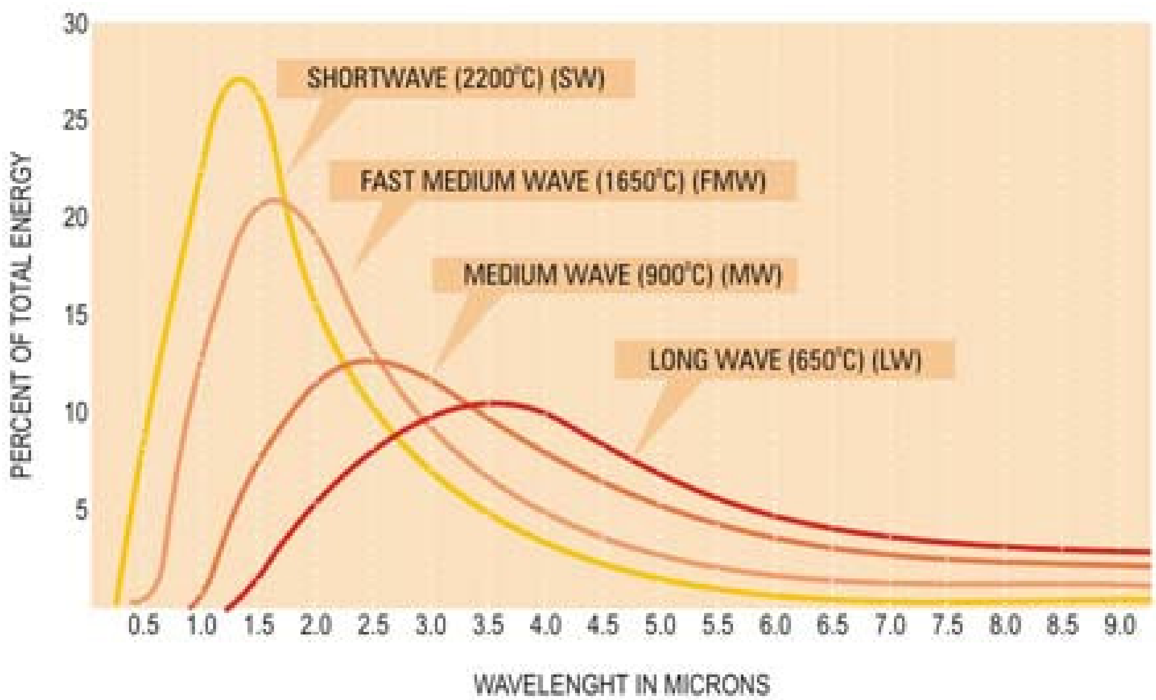
I]	# WHAT IS INFRARED?

Infrared (IR) is a part of electromagnetic spectrum and lies just beyond red color of visible light. Infrared is invisible. However it has properties similar to light i.e. it travels at the speed of light, it can be directed or focused and it can travel even in vacuum.

When an object absorbs IR radiation, heat is generated internally in the project as IR causes the atom of the object to vibrate, raising its temperature. (Temperature of any substance is a measure of the severity of the vibration of its atoms.) IR does not need a medium like air to heat a substance. IR wavelengths begin at 0.7 microns and wavelengths upto 10 microns have significance as far as industrial heating is concerned. The IR source temperature determines these wavelengths and each temperature has a characteristic spectrum with a "peak wavelength". A graph showing typical spectral distribution of energy for different types of IR sources in shown here. The ranges are

SW- 1800 – 2200°C
FMW- 1200 – 1800°C
MW- 750 – 1200°C
LW- upto 650°C



II]	**THE ADVANTAGES OF INFRARED HEATING**
	IMPROVED QUALITY DUE TO NON CONTACT HEATING : Infrared emitters can heat a product without physically contacting them or without the necessity of a medium like air having to contact the object. It can also heat in vacuum. This is advantageous where dust or other contaminants can mar the product's surface finish.
	HIGH ENERGY EFFICIENCY : In IR heating the heat lost to air or to surroundings is very small. Also, IR like light can be reflected, concentrated, directed i.e. it can be focused on the object. Hence energy efficiency is high. In many applications related to coatings it is not even necessary to heat entire mass of the product.
	FAST RESPONSE OF THE EMITTERS Because of low thermal inertia of Infrared emitters there is no need for long preheat period. In most cases this period is only a few minutes. Quartz short-wave IR systems are practically instant ON-OFF type. This has dual advantages – Firstly the systems can be switched OFF even during short breaks in production resulting savings. Secondly the heating system can be interlocked through safety interlocks to switch OFF within seconds in case of emergency.
	FASTER HEAT – SHORTER TIME CYCLES Infrared reduces the heating time cycle to typically one third of those required in convection ovens. This is because in convection oven the medium i.e. air gets heated first and it is only the film of air in contact with surface transfers heat to the products. Air itself gets heated slowly. This slows down the heat transfer process. Worse still, in case of coatings, the problem in compounded because the coatings themselves are not good conductors. Infrared heats the product directly without heating the medium in between. In case of coatings, infrared even penetrates the entire thickness of coatings instantly. This makes it a fast, one stage heat transfer.
	SPACE SAVINGS As a corollary of the above, for all continuous and conveyorized process IR heating systems require smaller lengths. Many a times it is possible to suspend the oven from ceiling. All this results in savings in valuable floor space.

	CONTROLLABILITY AND CONTROL ACCURACY : Electric IR emitters give the kind of controllability which is simply unmatched i.e. just not achievable by any other heating method. Direct product temp. sensing by IR thermometers, coupled with PID controllers & Thyristorised power regulators can give precise control of product temp. (As against air temp. measured in other methods). Again, a unique feature is the facility of zoning to control IR radiation on different parts of the object.
	FLEXIBILITY : IR heating can be installed for any type of material movement – vertical, horizontal, inclined etc. It can even be installed on bends, radii etc. in case of space constraints. They can be installed in very short times and subsequent additions for higher production are easy because of modular construction.

MFB IR BURNER

I	**MFB BURNER**
	The metal fibre burners represent the state-of-the technology in gas infrared. It combines the low operating cost advantage of gas with unique features such as • Unbreakable construction, with very high life. • Short heat-up and cool down time (3-4 seconds) when used in the fan driven mode. • Absolute uniformity of radiation over the emitting surface even in case of 2-3 m long burners. • Flexibility of shape • Thermal & mechanical shock-proof.
	There are two basic types: MFB Cloth 100. Sintered Mat 200/ Knitted Mat 250.
	Construction of MFB Burner. The cloth does not have strength of its own. A thin perforated sheet supports it. Housing is made of SS304 and is fully welded with diverters inside for equal distribution of premix. The mat is fully welded along its periphery. The housing can be made with or without collar. Gas entry is either from back or from side (height increases in case of side entry). MFB Cloth 100 is low density, 1.5Kg/m2 and is used mainly for blue flame applications. Sintered Mat 200 is medium density, 2.5Kg/m2 and is used mainly for radiant applications.
	Construction of Sintered Mat Burner. Knitted Mat 250 is high density, 4Kg/m2 and is used mainly for applications where the burner surface temperatures are consistently high. As the mat has strength of its own, it can be welded between the housing and a flange. Rest of the construction is as per the MFB design.
	Operation. The burner can be fired facing sideways, up or down (with some care). Also it can be fired vertically with no loss of uniformity till a heated length of 1000mm. Atmospheric firing is inexpensive but possible only if a pressure of 120 mbar is available. Also it has less modulation capacity. Firing gas-air premix requires paraphernalia but it has higher modulation range and can work with lower pressures. Also with the addition of gas train it can be made reliable for long-term usage.

II	GAS COMBUSTION.
	Important note. Composition of gas is the most important parameter in designing a safe system. An installation is always set for one particular type of gas. Variation in this can cause safety hazards, for example if butane is used in a system originally designed for propane or natural gas, flashback and explosion can occur because of lower self ignition temperature of butane (450 ºC) as compared to 550 ºC for propane and 750 ºC for natural gas and also due to higher calorific value of butane.
	<u>Chemistry of Combustion</u>. Generally CO_2 and H_2O are formed as byproducts of combustion of hydrocarbons. For example, $CH_4 + {}^{1/2}O_2 = CH_3OH$ $CH_3OH + {}^{1/2}O_2 = HCHO^* + H_2O$ $HCHO = CO + H_2$ $H_2 + {}^{1/2}O_2 = H_2O$ $CO + {}^{1/2}O_2 = CO_2$ * This is formaldehyde. If the mixture hits cold wall, the process stops here. This is why formaldehyde smell is observed in poor heat exchanger designs.
	<u>Gas / air ratios</u>. λ = stoichiometric ratio = 1 if air is just adequate for combustion $\lambda > 1$ if air is excess $\lambda < 1$ if gas is excess
	<u>Radiant / Blue flame modes</u>. With premix flow such that heat intensity is in the range of 100-500KW/m^2, most of the combustion takes place within the surface of the burner itself. This makes the surface heat, glow and transfer the heat in radiant form. This is infrared mode. Here the surface temperature is highest at 1050 ºC. If premix quantity is increased the burner actually cools down because of excess nitrogen flow. Combustion takes place outside the burner. This is blue flame mode. Here the heat transfer is in convection mode. Intensities as high as 20 MW/m^2 are possible. In both the cases flue gases are released in the air. For radiant operation, λ = 1.05 to 1.1 For blue flame mode, λ = 1.1 to 1.2
	<u>Efficiencies in Radiant mode.</u> At lower intensities higher amount of combustion takes place within the surface. At around 125KW/m^2 the radiant efficiency is highest at approx. 55-60%. Below 100KW/m^2 the flame cannot be sustained. Efficiency is high in face down position. It can be increased in any position by adding a grid in front.

MFB GAS IR BURNERS