## CLAIMS

1. A reactor assembly arranged in fluid communication comprising a first reactor for the partial oxidation of a $C_3 – C_6$ aldehyde, the first reactor comprising as reactor components
    a) a first inlet;
    b) downstream the first inlet an inlet volume;
    c) downstream the inlet volume a first metal plate;
    d) downstream the first metal plate a further metal plate;
    e) downstream the further metal plate an outlet volume;
    f) downstream the outlet volume a first outlet;
    g) a plurality of tubes with a tube length, wherein each of the tubes
        (i) is located between the inlet volume and the outlet volume,
        (ii) comprises an inlet-end,
        (iii) comprises an outlet-end,
        (iv) comprises an outer surface,
        (v) comprises an inner surface,
        (vi) comprises an inner volume confined by the inner surface of the tube;

    and wherein at least 50 % of the tubes each
        [I] comprise a first longitudinal portion, wherein the first longitudinal portion is positioned in the first metal plate,
        [II] comprise an additional longitudinal portion, wherein the additional longitudinal portion
            (a) is arranged downstream the first longitudinal portion, and
            (b) comprises a first solid catalyst,
        [III] comprise a further longitudinal portion, wherein the further longitudinal portion
            A) is arranged downstream the additional longitudinal portion,
            B) is positioned in the further metal plate,

C) comprises an inert particulated solid material, wherein the particulated solid material

(I) is adapted and arranged to dissipate heat,

(II) is gas-permeably adapted and arranged;

h) a liquid cooling aid, wherein a portion of the outer surfaces of the tubes are arranged and adapted to be contacted with the liquid cooling aid, with the portion being at least 50 % of the length of the additional longitudinal portion;

and wherein,

an average thickness of any layer comprising the particulated solid material present in the outlet volume, the inlet volume, or both, is less than 10 % of the average length of the further longitudinal portions.

2. The reactor assembly according to claim 1, wherein at least one or all of the following applies:

a) the mass percentage of the particulated solid material present in the first longitudinal portion is less than 5 wt-%, based on the total mass of the particulated solid material contained in the tube;

b) the mass percentage of the first solid catalyst contained in the first longitudinal portion is less than 5 wt-%, based on the total mass of the first solid catalyst contained in the tube.

3. The reactor assembly according to any of the preceding claims, wherein at least 30 % of the length of the further longitudinal portions is embedded in the further metal plate.

4. The reactor assembly according to any of the preceding claims, wherein the further longitudinal portions are in thermal contact with the further metal plate.

5. The reactor assembly according to any of the preceding claims wherein the further metal plate is in thermal contact with the liquid cooling aid.

6. The reactor assembly according to any of the preceding claims, wherein at least one or all of the following applies:

a) the mass percentage of the first solid catalyst contained in the additional longitudinal portion is more than 50 wt-%, based on the total mass of the first solid catalyst contained in the tube;

b) the ratio of a mass of the solid first catalyst to a mass of the particulated solid material, both contained in the further longitudinal portion, is 1:*x*, where *x* is at least 10. Here *x* represents the mass of the particulated solid material.

7. The reactor assembly according to any of the preceding claims, wherein the particulated solid material comprises one or more components selected from the group consisting of metals and metal oxides.

8. The reactor assembly according to any of the preceding claims, wherein the particulated solid material has at least one or all of the following physical properties:

a) thermal conductivity in the range of 0.01 W/m/°C to 500 W/m/°C;

b) specific geometric surface area in the range of 20 $m^2/m^3$ to 2000 $m^2/m^3$;

c) free volume in the range of 24 % to 99 %; or

d) particle size distribution in the range of 0.01 mm to 100 mm.

9. The reactor assembly according to any of the preceding claims, wherein the first metal plate, the further metal plate, or both, have independently from each other a thickness in the range of 10 mm to 300 mm.

10. The reactor assembly according to any of the preceding claims, wherein the reactor assembly comprises a gas cooler connected to the first outlet.

11. A method for producing a product, wherein the method comprises the following process steps and that the method is conducted in a reactor corresponding to any of the claims 1 to 10:

a) providing a gaseous feed stream, wherein the feed stream comprises an $C_3 – C_6$ aldehyde;

b) partially oxidising the $C_3 – C_6$ aldehyde in the feed stream in the presence of a solid catalyst to obtain a first product stream comprising a partial oxidation product, wherein the partial oxidation is performed along an additional longitudinal portion, and

c) cooling the first product stream along a further longitudinal portion, wherein

(i) the further longitudinal portion comprises a particulated solid material,

(ii) the temperature of the product stream in the further longitudinal portion decreases at a rate $R_p$; and

wherein

$R_p$ is larger than a rate of temperature decrease $R_e$, wherein the rate $R_e$ is for a scenario where the further longitudinal portion does not comprise the particulated solid material.

12. The method according to claim 10, wherein $R_p$ is at least 2 times larger than $R_e$.

13. The method according to any of the claims 11 to 12, wherein the rate $R_p$ is in the range of 0.1 °C/cm to 5 °C/cm.

14. The method according to any of the claims 11 to 13, wherein the temperature of the first product stream that exits the further longitudinal portion is below the autoxidation temperature of the first product stream.

15. The method according to any of the claims 11 to 14, wherein the temperature of the first product stream that exits the further longitudinal portion is in the range of > 230 °C to 360 °C.

16. The method according to claim 15, wherein the first product stream ~~that exits the first outlet~~ is fed into a gas cooler and wherein the temperature of the product stream that exits the gas cooler is in the range of 160 °C to 280 °C.

17. The method according to any of the claims 11 to 16, wherein the product is methacrylic acid or methyl methacrylate.