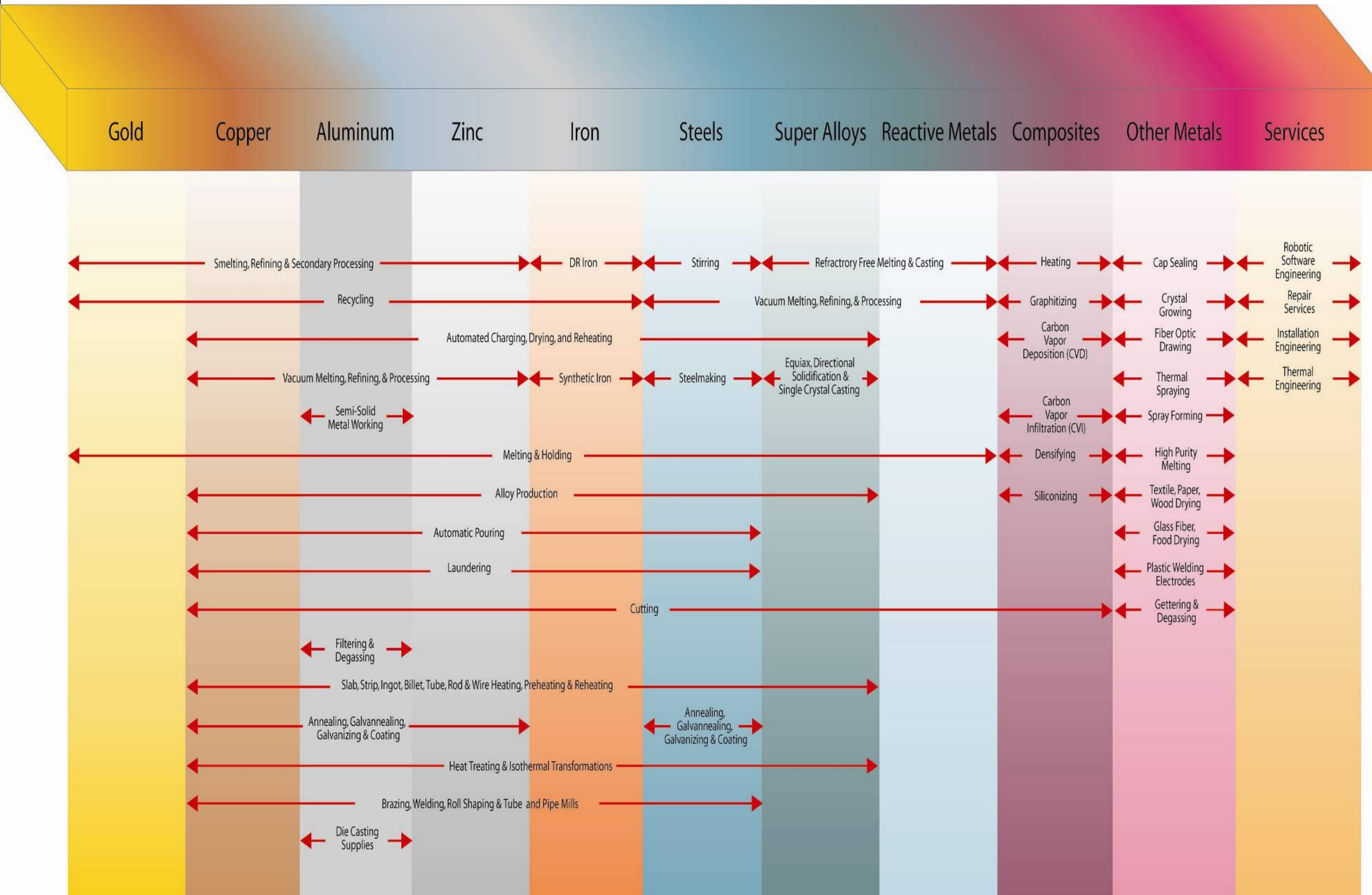
What We Do


Gold
Copper
Aluminum
Zinc
Iron
Steels
Super Alloys
Reactive Metals
Composites
Other Metals
Services
Smelting, Refining & Secondary Processing
DR Iron
Stirring
Refractrory Free Melting & Casting
Heating
Cap Sealing
Robotic Software Engineering
Recycling
Vacuum Melting, Refining, & Processing
Graphitizing
Crystal Growing
Repair Services
Automated Charging, Drying, and Reheating
Carbon Vapor Deposition (CVD)
Fiber Optic Drawing
Installation Engineering
Vacuum Melting, Refining, & Processing
Synthetic Iron
Steelmaking
Equiax, Directional Solidification & Single Crystal Casting
Thermal Spraying
Thermal Engineering
Semi-Solid Metal Working
Carbon Vapor Infiltration (CVI)
Spray Forming
Melting & Holding
Densifying
High Purity Melting
Alloy Production
Siliconizing
Textile, Paper, Wood Drying
Automatic Pouring
Glass Fiber, Food Drying
Laundering
Plastic Welding Electrodes
Cutting
Gettering & Degassing
Filtering & Degassing
Slab, Strip, Ingot, Billet, Tube, Rod & Wire Heating, Preheating & Reheating
Annealing, Galvannealing, Galvanizing & Coating
Annealing, Galvannealing, Galvanizing & Coating
Heat Treating & Isothermal Transformations
Brazing, Welding, Roll Shaping & Tube and Pipe Mills
Die Casting Supplies

Specialist Applications Knowledge

Inductotherm is a world leader in the design and manufacture of Induction Heating equipments for:

Induction Heating Systems for Non-Ferrous materials

(Aluminium, Copper, Brass)

In all NON FERROUS applications industries segment there are Induction Billet Heating furnaces prior to EXTRUSION

Distinct Advantages :

1) Compact installation
2) Clean working environment
3) Rapid start up and shut down
4) High overall energy efficiency
5) Lower maintenance costs

Understanding : Induction Heating

When a conductor carries electric current, it is surrounded by magnetic field, produced by and in proportion to the intensity of the current.

Alternating current passing through a coil shaped conductor produces alternating magnetic field inside and around the coil.

When a piece of metal is placed within such alternating magnetic field, electric currents are induced in the metal. Since metal posses electrical resistance, heat is generated by the current induced in the metal, (see Diagram 1)

Heating different shaped work pieces is easily achieved by appropriate Induction coil design. Diagram 2 shows example.

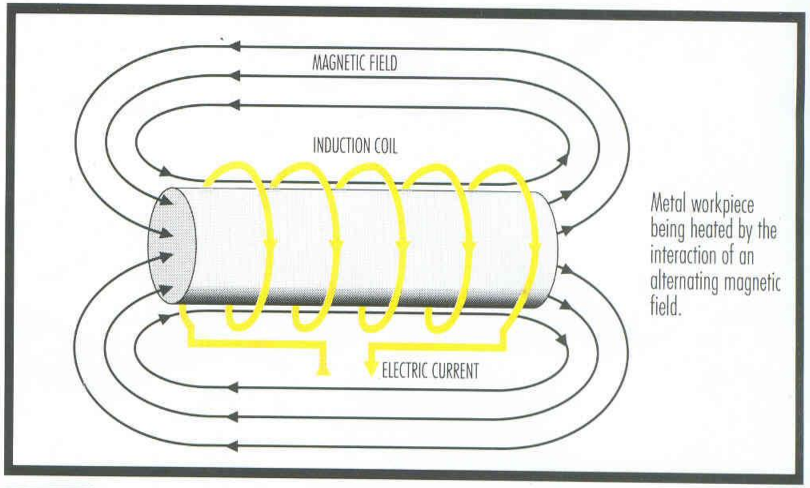


DIAGRAM 1

Shows a piece of metal being heated by magnetic fields generated by an induction coil.

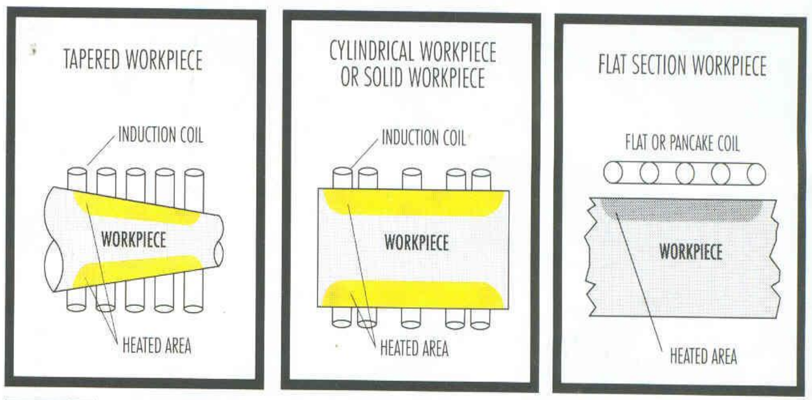
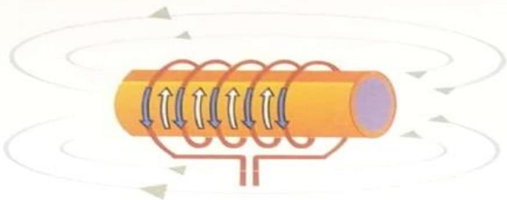


DIAGRAM 2

INDUCTION FORGING SYSTEMS - BASICS

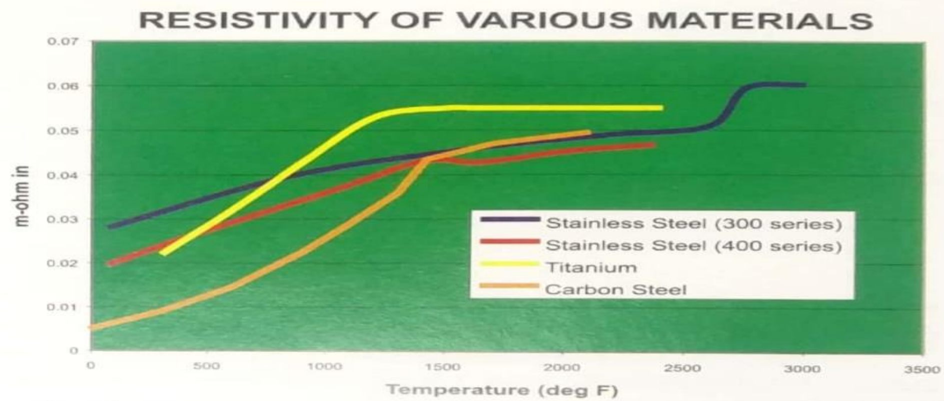


Induction heating, as the name implies, involves magnetically inducing a current at a level and specific frequency in a work piece to heat the part both by magnetic hysteresis and through its resistive qualities.

The figure on left side is a graphical representation of an induction coil wrapped around a work piece. As current passes through the induction coil, an electromagnetic field is generated. As the magnetic field's flux lines penetrate the work piece, an opposing current is developed in the work piece.

The I^2R (resistive) heating in the workpiece is governed by the level of electrical current, the resistivity of the workpiece, and the depth of current penetration. Eighty six percent of the induction heating occurs due to the electrical current flowing within a specific depth of the surface of the material. This is known as the reference or penetration depth and is determined largely by the induction heating frequency.

The graph on right side provides the resistivity of various materials. The resistivity varies according to temperature.



Efficient induction heating is achieved when the ratio of the depth of current penetration to the diameter of the workpiece is 4 or greater (for example, a depth of penetration of 0.125 inches and a part diameter of 0.50 inches). However, induction heating can be applied to where the ratio is as small as 2.5:1 or lesser, but with significantly decreasing efficiency.

FREQUENCY SELECTION

There are basically three limiting factors which affect the choice of operational frequency for a billet or bar heating installation. These are:

1) The size or cross section of the billet or bar.

2) The temperature to which the billet or bar is to be heated.

3) The resistivity and magnetic qualities of the material to be heated.

Detailed in the chart next page is the ideal cross section with respect to the operational frequency relative to heating a magnetic carbon steel billet or bar from ambient (20°C) to 1225 °C.

better way

INDUCTION HEATING - A BETTER METHOD

Improved Economics -

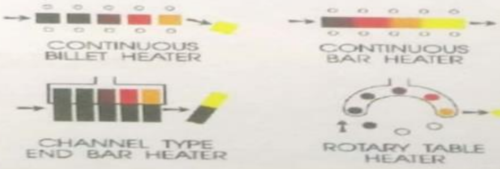
- SHORTER START UP TIME
- SHORTER HEATING TIMES
- HIGH EFFICIENCY
- REDUCED SCALING
- ACCURATE TEMPERATURE CONTROL
- IMPROVED DIE LIFE
- REDUCED FLOOR AREA
- LESS REJECTS
- EASILY ADAPTABLE TO AUTOMATIC PROCESS

Improved Environment -

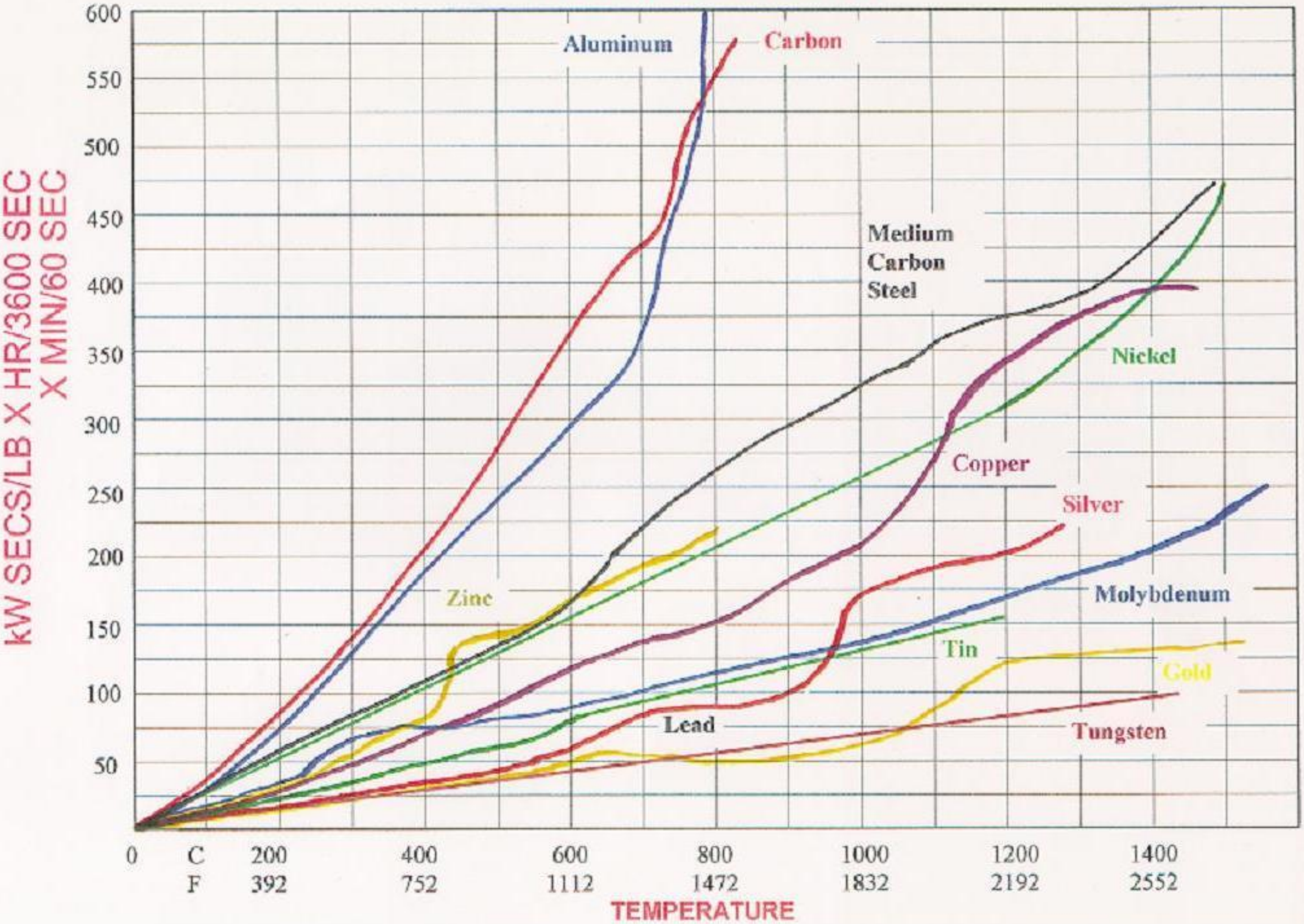
- IMPROVED WORKING CONDITIONS
- NO PRODUCTS OF COMBUSTION
- NO EFFLUENT

Adaptable to an Automatic Process

High speed heating, coupled with accurate and repeatable temperatures, encourages the intergration of induction heating equipment into fully automated production lines.



HEAT CONTENT



INDUCTION HEATING ADVANTAGES

SHORTER START UP TIME

No preheat time is required to bring the induction heating system up to temperature at start up time. (No waiting after breaks, etc.)

FAST HEAT UP TIMES

The workpiece can be heated to forging temperature in mere seconds. This enables billets to be heated individually and fed automatically to the operator, thus reducing the labour content of the total process. In addition, rapid heating preserves a strong, fine grained" structure metallurgically.

REDUCED SCALE LOSSES

One of the areas of greatest cost savings. Operating data from a number of fuel fired furnace installations indicates an average scale loss of 2.5% by weight. This is reduced to 0.5% with induction heating.

REDUCED FLOOR AREA

A simple induction heating system can replace large fuel fired furnaces, thus freeing valuable floor space for increased productivity. The induction heating power supply can be located below, overhead or remote of the heating coil line.

ACCURATE TEMPERATURE CONTROL

Temperature control is precise and consistent. Control is achieved with timers or radiation pyrometer feedback.

IMPROVED DIE LIFE

Analysis of die life statistics from many forging operations converted from fuel fired to electric induction heating reveal substantial increases in die life - ranging from 25% to 400%. Uniformity in temperature and reduction in scale formation are the major contributing factors.

HIGH ENERGY EFFICIENCY

Energy consumption is low when compared with conventional furnaces - in the order of 5:1 in favour of electricity.

Furthermore, energy is only drawn when the workpiece is in position and ready to absorb it.

IMPROVED ENVIRONMENT

Working conditions for the operator are improved. Noise, heat and fume levels, the main cause of operator fatigue and absenteeism, are reduced or eliminated. The need for external pollution control equipment is also eliminated with induction heating.

INDUCTION HEATING FREQUENCY SELECTION

MATERIAL	TEMP DEG C	DIAMETER RANGE (mm)							
		25kHz	10kHz	6kHz	3kHz	1kHz	500Hz	200Hz	50Hz
STEEL	1250	7-25	15-50	20-70	30-85	45-120	70-180	150-400	180-500
BRASS	750	6-12	10-15	10-20	15-30	20-50	25-150	45-250	90-320
COPPER	850	2-4	4-10	4-15	10-20	15-40	20-150	40-250	60-300
ALUMINIUM	450	4-8	8-15	8-20	15-25	20-50	20-160	35-250	65-300

Use this table as a guide only

INDUCTOTHERM GROUP

Leading Manufacturers of Melting, Thermal Processing & Production Systems for the Metals & Materials Industry Worldwide.

INDUCTION HEATING FREQUENCY SELECTION

MATERIAL	TEMP DEG C	DIAMETER RANGE (mm)							
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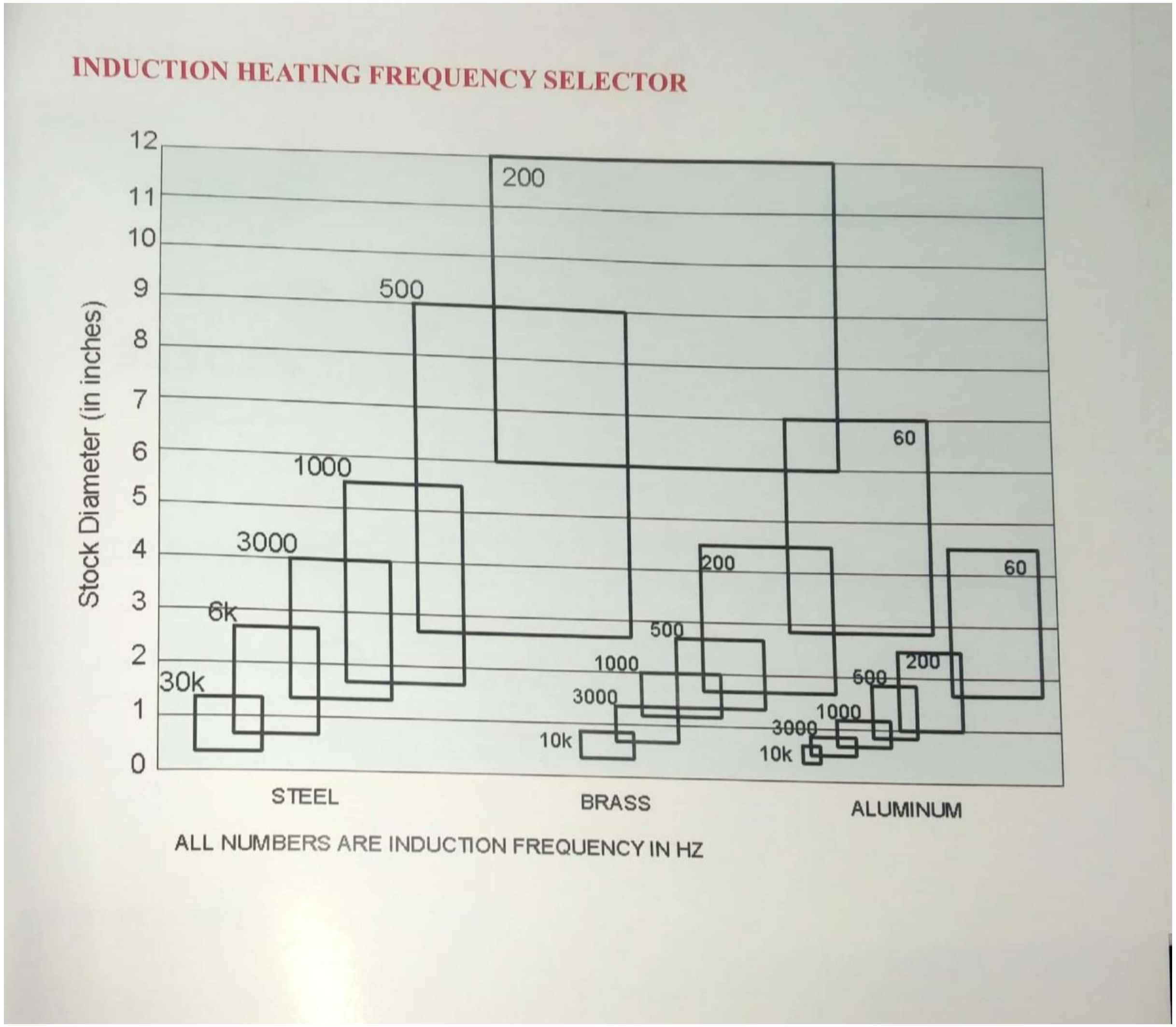
STEEL	1250	7-25	15-50	20-70	30-85	45-120	70-180	150-400	180-500
BRASS	750	6-12	10-15	10-20	15-30	20-50	25-150	45-250	90-320
COPPER	850	2-4	4-10	4-15	10-20	15-40	20-150	40-250	60-300
ALUMINIUM	450	4-8	8-15	8-20	15-25	20-50	20-160	35-250	65-300



INDUCTION HEATING FREQUENCY SELECTOR
Stock Diameter (in inches)
12
11
10
9
8
7
6
5
4
3
2
1
0
200
500
1000
3000
6k
30k
60
200
500
1000
3000
10k
60
200
500
1000
3000
10k
STEEL
BRASS
ALUMINUM
ALL NUMBERS ARE INDUCTION FREQUENCY IN HZ

Extrusion temperatures of common metals & alloys

Metals & Alloys	Temp. of extrusion, K	º C
Aluminum and alloys	673 – 773	400 – 500
Magnesium and alloys	573 – 673	300 – 400
Copper	1073 – 1153	800 – 880
Brasses	923 – 1123	650 – 850
Nickel brasses	1023 – 1173	750 – 900
Cupro nickel	1173 – 1273	900 – 1000
Nickel	1383 – 1433	1110 – 1160
Monel	1373 – 1403	1110 – 1130
Inconel	1443 – 1473	1170 – 1200
Steels	1323 – 1523	1050 – 1250

Induction Heater Block Diagram

EQUIPMENT SELECTION

In most cases, the choice of equipment for a particular application is a compromise both in the selection of the power source and material handling. This is most often due to the range of stock material that needs to be processed on a single induction heating system.

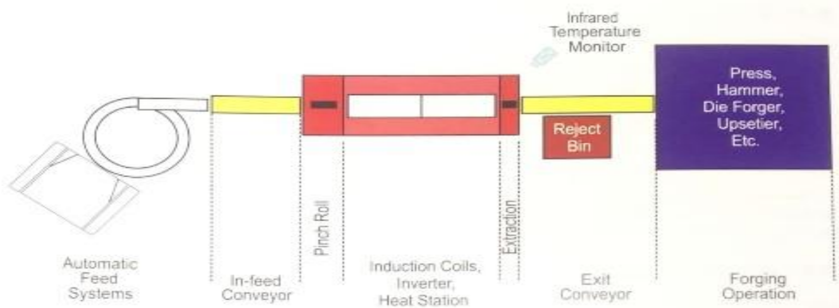


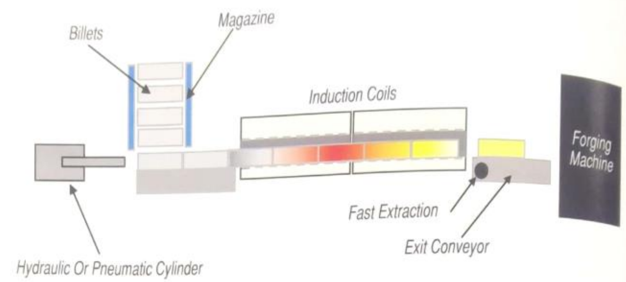
FIGURE-1: Typical Induction Heating System for Forging

PRINCIPAL ELEMENTS

The principal elements in a typical induction billet or bar heating systems are:

- Primary power source - Disconnects and primary transformer (not shown).
- Induction power source
- Load matching equipment
- Induction heating coils
- Electrical control system and operator interface (not shown)
- Mechanical handling equipment
- Water cooling system (not shown)
- Optional optical pyrometer which may include a billet/bar reject system.

Pusher System



Single Shot Booster Heater

Accurate, Controlled Repeatable Profile

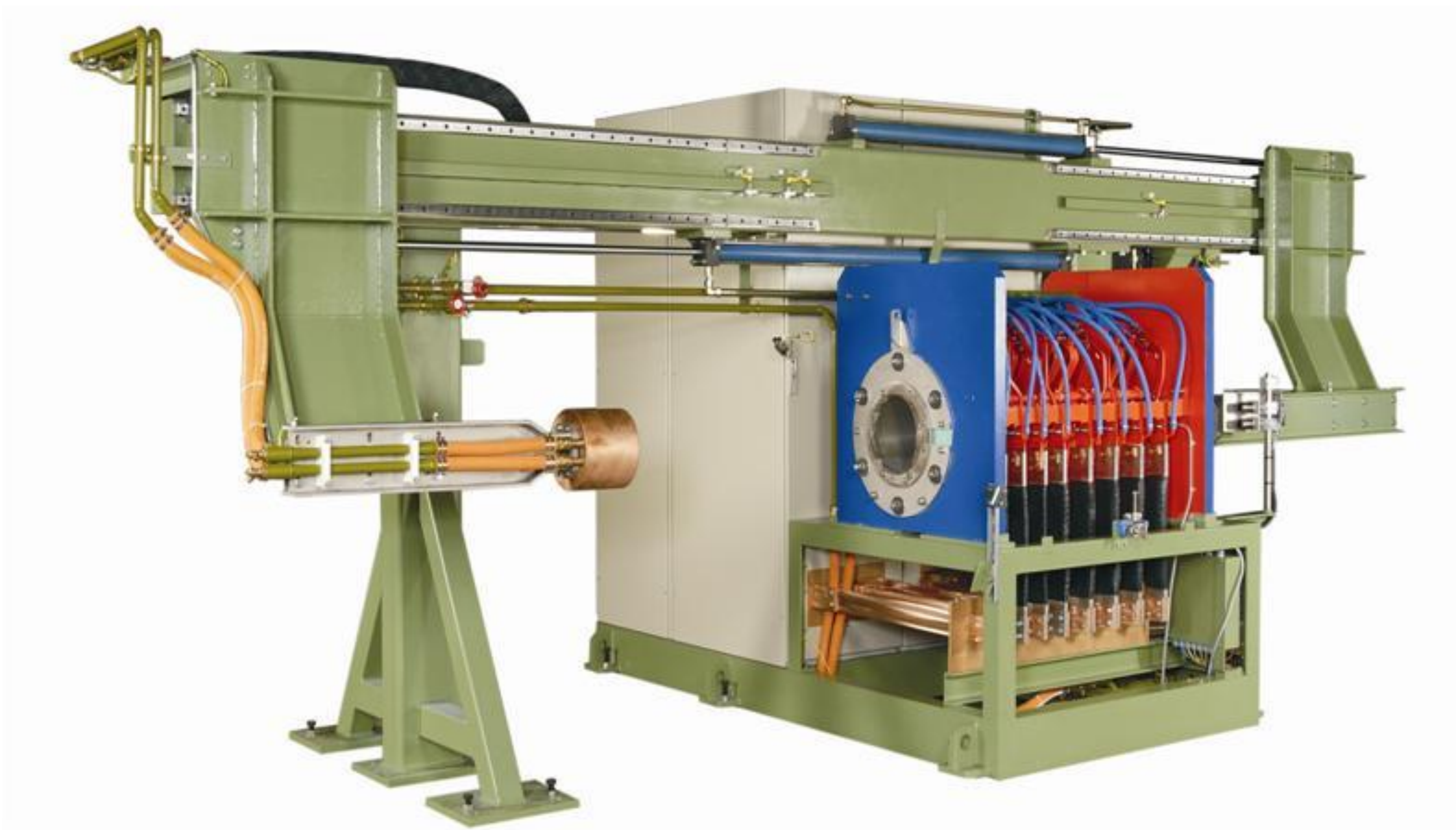
Increase Temperature Accuracy, Repeatability

15°C Each 100mm

Increase product quality & Die Life

Reduced Cost Increased Production *

Single Shot Push Through Taper Heater



Non – Ferrous Billet Heating
Zero Friction Taper Billet Heater

INDUCTOTHERM

Inductotherm specialises in non-ferrous induction heating technology providing mains and low frequency heating solutions for Aluminium, Brass, Copper and exotic alloys for both sawn and sheared billets.

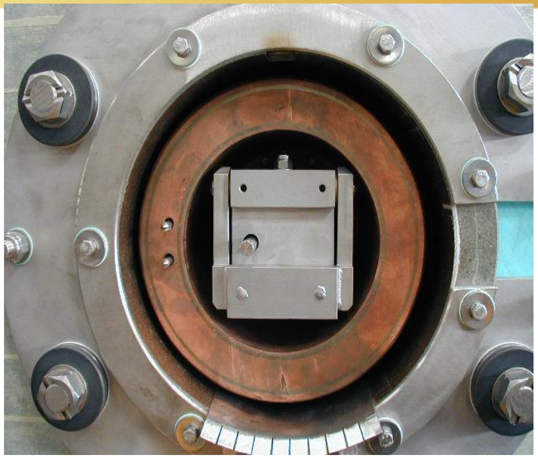
Multi – Layer Coil

Support beam and end plates clamp the disc pairs about a stainless steel / mica liner forming a robust - rugged induction coil

Water temperature trip protection for each Disc pairs interlocked with in the heater after inspection trips are manual reset

Reduced kwh/t
Increase production
Increase temperature accuracy, repeatability

Temperature Control



- Thermocouples positioned at depth of current penetration, and on billet end faces used in dynamic & static heating.
- Side entry thermocouples for taper/base profiles
- Multiple, Controlled zones optimise billet temperature

Heating rates Aluminium for Extrusion - 480°C LF

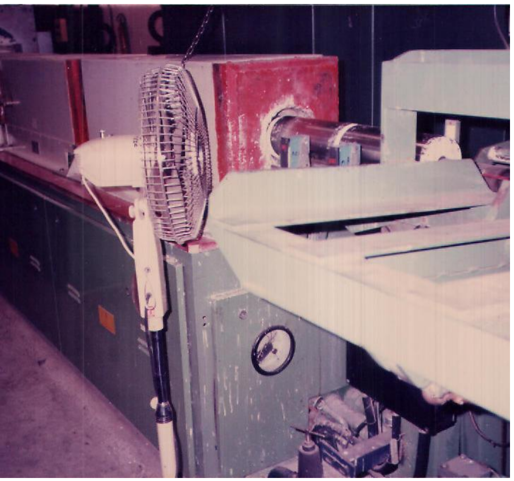
400mm Inductor

Billet Dia.	PR	EF	Efficiency %	kWHrs / Tonne	Q Graph 7A	Kg/kWHr Theory
300	0.75	37.5	54.0	288	10.0	3.48
280	0.70	35.0	52.0	300	10.5	3.30
260	0.65	32.5	48.5	320	11.0	3.13
240	0.60	30.0	46.0	340	12.0	2.94
220	0.55	27.5	43.0	362	12.5	2.76
200	0.50	25.0	40.0	388	13.2	2.58

300mm Inductor

Billet Dia.	PR	EF	Efficiency %	kWHrs / Tonne	Q Graph 7A	Kg/kWHr Theory
220	0.73	35.0	52	300	8.0	3.30
200	0.67	25.0	46	336	9.0	2.98
180	0.60	22.5	43	358	9.8	2.80
160	0.52	20.0	39	400	10.1	2.50
150	0.50	18.7	37	420	11.0	2.38

Stainless Steel Billet Heater Prior to Extrusion



Billet Size 125- 153 round for manufacturing seamless tubes

Application Process :

Mass heating of magnesium billet prior to extruding

Part name	Magnesium billet
Part dimensions	90-120mm billet heater 155-290mm long
Machine (fixture) type	Two single billet station with 45° C gravity loading and pneumatic eject
Coil type	Solenoid
Production rate	40 – 100 billets per hour

The operator loads a billet onto the loading ramp and presses the load button. The load/unload cylinder rejects allowing gravity loading of the billet into the coil which is mounted at 45°. The billet is ejected Automatically when it reaches the pre-set final temperature as measured by an optical pyrometer.

The system renders accurate predication of the heat time for a given billet impossible as each coil is affected by the load condition of the other during the heat cycle. However the required heat time window is wide between 1 & 3 minutes and this method does allow for random loading independently from the other heat station of any billet size within the predretimined range.

Thank you