MINING

Fluidized bed electrical heating systems

Heating systems

Metso has designed and supplied numerous fluidized bed dryers, heaters, calciners, roasters and coolers to the mineral sands industries within Americas, Australia, Africa, and Asia for many years. These plants are fired on gas or liquid fuels and often custom designed to fit within existing buildings and process requirements. A need was identified for an economical and compact design for relatively low thermal energy/throughput mineral sand heaters. Metso designed and built an electrically heated prototype, which was successfully installed and commissioned at Namakwa Sands Ltd in South Africa. The unit was so successful that four more units were ordered with capacities up to 35tph.

Heaters are suitable for:

Mineral Sands, Heavy Minerals Sands, any fluidizable material with particle size up to 2000 micron.

Main benefits of Metso's systems:

- Designed on the fluidized bed principles
- Very small flow of fluidizing air
- Very small flow of exhaust air
- Minimal heat losses as the heat is directly injected to the particles of mineral
- Skid mounted
- Electrically powered
- Quick response time
- The unit can be fitted into an existing system.
- Years of experience with all types of mineral processing equipment
- Capable of installation anywhere in world
- True understanding of process conditions
- Custom fit applications

Fluid bed principals

The Metso heater design is based on the fluidized bed principle. To fully appreciate the operation of the heater, a few relevant principles of fluidization need to be understood:

A When air is passed up through a loosely packed bed of granular material, either of three states exists, depending on the velocity of the air through the bed.

- At low air velocities, the air will percolate through the bed and cause minimum particle movement in the bed.
- As the air velocity is increased, the bed will expand and the particles will become mobile within the bed of air or fluidized.
- As the air velocity is increased yet further, the particles become entrained and leave the bed - this is termed pneumatic conveying.

B The air in the static bed finds a path of least resistance or "ratholes" through the bed. In the fluidized state this does not occur as each particle is enveloped by air thus ensuring optimum air to solids contact. In heating applications this is very important as heat transfer is optimized and localized heating is avoided. The air cushioning also minimizes mechanical degradation of the bed particles.

C Material in a fluidized state behaves as a liquid; it flows over and under weirs, has a level surface and exerts a hydrostatic head, or pressure, proportional to the bed depth.

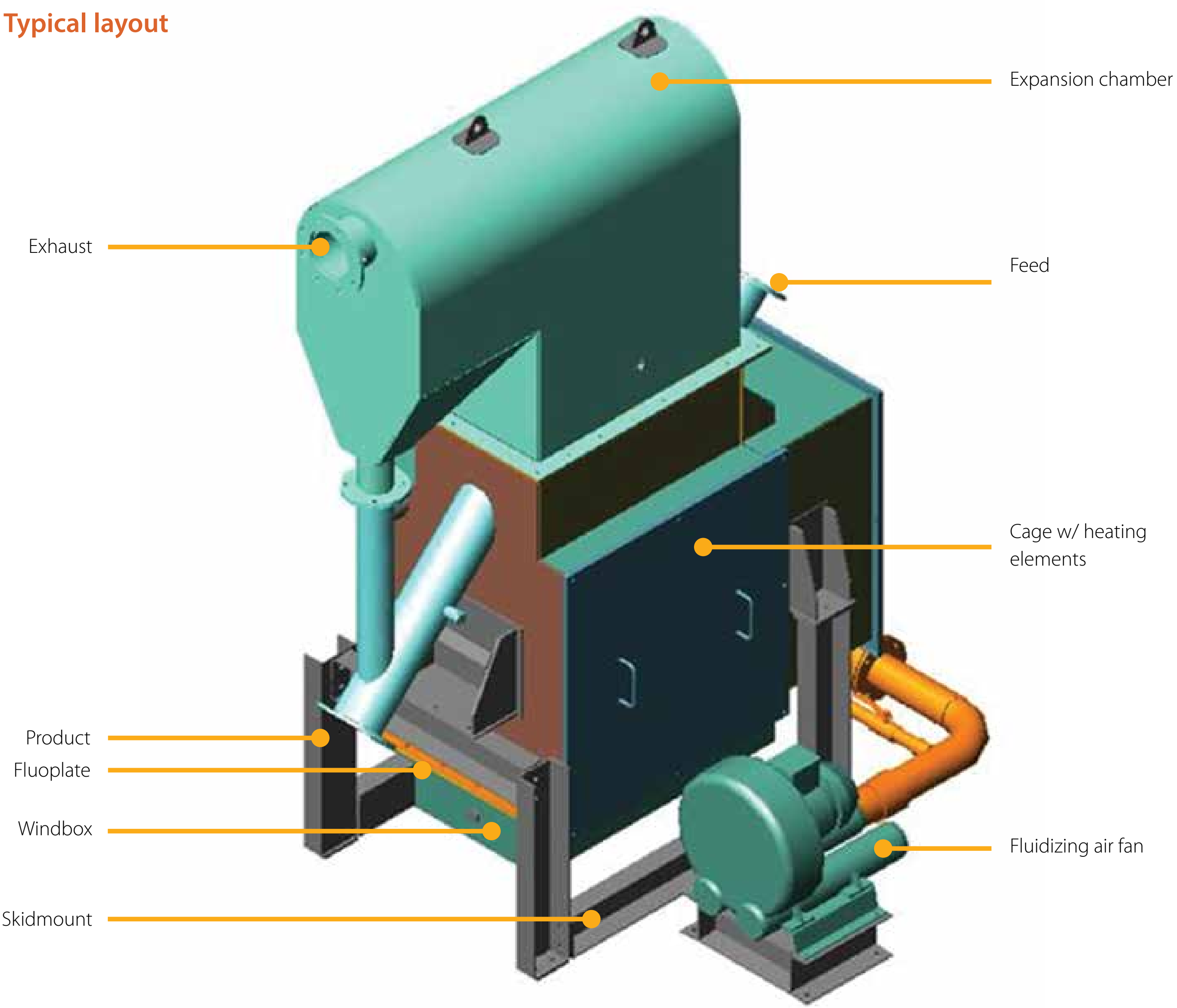
D The higher thermal efficiency of fluidized beds is attributable to a number of characteristics found only in part in other heating techniques. Exposure of surface area on which heating takes place is one of the fundamental requirements of successful heating. Fluidized beds, by virtue of the fluidizing air passing through the bed medium, present a maximum, constantly moving area per unit volume on which the heating can occur.

Main components of system

The fluidized bed electric heater consists of a rectangular steel vessel separated by an air distributor or fluoplate. Ambient temperature air from the fluidizing fan is introduced into the lower portion (or windbox) of the vessel and enters the upper portion (heat exchanger) via tuyeres in the fluoplate.

The material to be heated is fed onto the fluoplate where it is fluidized and heated by electrical elements immersed in the bed of material. The heated material is discharged from the heater over a weir for further processing.

Typical layout



Dust collection

Primary dust collection consists of a baffle chamber arrangement, which forms an integral part of the heater expansion chamber. The heated dust collected by the baffle chamber is mixed back with the heated bed product. The exhaust gases are then directed to a common baghouse dust collection system.

Process description

The main advantage regarding the energy efficiency of Metso electric heater lies in very quick response time to fluctuating thermal demand. The electric elements are located in the bed of fluidized material inside a stainless steel tubes. On the outside of the tube the constantly moving bed of mineral receives the heat generated by the elements in a rapid and very efficient process. The heat is virtually directly injected to the moving particles instead of being supplied with the fluidizing air. This approach minimizes the quantity of fluidizing air and at the same time reduces the heat losses with exhaust gasses.

Control of the heating operation is automatic. A thermocouple in the fluidized bed controls the power input to the electric elements and hence the thermal requirement of the heater.

When the temperature or rate of the feed changes, the thermal demand of the heater changes. Because the heat transfer from the elements to the bed is very fast the energy generated by the elements is adjusted immediately thus reducing fluctuations in the product temperature.
In most Mineral Separation Plants such fluctuations are very common. For every second that the product temperature is higher than set by the plant operator unnecessary energy is carried out by the product thus reducing the efficiency of the system.

Controls description

The controls of the heaters are enclosed in one panel. This includes all the equipment required for power distribution and control of the equipment. The logic and temperature control can be managed from the front panel or from the remote location. The control system allows for the remote start/stop of the heater as well as for a remote set point of the required temperature. As stated earlier, control of the heating operation is automatic. A thermocouple in the fluidized bed, controls the power input to the electric elements and hence the thermal requirement of the heater.

As an example if the feed rate to the heater is 10,000 kg/h and the temperature is higher than set by 1°C for a period of 1 hour the wasted energy is about 2.3 kWh. The same principle would apply if the temperature were lower.

From the process control point of view, the ability of the heater to quickly respond to the set point is very important. The same applies if energy conservation is important.

The best energy efficiency is achieved when the heater is operating at its maximum feed rate. This is because the fluidizing air that is introduced to the heater removes a certain amount of the heat generated and exhausts it. The amount of heat wasted is constant and does not depend on the feed rate, it only depends on the exhaust gas temperature, which is equal the bed temperature.

Typical layout

Technical & Performance data

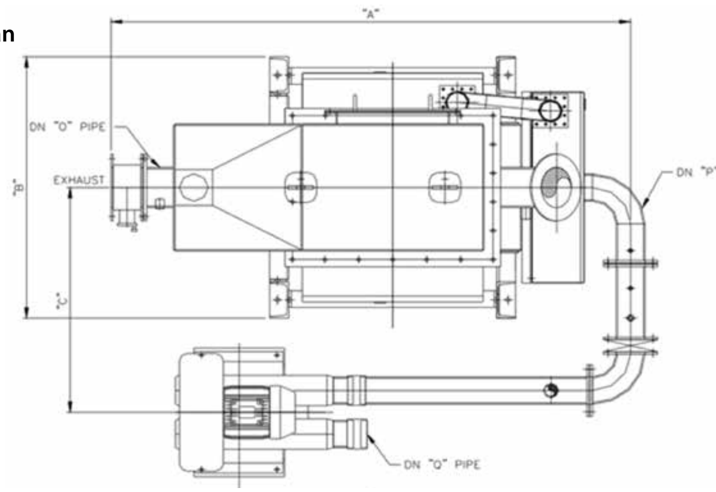
General model Selection

Heater model	EH	18	36	48	81	120	165
Feed Rate @ ΔT=30^{o}C	tph	4.1	8.5	11.4	20	30	42
Exhaust air flow @ 100 ^{o}C	Am^3/h	191	331	442	498	607	607
Efficiency @ max	%	85.4	88.1	88.3	92.3	93.7	95.4
Max. Thermal Load	kW	28.8	59.4	79.4	140.0	210.5	294.7
Number Of Elements		18	36	48	81	120	165
Fan Power: installed	kW	2.2	4.0	5.5	11.0	11.0	11.0
Heater Power: installed	kW	33.7	67.4	89.9	151.6	224.6	308.9
Weight – empty	Kg	280	810	910	1240	1440	1560
Weight – running	Kg	480	1110	1300	1820	2320	2560

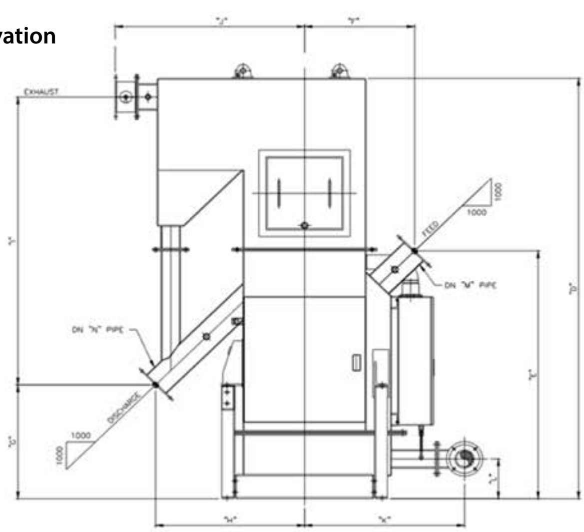
Performance calculated at the following conditions

- Power Supply 415 VAC
- Element type installed LP
- Ambient temperature 20 ^{o}C
- Atmospheric pressure 101.325 kPa
- Specific heat of solids 0.2 kcal / kg.K
- Max. product temperature 140 oC
- Feed temperature 70 ^{o}C
- Product temperature 100 ^{o}C

Plan



Elevation



General model dimensions

EH	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
36	1636	960	910	2006	1215	480	550	630	1340	854	780	182	100	100	100	80	80
48	1776	960	910	2156	1415	550	550	700	1490	926	850	182	100	100	100	80	80
81	2054	1092	940	2619	1545	650	710	880	1794	1119	945	248	150	150	150	100	100
120	2204	1092	940	2739	1665	720	830	950	1794	1189	1015	248	150	150	150	100	100
165	2204	1092	940	2979	1905	720	1070	950	1794	1189	1015	248	150	150	150	100	100



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Brochure No. 3011-05-14-ESBL/Danville-English