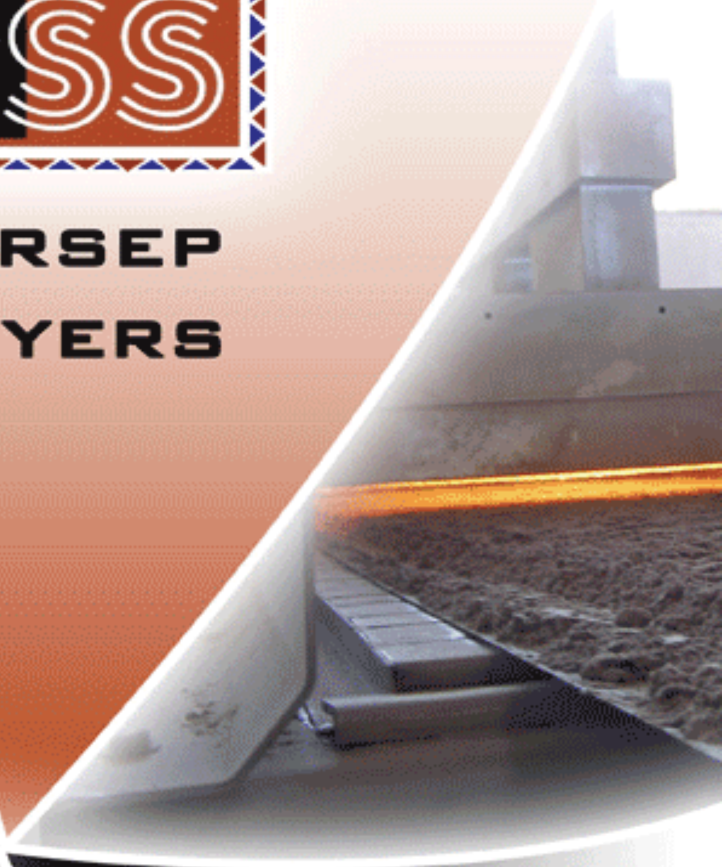
PARSEP DRYERS



SIMPLE COST EFFECTIVE DRYING TECHNOLOGY

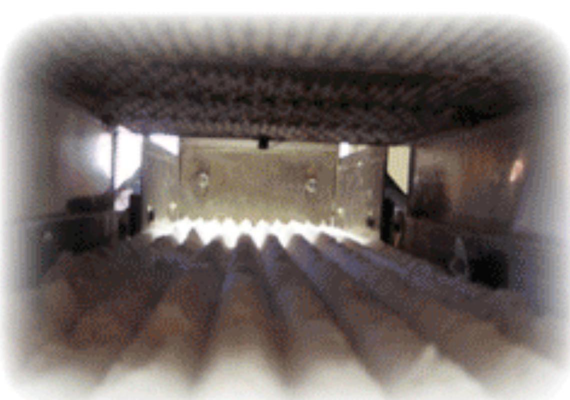
PARSEP DRYER FEATURES
MEDIUM WAVE INFRARED DRYING
WHILE SUBJECTED TO VACUUM

- Woven Steel Belts To Transport Substrates
- Applied Suction Underneath The Belts
- Medium Wave Infrared Radiation (MIR) above the substrate

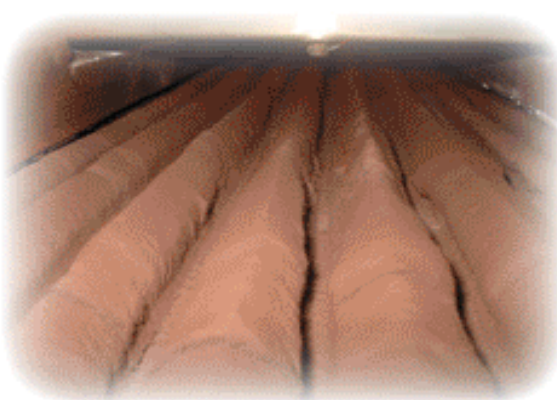
- Simple
- Economical
- Low Maintenance
- Silent
- No Dust
- High Evaporation Rates

Manganese Drying

Sodium Sulphate Drying



PVC Drying



Iron Fines Drying

Patented Drying Technology

Parsep Drying

Medium Wave Infrared Technology Explained

Heat transfer

Heat transfer is the process of heat energy flowing from a source at a high temperature to a load at a lower temperature. The three forms of heat transfer are conduction, convection, and infrared radiation. Conduction occurs when there is a transfer of heat energy due to a temperature difference within an object or between objects in direct physical contact.

Convection is the result of a transfer of heat energy from one object to another via a moving fluid or gas.

Radiation heat transfer can occur by infrared, ultraviolet, microwave and radio waves. Infrared (electromagnetic radiant infrared energy) is the transfer of heat energy via invisible electromagnetic energy waves that can be felt as the warmth from the sun or a downwind fire or other hot objects.

Electromagnetic Energy

Infrared rays are part of the electromagnetic spectrum. Infrared energy travels at the speed of light without heating the air it passes through, (the amount of infrared radiation absorbed by carbon dioxide, water vapour and other particles in the air typically is negligible) and gets absorbed or reflected by objects it strikes.

Any object with a surface temperature above absolute zero - 460°F or - 273°C, will emit infrared radiation. The temperature of the object as well as its physical properties will dictate the radiant efficiency and wavelengths emitted. Infrared radiation can be compared to radio waves, visible light, ultraviolet, microwaves, and x-rays. They are all electromagnetic waves that travel through space at the speed of light. The difference between them is the wavelength of the electromagnetic

wave. The infrared radiation wavelength is measured in microns (μm), starting at 0.70μm and extending to 1000μm. Although the useful range of wavelengths for infrared heating applications occurs between 0.70μm to 10μm. An emitter at a particular temperature emits power over a range of different wavelengths.

Infrared Heating

Infrared heating is the transfer of thermal energy in the form of electromagnetic waves. True infrared heat should have one common characteristic: that the transfer of heat is emitted or radiated from the heated object or substance. The source emits radiation at a peak wavelength towards an object. The object can absorb, reflect and re-radiate wavelengths. It is the absorbed radiation that creates the heat within the object. Infrared heating varies by efficiency, wavelength and reflectivity. It is these characteristics that set them apart and make some more effective for certain applications than others. Varying levels of efficiency are possible within IR heating and often depend on the material of the heat source. The basic measure of efficiency lies in the ratio between the energy emitted and the energy absorbed. Other considerations may affect this measurement. One is the emissive value of the heat source as based on the perfect 'black body" emissive level of 1.0. Ceramic emitters are capable of 90% or better emissions as opposed to the lower values of other heater substance. The useful range of wavelengths for infrared heating applications fall within the range of 0.7μm – 10μm on the electromagnetic spectrum and are termed short wave, medium wave or long wave.

The medium to long range wavelengths are most advantageous to industrial applications since almost all materials to be heated or dried provide maximum absorption in the 3 μm to 10 μm region. Energy from an infrared heat source that also emits light (short-wave) will typically emit 80% of its energy around the 1μm wavelength; whereas the ceramic infrared heater emits 80% of its energy around the 3μm wavelength.
The emission efficiency of the infrared heating element itself is not enough since they are used within a fixture. The reflectivity of the fixture greatly contributes to the overall efficiency of the heater. The elements are typically housed within the effective combination of an aluminium / stainless steel clad reflector. The steel adds strength and rigidity while the polished surface makes for high reflectivity and minimal heat loss.

Infrared Absorption and Reflection Rate of Materials

The amount of energy absorbed or reflected by a body can be determined for all objects and is dependent on the wavelength of the radiation. This is beyond the scope of this discourse therefore for absorption and reflection percentage rates for specific materials please see a Physical Property of Materials table. For exact wavelength absorption and reflection for selected materials similarly please see a table on spectral absorption curves.

The Effect of Air Alone

If a wet substrate is left in open air it will eventually dry to the extent that the relative humidity in the ambient air will allow - the drier the air the drier the substrate. This is as a result of the partial pressures of the gases which make up the air including the gas phase of water which is vapour.

Factors Affecting The Rate And Amount Of Moisture Removed From A Substrate:

- Air temperature
- Atmospheric pressure
- Partial pressure ratio between the water vapour and other constituent gases (relative humidity)
- Movement of air

Air Forced Onto a Wet Substrate

When air is forced onto a substrate, the boundary between the substrate and the air is continually refreshed with air at ambient conditions. This disallows the saturation of the air at the boundary and consequently causes a higher rate of moisture removal.

Air Drawn Through a Substrate

When a vacuum is placed at a surface of a substrate, causing air to be drawn through the substrate, the moisture removal efficiency is further enhanced due to:

- The total surface area of the substrate, exposed to the air being greatly increased by including inner surfaces and both top and bottom surfaces
- The reduced pressure at the substrate surface where the vacuum is applied - this causes expansion of the air and consequently a greater capacity for moisture removal

The branch of science which deals with the phenomenon of gases' ability to remove or exchange moisture is known as Psychrometry. A Psychrometric Chart may be used to determine the carrying capacity of normal air at different temperatures
From the above it can be seen that air at ambient conditions, forced through a wet substrate does work on the substrate to remove moisture - the rate and amount dependent on the factors mentioned.

Adding an Energy Source

When water evaporates, it requires energy to change state; this energy is drawn from the surroundings. In the case of using air alone, this latent heat of evaporation is drawn from the substrate material (causing lower temperature) as well as from the air. This sets the pace insofar as moisture removal is concerned. When heat energy is applied however, the entire process is speeded up due to the fact that energy is absorbed (not from the ambient material and air as this is normally well below the temperature of the heat source) for the following:

heating the substrate – this may get close to the boiling point of water but will depend on the nature and physical properties of the substrate, such as specific heat and surface absorptivity

- heating the water to boiling point
- supplying latent energy for change of state to vapour

Calculation of Efficiency

Calculating the total energy needed to remove moisture at a particular rate is a simple enough procedure. When attempting to calculate the efficiency of heat energy supplied against the rate of moisture removal, the plot thickens:

as the energy source, one needs to take into account that the entire system containing the emitters/elements first heats up and then continuously radiates energy from its surface.

Furthermore the energy which is "aimed" at the substrate does not all get absorbed by the water – a significant portion of it heats air which is not involved in removing moisture.

Additionally, the energy used to heat the substrate in the process, is lost as it cools down after drying – this is a significant amount of energy. One cannot then accurately determine how much electrical energy has actually been used to remove moisture. The largest error however would be in neglecting the effect of the moisture removed by the inherent psychometric properties of the air alone. To take this into account a number of measurements would need to be continuously recorded, e.g.:

- wet bulb temperature of ambient air
- Dry bulb temperature of ambient air
- Rate of air flow etc.

This in itself may not be justified when looking at the overall picture, as the correct approach to efficiency should be, during the design stages, to minimize energy losses from the system and maximize energy absorbed by the substrate

For systems with low losses and high absorption, the efficiency of the electrical power used in kW to remove moisture at a certain rate, may in fact be calculated at less than the power absorbed.

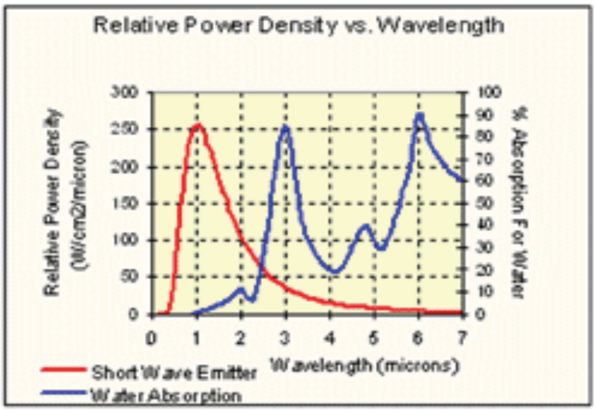
Water Absorption

The accompanying charts show the graphs of two emitters – one at a temperature causing it to radiate at Short Wave with a peak relative power wavelength of 1μm, and the other at a temperature causing it to radiate at Medium Wave with a peak relative power wavelength of 3μm.

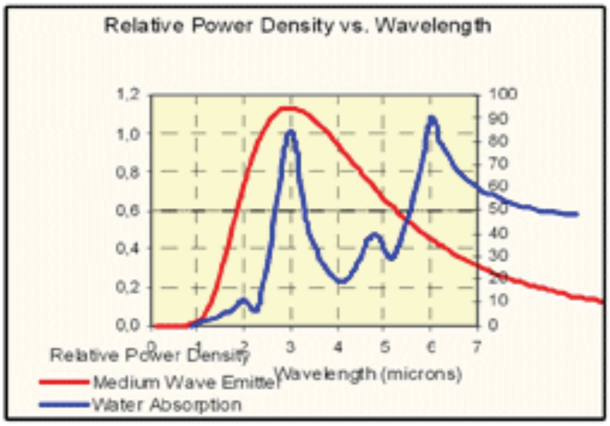
In each chart is a graph showing the ability of water (moisture) to absorb energy at various wavelengths, the energy not absorbed is either reflected or transmitted through. As can be seen, water has a peak absorption in the region of 3μm and 6μm.

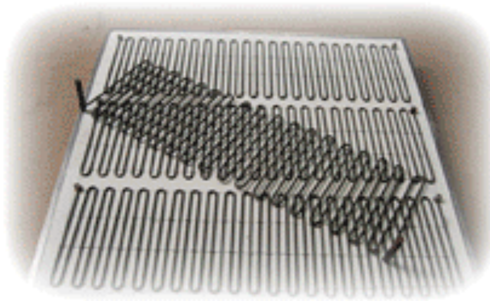
The opposite is true for power radiated by a Medium Wave emitter – here as can be seen a significant portion of the radiated energy is efficiently absorbed. The peak relative power reduces for each successively lower emitter temperature, thus the amount of energy available at Medium Wave will also be significantly higher than a Long Wave emitter working at the other high absorption peak for water at 6 microns.

The high efficiency and relatively higher power radiation results in Medium Wave being the obvious choice for efficiently removing water from substrates.



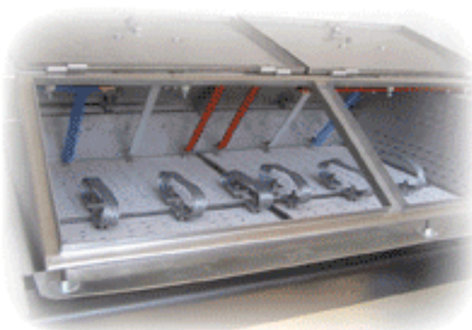
Research graphs as developed by Eskom shows why medium wave is the preferred source to heat up water.





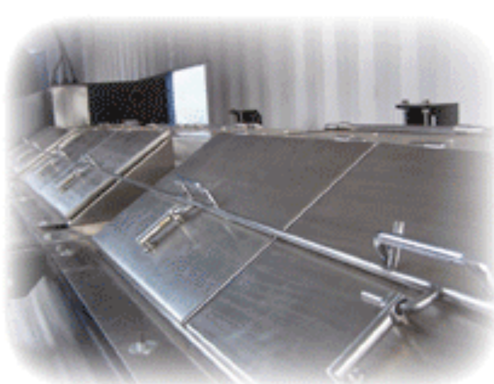
FAST RESPONSE EMITTER BOARDS
METAL EDGED AND RIGIDISED
MANUFACTURED TO 60 kW/m²
POWER OUTPUT
NiCr EMITTER WIRES 220/380/525V

INHOUSE CONTROL
PANEL MANUFACTURE



EASILY ACCESSIBLE ARRAYS
MANUFACTURED IN STAINLESS STEEL

ROBUST ENGINEERED FRAME AND
PULLEYS MANUFACTURED IN
MODULAR DESIGN



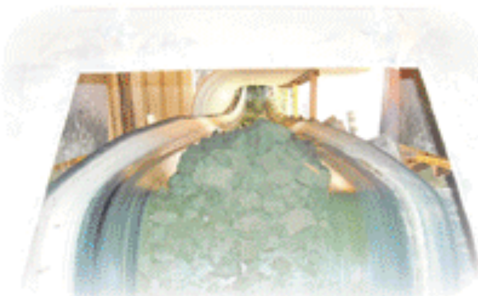
INTERLOCKED ARRAY DOORS

PNEUMATIC LINKED BELT TRACKING
AND TENSIONING ENSURES PERFECT
BELT ALIGNMENT

EVAPORATION RATES 2L/KW TO 6L/KW

FUSED ALUMINIUM DRYING

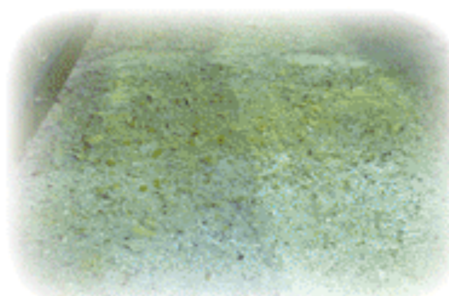
80% SOLIDS TO DRY



COBALT SALT DRYING

25% SOLIDS TO DRY

AMMONIUM META VANADATE DRYING



80% SOLIDS TO DRY

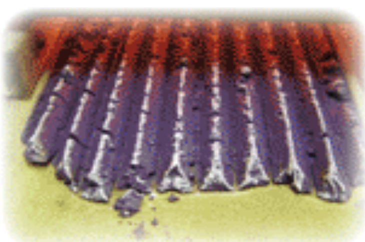
GRANULATED COAL DRYING 80% SOLIDS TO 90% SOLIDS

EXTRUDED COAL DRYING 70% SOLIDS TO 90% SOLIDS

Simple, Dustfree and Efficient Drying

Iron ore
Diamond Gravel
Silica Sands
Mica
Cobalt Hydroxide
Magnetite
Manganese
Alumina
Gypsum
PVC
Chromium
Phosphates
Coal
Nickel Concentrate
Copper Concentrate

Alumina Drying



Cobalt Carbonate Drying
80% water to Dry

1 kW evaporates 1 – 6L of water depending on application

Can dry minerals from a paste
Can accept free water
Can dry from 100 – 800ºC

Rubber Drying

Mineral Sands
12% to Dry

Diamond Gravel Drying

Environment Friendly Drying

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