PATENT CLAIMS

1. A powder drying system (1) comprising a powder drying component (200, 400, 500) and a CO gas detection system adapted for detection of CO gas from smoldering powders in said powder drying system component, such as a spray dryer chamber (200), a fluid bed (500) or a bag filter (400), characterized in that the CO gas detection system comprises:

at least one inlet CO gas detector arranged on at least one gas inlet (201) of said powder drying system component such as to provide at least one inlet CO gas content measurement,

at least one outlet CO gas detector (3) arranged on at least one gas outlet (202) of said powder drying system component such as to provide at least one outlet CO gas content measurement, and

an analyzing unit (5) adapted for receiving the at least one inlet CO gas content measurement from the at least one inlet CO gas detector, receiving the at least one outlet CO gas content measurement from the at least one outlet CO gas detector (3) and comparing the sum of the at least one inlet CO gas content measurement and the sum of the at least one outlet CO gas content measurement while compensating for dilution, mixing, and time delay of the outlet CO gas content measurement such as to provide a differential measurement, ΔC_{outlet}, indicative of the CO gas content from smoldering powders in a powder drying system component, wherein at least the at least one outlet CO gas detector (3) comprises an IR laser transmitter (7) and is adapted for detecting over a measurement volume and is arranged on the at least one gas outlet (202) in such a way that said measurement volume extends directly inside a gas flow in said at least one gas outlet (202).

2. A powder drying system according to claim 1, wherein the at least one inlet CO gas detector also comprises an IR laser transmitter and is adapted for detecting over a measurement volume and is provided on the at least one gas inlet in such a way that its measurement volume extends directly inside a gas flow in said gas inlet.

3. A powder drying system according to claim 1 or 2, wherein at least the at least one outlet CO gas detector and/or at least the at least one inlet CO gas detector comprises an IR laser transmitter and an IR receiver and optionally a reflector the IR laser transmitter and the IR receiver being arranged on positions being one of mutually offset in a radial and/or longitudinal direction, mutually opposite and diametrically opposite such that its measurement volume extends between said positions, and optionally wherein at least the at least one inlet CO gas detector and/or outlet CO gas detector comprises an IR laser transmitter and an IR receiver and at least one reflector, the IR laser transmitter and the IR receiver being arranged in the same position and the at least one reflector being arranged in a position being one of offset in a radial and/or longitudinal direction, mutually opposite and diametrically opposite with respect to the position of the IR laser transmitter and/or the IR receiver such that the measurement volume of the at least one inlet and/or outlet CO gas detector system extends between said positions.

4. A powder drying system according to any one of the above claims, wherein the measurement volume of the outlet CO gas detector and/or the measurement volume of the inlet CO gas detector extends over a length of at least 1 meter.

5. A powder drying system according to any one of the above claims, wherein the at least one outlet CO gas detector and/or the at least one inlet CO gas detector further comprises at least one purging device (9) arranged and adapted for purging the outlet CO gas detector prior to providing the outlet CO gas content measurement and/or the inlet CO gas detector prior to providing the inlet CO gas content measurement.

6. A powder drying system according to any one of the above claims, wherein the measurement volume of the outlet CO gas detector and/or the measurement volume of the inlet CO gas detector may extend along any one of:

- a radial direction of the gas inlet or gas outlet,
- a longitudinal direction of the gas inlet or gas outlet perpendicular to the radial direction, and
- a direction being inclined with respect to the longitudinal direction and/or the radial direction of the gas inlet or gas outlet.

7. A powder drying system according to any one of the above claims, and further comprising a plurality of outlet CO gas detectors arranged on the same gas outlet and/or on outlets of different components of said powder drying system such as to provide a plurality of outlet CO gas content measurements, and/or a plurality of inlet CO gas detectors arranged on the same gas inlet and/or on inlets of different components of said powder drying system such as to provide a plurality of inlet CO gas content measurements.

8. A powder drying system according to any one of the above claims, wherein the analyzing unit is adapted for comparing the inlet CO gas content measurement and the outlet CO gas content measurement to obtain a differential measurement, $\Delta C_{outlet}(x)$, indicative of the CO gas content from smoldering powders in a powder drying system at a given time x by means of the relation:

$$\Delta C_{outlet}(x) = C_{outlet,measured}(x) - C_{outlet}(x),$$

where:

$$C_{outlet}(x) = \frac{\left(\frac{C_{inlet}(x-t_p)*FLOW_{inlet}}{V_{spraydyer}}\right)*t_s + C_{outlet}(x-t_s)}{1+(\frac{FLOW_{outlet}*t_s}{V_{spraydryer}})},$$

and where:

$C_{outlet,\ measured}(x)$ is the concentration of CO gas in ppm in the gas outlet according to an outlet CO gas content measurement as measured by means of the outlet CO gas detector at the time x,

$C_{outlet}(x)$ is the calculated concentration of CO gas in ppm in the gas outlet at the time x,

$C_{outlet}(x\text{-}t_s)$ is the calculated concentration of CO gas in ppm in the gas outlet at the time x minus the sampling time t_s, i.e. the latest previously calculated value of the concentration of CO gas in ppm in the gas outlet,

$C_{inlet}(x\text{-}t_p)$ is the concentration of CO gas in ppm in the gas inlet according to an inlet CO gas content measurement as measured by means of the inlet CO gas detector a number of seconds t_p before the time x,

$V_{spraydryer}$ is the volume of the spray dryer in m^3,

$FLOW_{inlet}$ is the air flow in m^3/s in the main air inlet,

$FLOW_{outlet}$ is the total gas flow out of the spray dryer, calculated as the sum of the gas flow in each of the main gas outlet, the gas outlet of the static fluid bed and the gas outlet of the vibro-fluidizer in m^3/s, and

t_s is the sampling time.

9. A method of detecting CO gas from smoldering powder in a powder drying system component, such as for instance a spray dryer chamber, a fluid bed or a bag filter, of a powder drying system according to any one of claims 1-8, the method comprising the steps of:

providing an inlet CO gas content measurement by means of said inlet CO gas detector arranged on said gas inlet of a powder drying system component,

providing an outlet CO gas content measurement by means of said at least one outlet CO gas detector arranged on said gas outlet of said powder drying system component,

receiving the inlet CO gas content measurement from the inlet CO gas detector,

receiving the outlet CO gas content measurement from the at least one outlet CO gas detector,

comparing the inlet CO gas content measurement and the outlet CO gas content measurement to compensate for dilution, mixing, and time delay of the outlet CO gas content measurement such as to provide a differential measurement, ΔC_{outlet}, indicative of the CO gas content from smoldering powders in a powder drying system component, wherein

the at least one outlet CO gas detector comprises said IR laser transmitter and is adapted for detecting over a measurement volume and is, prior to providing the outlet CO gas content measurement, arranged on the gas outlet in such a way that its measurement volume extends directly inside a gas flow in the gas outlet.