

Fluidized Bed Incinerator (FBI)

General description

RASCHKA fluidized bed incinerator

The fluidized bed incinerator (FBI) is a steel casing with an inner refractory lining and an outer thermal insulation. The main sections are the windbox with the heating-up combustion chamber, the nozzle bottom, the fluidized bed area, the cylindrical freeboard and the upper part with the flue gas outlet.

The refractory lining consists of high quality, wear resistant and proven materials to ensure a long lifetime and minimum maintenance. Generally the furnace is brick-lined with low density insulating bricks and abrasion resistant high density bricks (fluidized bed area).

The outer thermal insulation of the fluidized bed incinerator consists of fibrous insulating material and an outer cover made of aluminum sheet. Insulating mats made of ceramic fibres are covered with glass cloth to avoid the release of fibres from the mats. The outer aluminum cover sheets are mounted with a certain distance from the insulating mats to enable ventilation between insulating mats and sheet cover. With this ventilation the surface temperature of the sheet cover is limited. As air inlets and air outlets perforated sheets are installed at the lower and the upper end of the sheet cover.

The nozzle bottom is a special ceramic sandwich construction (refractory castable) equipped with air nozzles made of heat resistant cast steel. The thickness of the nozzle bottom is 500 mm. The combustion air is blown through the nozzles upwards into the sand-layer upon the nozzle bottom. The air fluidizes the sand evenly and thus the sand-layer expands to the fluidized bed being ~ 1.5 m high.

At plant start-up the combustion air is heated by means of the combustion chamber burner. The hot air heats the fluidized the sand and the entire furnace up a temperature (min. 850 °C) that is higher than the ignition temperature of the materials to be combusted (combustible). The heating up is supported by special fuel injection lances mounted in the fluidized bed area (see below). Then the combustible is conveyed evenly and exactly dosed to the RASCHKA-feeding device (RASCHKA-spreader). The spreader opens up and feeds the combustible evenly distributed across the fluidized bed. The glowing hot expanded (fluidized) bed material serves for an outstanding effective heat transfer to the combustible. In the furnace the moisture of the combustible is evaporated and super-heated, the organic substance combusts completely and the inorganic dry substance glows out. As soon as stable incineration conditions are achieved, the start-up burner and the lances are switched off and an auto-thermal incineration process continues (sufficient heating value of the combustible).

The large-dimensioned freeboard area above the fluidized bed area serves as post-combustion zone with long retention times of the flue gas and the fly ash particles. So a perfect combustion is achieved. The temperature in the upper area of the furnace can be controlled by the injection of secondary air. Thus the incineration process is optimized. The secondary air lances are arranged tangentially to the circumference of the incinerator. This effects a rotation of the flue gas in the furnace and a perfect mixing of the flue gas.

The content of the fluidized bed may increase or decrease during operation depending on the condition of the combustible. A surplus of bed material can be discharged discontinuously during the operation by the RASCHKA bed material discharge device

which is connected to the fluidized bed incinerator. This special discharge system avoids the energy losses that are caused by a permanently operated bed material discharge, screening and re-feeding system. In case of a decrease of bed material quartz sand is fed into the incinerator.

The fluidized bed incinerator is equipped with a special injection lances system for the injection of additional fuel or water directly into the fluidized bed area. The lances serve for supporting the heating-up process. In case of a decrease of the heating value of the combustible the immediate injection of additional fuel serves for maintaining the incineration and the minimum combustion temperature (850 °C). In case of an increase of the combustible heating value water can be injected in order to discharge excess heat, to equilibrate the heat balance and to keep the process parameters (incineration temperature, limitation of combustion air and flue gas quantities) and furthermore to avoid too high temperatures and emissions.

The outstanding lay-out and design of the RASCHKA fluidized bed incinerator offer very low NO_x values (remarkably below the European/German emission limits) without any NO_x reduction systems (see RASCHKA references). In case of a special demand a SNCR-system can be installed in the freeboard area of the fluidized bed incinerator.

Alternative RASCHKA-FBI-designs

For combustible containing not fluidizable foreign matters (e.g. nails, screws, stones) RASCHKA offers a special design FBI equipped with a nozzle system that allows the discharge of the coarse foreign matters during the operation: the bed material with the foreign matters is discharged, the coarse material separated and the fine grain bed material (silica sand) is re-fed into the FBI.

Another type of the RASCHKA-FBI can be equipped with a nozzle bottom made of steel with an upper protective refractory cover and a steel windbox that is not refractory lined. This type of FBI must be heated up by means of freeboard burners and the injection lances system (like the “open system” above).

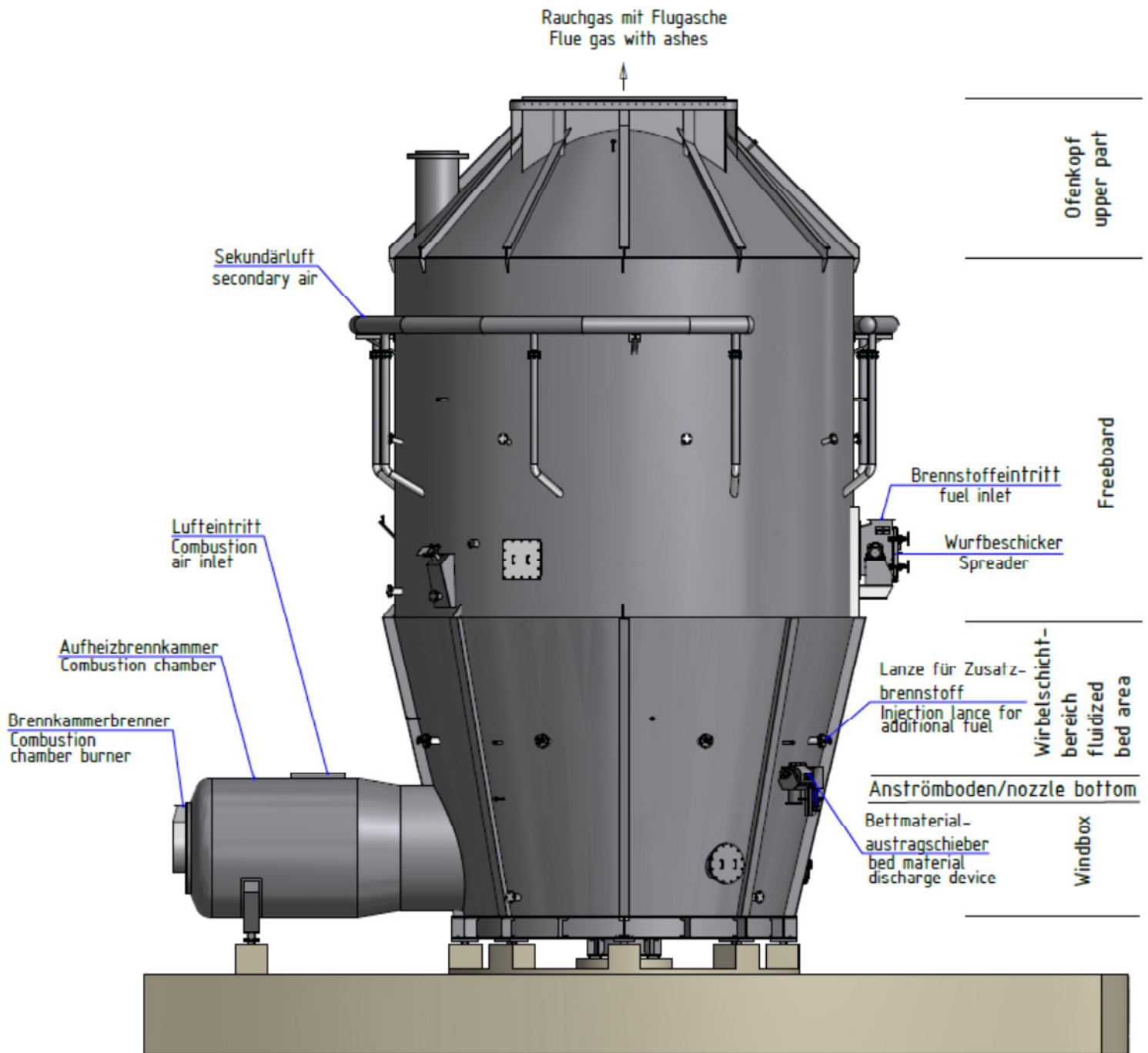
Energy recovery/utilization, flue gas cleaning

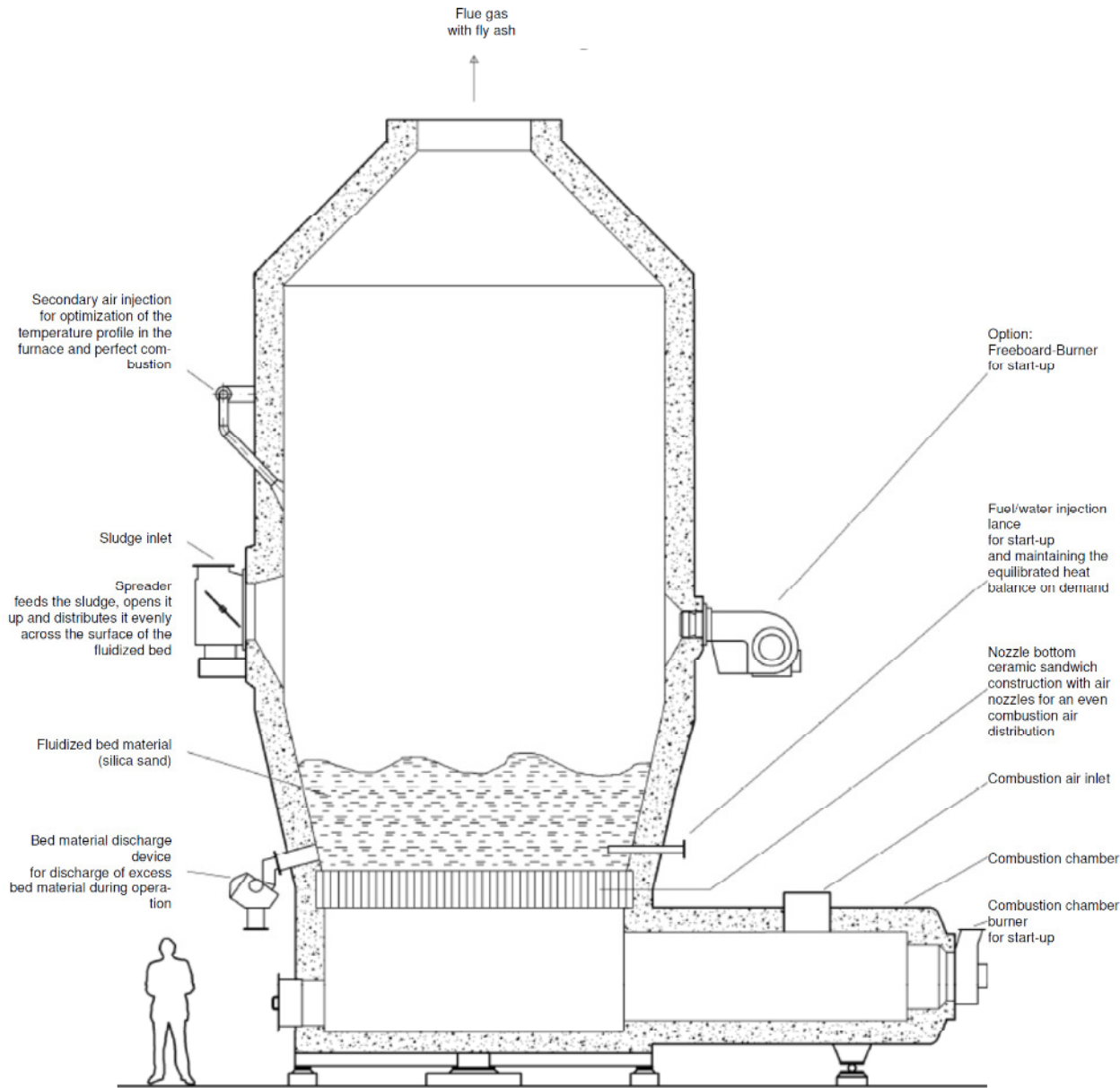
The ash loaded flue gas (~ 870-900 °C) leaving the fluidized bed incinerator is led into a subsequently installed waste heat steam boiler producing super-heated or saturated steam (alternatively a thermal oil heater) for further energy utilization -for the process itself and/or power production and/or heating purposes. Then the flue is de-dusted and cleaned from harmful components before it is released into the atmosphere.

Monitoring and control

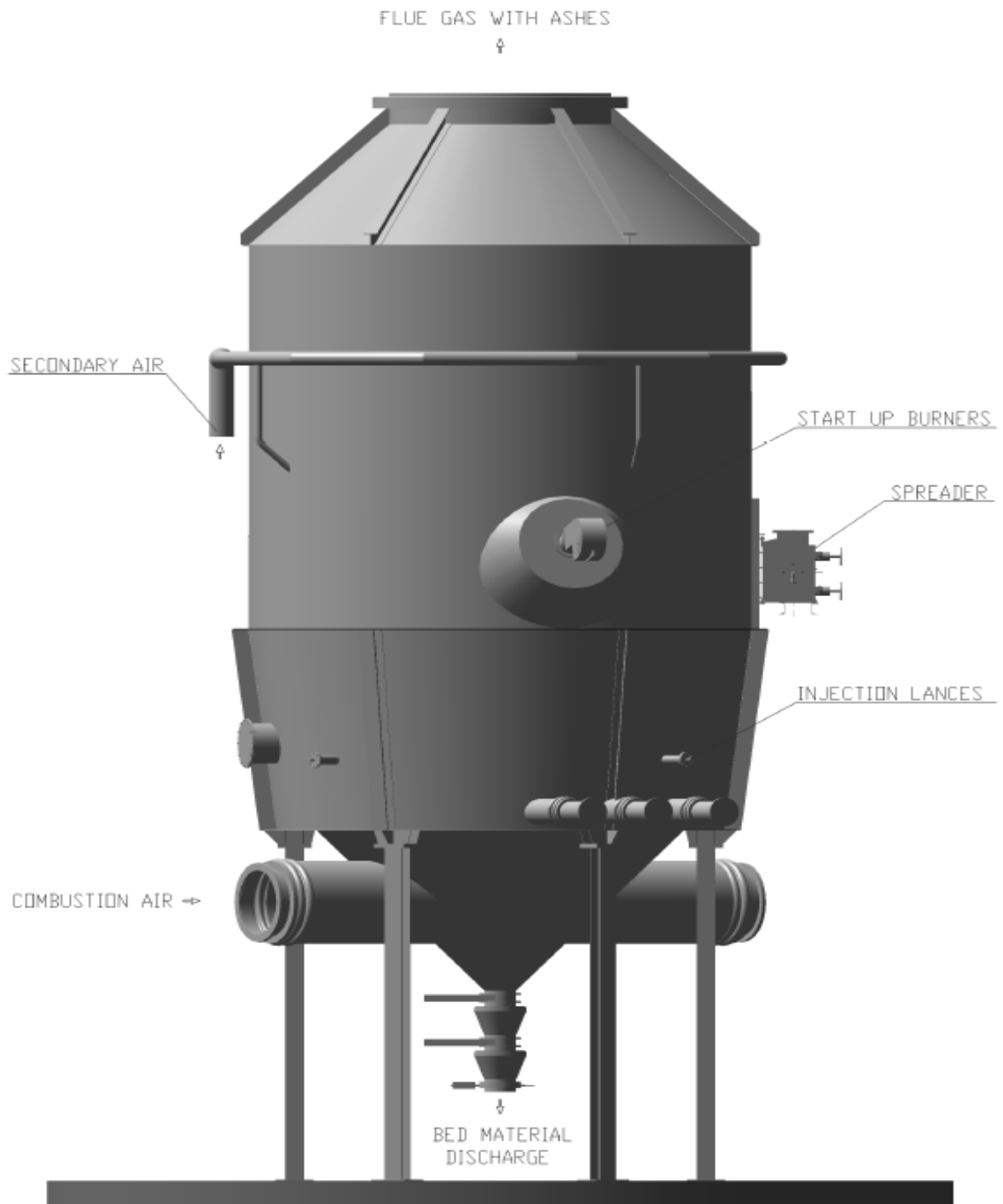
The fluidized bed incinerator is equipped with sensors for temperature, flow and pressure, the burners are equipped with local switch cabinets. These instruments are integrated in the plant control system.

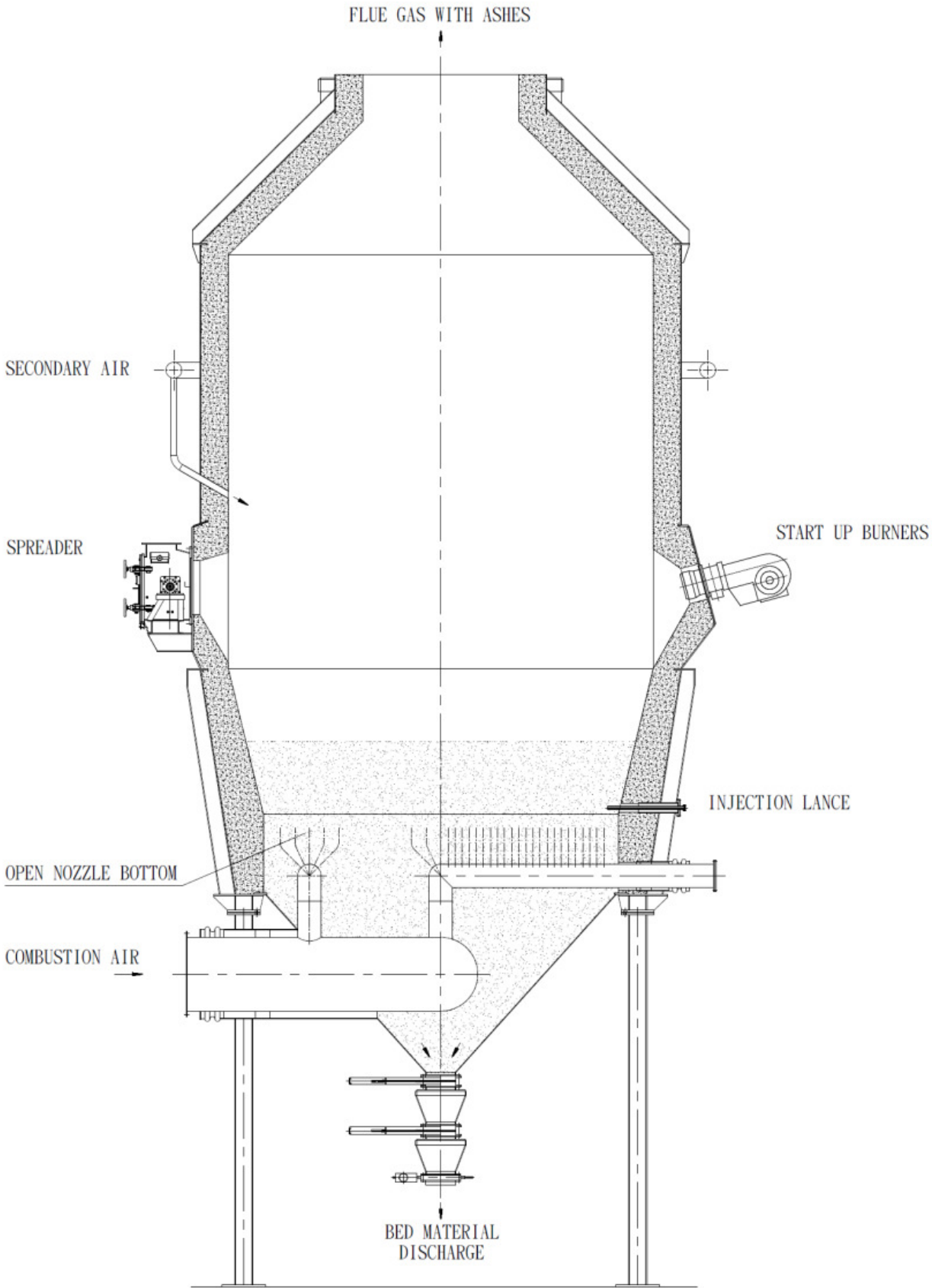
RASCHKA fluidized bed incinerator –basic sketches-



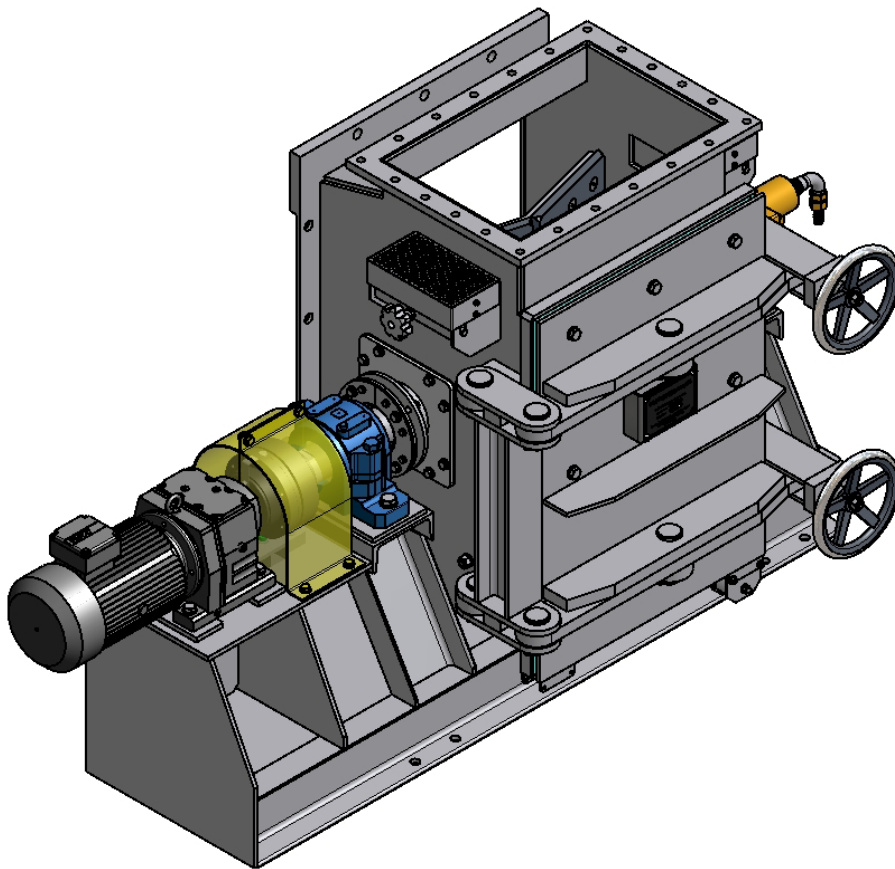


RASCHKA-FBI for combustible containing foreign matters





Spreader, bed material discharge device, injection lances

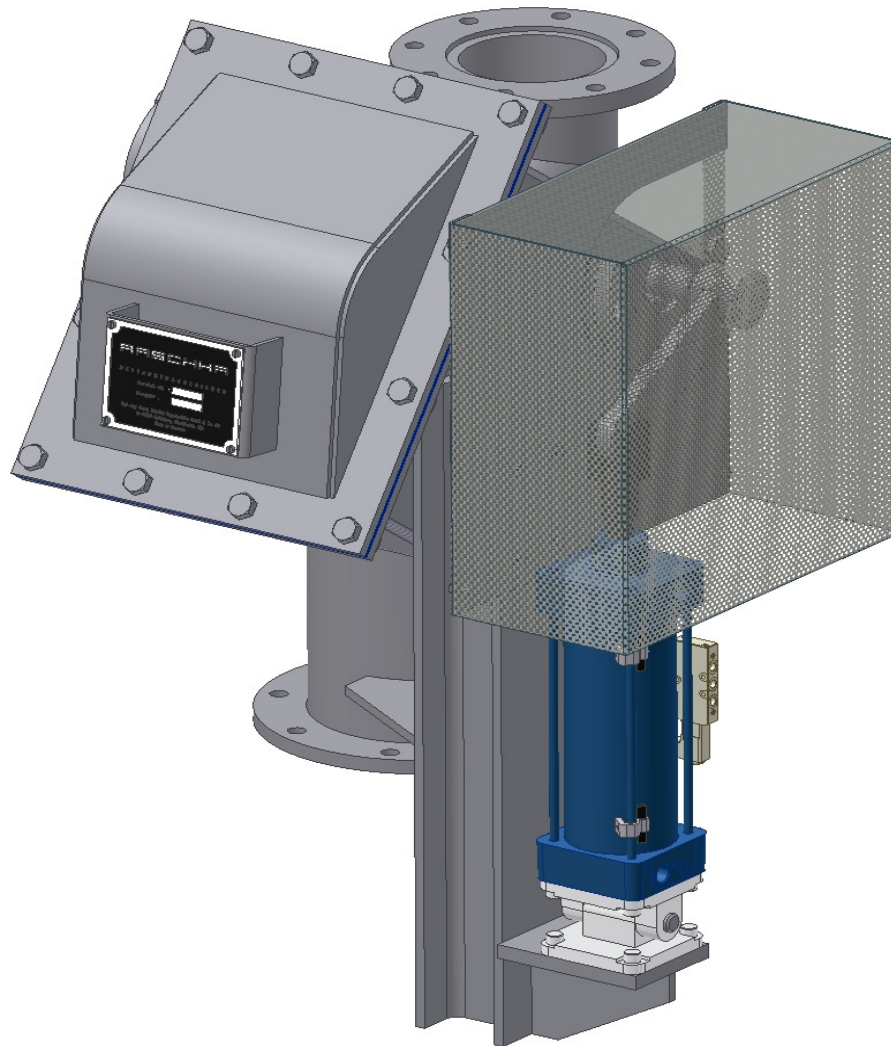


Characteristics of the RASCHKA-spreader

The RASCHKA-spreader serves for feeding, opening up and an even distribution of combustible in a fluidized bed incinerator.

The RASCHKA-spreader has been a proven, solid and reliable apparatus for more than 30 years and it has been developed further continuously. The spreader serves for excellent operation results. The characteristics of the actual design spreader are:

- Special shape spreader paddles: the combustible is opened up and fed evenly distributed into the furnace all across the entire cross section of the combustion zone and the fluidized bed, spreading paddles are equipped with adjustable and replaceable wearing plates
- Water-cooled spreader shaft with outer bearings, torque adjustable safety clutch for the shaft and the electric drive to be controlled by a frequency inverter, slip control of the safety clutch by inductive proximity switches
- Large maintenance door: comfortable maintenance and repair, easy removal of foreign matters, maintenance door can be mounted at the right or the left side of the spreader housing, safety control of the maintenance door
- Water-cooled protective plate: shut-off to the hot furnace, avoids one-side heating of the shaft and the paddles by the hot furnace, maintenance and repairs can be executed even if the furnace is hot
- Spreader housing: replaceable inner wearing plates
- Ventilation doors for cooling the housing on demand



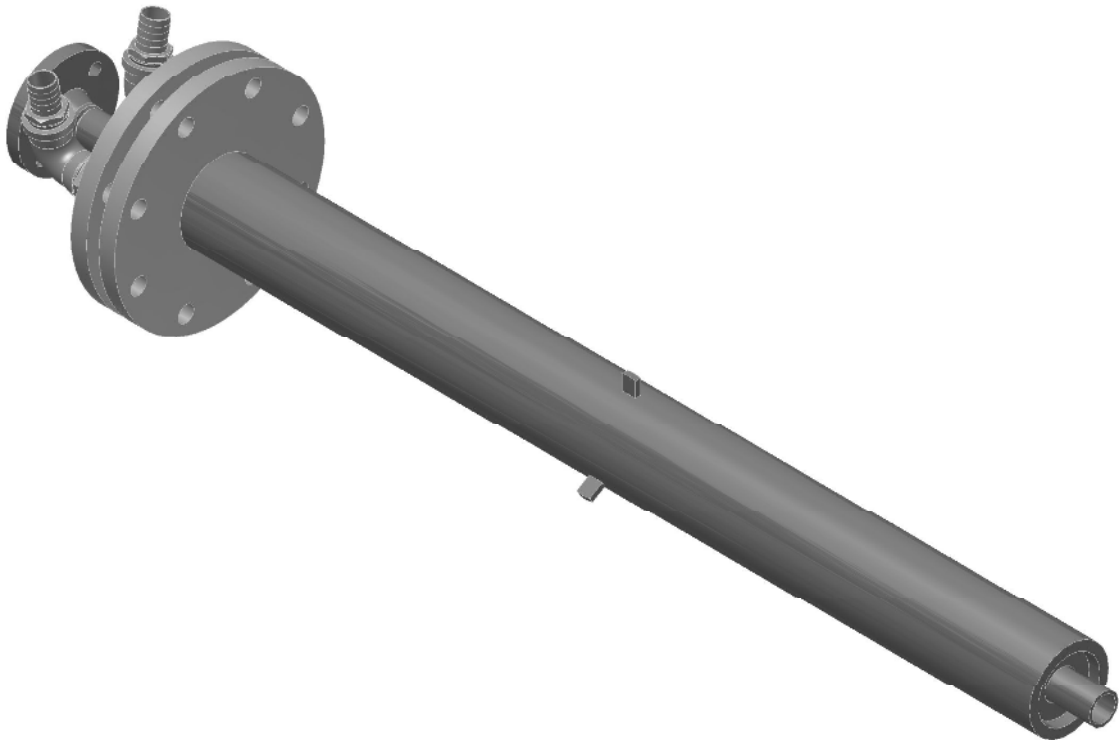
Characteristics of the RASCHKA-bed material discharge device

The RASCHKA-bed material discharge device (BMDD) serves as shutoff and discharge device to be mounted to the bed material outlet socket of a fluidized bed incinerator.

By means of the BMDD surplus bed material can be discharged discontinuously from the fluidized bed incinerator during operation. The quantity of bed material increases if more inert material is fed into the fluidized bed incinerator than inert material is leaving the incinerator together with the flue gas. (e.g. in case of a high sand content of the fuel).

The BMDD has been a proven, solid and reliable apparatus for more than 30 years and it has been developed further continuously. The BMDD serves for excellent operation results. The characteristics of the actual design BMDD are:

- Pneumatic lifting cylinder for actuating the shutoff and discharge element inside the BMDD housing
- Signals "OPEN" and "CLOSE" by inductive proximity switches
- Drive pulse by means of a 5/2 way solenoid valve to of the pneumatic lifting cylinder
- Shaft seals (stuffing boxes) at the BMDD casing
- Casing cover demountable for maintenance and repairs



Characteristics of the RASCHKA-injection lance

The RASCHKA-injection lance serves for the injection of additional fuel (fuel oil, gas) or water directly into the fluidized bed on demand. The injection of additional fuel supports heating up the incinerator, maintains the combustion process in case of a low heating value of the combustible and serves for achieving a minimum temperature of 850 °C in the furnace. In case of short term changes of the combustible heating value the immediate injection of additional fuel resp. water equilibrates the heat balance in the fluidized bed incinerator. Thus an even and smooth operation can be realized.

Depending on the size of the fluidized bed incinerator one or more lances are installed at the circumference of the incinerator casing.

The RASCHKA-injection lance has been a proven, solid and reliable apparatus for more than 30 years and it has been developed further continuously. The injection lance serves for excellent operation results. The characteristics of the actual design RASCHKA-injection lance are:

- High heat and abrasive wear resistant outer protective tube
- Scavenging air for inside cooling and for avoiding the penetration of bed material
- Replaceable inner medium tube

Depending on the requirements the RASCHKA-injection lances can be mounted together with a special mixing device, the RASCHKA-mixing vessel. The mixing vessel serves for the homogeneous mixing of the permanently blown purging and transportation air with the media to be injected (fuel oil, gas, water) via the lances into the incinerator.