

Claims

1. Method to prevent the fluidization of a catalytic fixed bed present in a tubular reactor of a furnace suitable for performing endothermic reactions, where the reactant gas flows upwardly,
5 characterized in that it comprises the steps of:
- a) estimating a pressure drop margin remaining before fluidization of the catalytic bed, with the pressure drop at fluidization of the catalytic bed being:
- $$DP_{critical} = M_{cat} \times g / S \quad \text{with}$$
- 10 M_{cat} being the mass of the catalyst in the catalytic bed,
 g being the gravitational constant,
 S being the gas-cross-sectional area through which the reactant gas flows in the catalytic bed,
comprising the steps of:
- i) calculating the pressure drop at fluidization of the catalyst bed,
15 ii) measuring the pressure drop DP_{bed} between the top and the bottom of the catalytic bed,
iii) determining a pressure drop margin before fluidization,
- b) adjusting the reactant gas flow in response to the pressure drop margin.
- 20 2. Method according to claim 1 where DP_{bed} is measured by means of a Differential Pressure Transmitter (DPT).
3. Method according to claim 1 where DP_{bed} is measured by means of two Pressure Transmitter (PT), one installed at the catalytic bed inlet and the other installed at the
25 catalytic bed outlet, and the pressure drop is calculated in the plant Distributed Control System (DCS)
4. Method according to any of the claims 1 to 3 where the pressure drop margin before fluidization is expressed as a consumed margin, preferably as the percentage $(DP_{bed} / DP_{critical}) \times 100$, the reactant gas flow being adjusted to keep the consumed margin below
30 90%, preferably below 80%.
5. Method according to any of the claims 1 to 3 where the pressure drop margin is expressed so as to give a remaining margin before fluidization, preferably as the
35 percentage $(1 - DP_{bed} / DP_{critical}) \times 100$, the reactant gas flow being adjusted to keep the reactant margin above 10%, preferably above 20%.

5 6. Method to operate safely a furnace suitable for performing endothermic reactions,
containing a plurality of catalytic fixed bed reactors operated in upward-flow configuration
characterized in that it comprises the prevention of the fluidization of the catalyst fixed bed
present in said reactors by applying the method of any of the claims 1 to 5 to at least one
of said reactors.

10

7. Method according to claim 6 characterized in that the furnace is a steam methane reformer
furnace.

15

8. Method to debottleneck safely a catalytic fixed bed present in a tubular reactor of a furnace
suitable for performing endothermic reactions, with the reactant gas flowing upwardly,
where the method includes increasing the reactant gas flow in the reactor characterized in
that the risk of fluidization of the catalyst bed present in the reactor is simultaneously
prevented by applying the method of any of the claims 1 to 5.

20