Claims:

1. A pipe for thermal cracking of hydrocarbons in the presence of steam, in which ~~the~~ a feed mixture is guided through externally heated pipes, wherein

- the pipe (1) extends along a longitudinal axis (A) and has a number N_T of grooves (2) that have been introduced into the inner surface of the pipe (1) and extend in a helix around the longitudinal axis (A) along the inner surface,
- the inner surface into which the grooves (2) have been introduced, in a cross section at right angles to the longitudinal axis (A), has a diameter Di and a radius $r_1 = Di/2$,
- the grooves (2) in the cross section at right angles to the longitudinal axis (A), in their groove base (4), each have the form of a circular arc and the circular arc has a radius r_2,

the grooves (2) each have a groove depth TT which, in the cross section at right angles to the longitudinal axis (A), corresponds in each case to the smallest distance between the circle having the diameter Di on which the inner surface lies and the center of which lies on the longitudinal axis (A), and the furthest removed point of the groove base (4) of the groove (2) from the longitudinal axis (A), **wherein** the numerical value $|D_{eqv}|$ of an equivalent diameter D_{eqv} and the number N_T of grooves (2) and the numerical value |TT| of the groove depth TT of the grooves (2) measured in mm satisfy the relationship

$$P1 * |D_{eqv}|^2 + P2 * |D_{eqv}| + P3 = C1 + C2 * |TT| + C3 * VD + C4 * |D_{eqv}| + (|TT| - C5) * (VD - C6) * C7 + (|TT| - C5) * (|D_{eqv}| - C8) * C9$$

with the constants

C1 = 1946.066
C2 = 302.378
C3 = -2.178
C4 = 266.002
C5 = 1.954
C6 = 50.495
C7 = -2.004
C8 = 79.732
C9 = -1.041

-0.2 ≥ P1 ≥ -0.3
310 ≤ P2 ≤ 315
200 ≤ P3 ≤ 1500,

where the groove density VD that describes the ratio of the grooves N_T in the pipe in relation to the reference number N_{ref} of the maximum number of grooves having a groove depth TT = 1.3 mm that can be introduced in the inner surface area of a pipe having the same equivalent diameter D_{eqv}, in percent is found from the following relationship:

$$VD = N_T / N_{ref} * 100$$

and the reference number N_{ref} is the greatest natural number that satisfies the relationship

$$N_{ref} \leq \frac{\pi}{arcsin\left(\frac{\left|\sqrt{2 \cdot |r_{eqv}| \cdot \frac{2 \cdot |r_2| \cdot 1.3 - 1.3^2}{2 \cdot (|r_{eqv}| - |r_2| + 1.3)} - \left(\frac{2 \cdot |r_2| \cdot 1.3 - 1.3^2}{2 \cdot (|r_{eqv}| - |r_2| + 1.3)}\right)^2}\right|}{|r_{eqv}|}\right)}$$

where

$$|r_{eqv}| = \left|\sqrt{\frac{|A_{eqv}|}{\pi}}\right|$$

$$A_{eqv} = A_1 + N_T \cdot A_T$$

$$A_1 = \pi \cdot |r_1|^2$$

$$A_T = \left[|r_2| \cdot \frac{b_2}{2} - \frac{s \cdot (|r_2| - (|TT| + h))}{2}\right] - \left[|r_1| \cdot \frac{b_1}{2} - \frac{s \cdot (|r_1| - h)}{2}\right]$$

$$b_1 = 2 \cdot |r_1| \cdot arcsin\left(\frac{\left|\sqrt{2 \cdot |r_1| \cdot \frac{2 \cdot |r_2| \cdot |TT| - |TT|^2}{2 \cdot (|r_1| - |r_2| + |TT|)} - \left(\frac{2 \cdot |r_2| \cdot |TT| - |TT|^2}{2 \cdot (|r_1| - |r_2| + |TT|)}\right)^2}\right|}{|r_1|}\right)$$

$$b_2 = 2 \cdot |r_2| \cdot arcsin\left(\frac{\left|\sqrt{2 \cdot |r_1| \cdot \frac{2 \cdot |r_2| \cdot |TT| - |TT|^2}{2 \cdot (|r_1| - |r_2| + |TT|)} - \left(\frac{2 \cdot |r_2| \cdot |TT| - |TT|^2}{2 \cdot (|r_1| - |r_2| + |TT|)}\right)^2}\right|}{|r_2|}\right)$$

$$s = 2 \cdot \left|\sqrt{2 \cdot |r_1| \cdot \frac{2 \cdot |r_2| \cdot |TT| - |TT|^2}{2 \cdot (|r_1| - |r_2| + |TT|)} - \left(\frac{2 \cdot |r_2| \cdot |TT| - |TT|^2}{2 \cdot (|r_1| - |r_2| + |TT|)}\right)^2}\right|$$

$$h = \frac{2 \cdot |r_2| \cdot |TT| - |TT|^2}{2 \cdot (|r_1| - |r_2| + |TT|)}$$

and for which there is an r_{Nref} which, with reference to the value of A_{eqv} ascertained by the above relationship, satisfies the following conditions that A_{eqv} is likewise

$$
\begin{aligned}
&A_{eqv} \\
&= \pi \cdot \left|r_{N_{ref}}\right|^2 + N_{ref} \\
&\cdot \left[\left[\left[|r_2|^2 \right. \right. \right. \\
&\cdot arcsin\left(\frac{\left| \sqrt{2 \cdot \left|r_{N_{ref}}\right| \cdot \frac{2 \cdot |r_2| \cdot 1.3 - 1.3^2}{2 \cdot \left(\left|r_{N_{ref}}\right| - |r_2| + 1.3\right)} - \left(\frac{2 \cdot |r_2| \cdot 1.3 - 1.3^2}{2 \cdot \left(\left|r_{N_{ref}}\right| - |r_2| + 1.3\right)} \right)^2 } \right|}{|r_2|} \right) \\
&- \left| \sqrt{2 \cdot \left|r_{N_{ref}}\right| \cdot \frac{2 \cdot |r_2| \cdot 1.3 - 1.3^2}{2 \cdot \left(\left|r_{N_{ref}}\right| - |r_2| + 1.3\right)} - \left(\frac{2 \cdot |r_2| \cdot 1.3 - 1.3^2}{2 \cdot \left(\left|r_{N_{ref}}\right| - |r_2| + 1.3\right)} \right)^2 } \right| \\
&\left. \left. \left. \cdot \left(|r_2| - \left(1.3 + \frac{2 \cdot |r_2| \cdot 1.3 - 1.3^2}{2 \cdot \left(\left|r_{N_{ref}}\right| - |r_2| + 1.3\right)} \right) \right) \right) \right] \\
&- \left[\left[\left[\left|r_{N_{ref}}\right|^2 \right. \right. \right. \\
&\cdot arcsin\left(\frac{\left| \sqrt{2 \cdot \left|r_{N_{ref}}\right| \cdot \frac{2 \cdot |r_2| \cdot 1.3 - 1.3^2}{2 \cdot \left(\left|r_{N_{ref}}\right| - |r_2| + 1.3\right)} - \left(\frac{2 \cdot |r_2| \cdot 1.3 - 1.3^2}{2 \cdot \left(\left|r_{N_{ref}}\right| - |r_2| + 1.3\right)} \right)^2 } \right|}{|r_1|} \right)
\end{aligned}
$$

$$-\left|\sqrt{2\cdot\left|r_{N_{ref}}\right|\cdot\frac{2\cdot|r_2|\cdot 1.3-1.3^2}{2\cdot\left(\left|r_{N_{ref}}\right|-|r_2|+1.3\right)}-\left(\frac{2\cdot|r_2|\cdot 1.3-1.3^2}{2\cdot\left(\left|r_{N_{ref}}\right|-|r_2|+1.3\right)}\right)^2}\right|$$

$$\cdot\left(\left|r_{N_{ref}}\right|-\frac{2\cdot|r_2|\cdot 1.3-1.3^2}{2\cdot\left(\left|r_{N_{ref}}\right|-|r_2|+1.3\right)}\right)\Bigg|\Bigg|$$

without infringing the boundary conditions

$$\pi \geq N_{ref}\cdot arcsin\left(\frac{\left|\sqrt{2\cdot\left|r_{N_{ref}}\right|\cdot\frac{2\cdot|r_2|\cdot 1.3-1.3^2}{2\cdot\left(\left|r_{N_{ref}}\right|-|r_2|+1.3\right)}-\left(\frac{2\cdot|r_2|\cdot 1.3-1.3^2}{2\cdot\left(\left|r_{N_{ref}}\right|-|r_2|+1.3\right)}\right)^2}\right|}{\left|r_{N_{ref}}\right|}\right),\ r_{N_{ref}}<r_{eqv}$$

and where the equivalent diameter D_{eqv} is found from the relationship $D_{eqv} = 2\ r_{eqv}$.

2. A pipe for thermal cracking of hydrocarbons in the presence of steam, in which ~~the~~ a feed mixture is guided through externally heated pipes, wherein

- the pipe (1) extends along a longitudinal axis (A) and has a number N_T of grooves (2) that have been introduced into the inner surface of the pipe (1) and extend in a helix around the longitudinal axis (A) along the inner surface,
- the inner surface into which the grooves (2) have been introduced, in a cross section at right angles to the longitudinal axis (A), has a diameter Di and a radius $r_1 = Di/2$,
- the grooves (2) in the cross section at right angles to the longitudinal axis (A), in their groove base (4), each have the form of a circular arc and the circular arc has a radius r_2,

the grooves (2) each have a groove depth TT which, in the cross section at right angles to the longitudinal axis (A), corresponds in each case to the smallest distance between the circle having the diameter Di on which the inner surface lies and the center of which lies on the longitudinal axis (A), and the furthest removed point of the groove base (4) of the groove (2) from the longitudinal axis (A), **wherein**

the numerical value $|D_{eqv}|$ of an equivalent diameter D_{eqv} and the number N_T of grooves (2) and the numerical value |TT| of the groove depth TT of the grooves (2) measured in mm satisfy the relationship

$$P1 * |D_{eqv}|^2 + P2 * |D_{eqv}| + P3 = C1 + C2 * |TT| + C3 * VD + C4 * |D_{eqv}| + (|TT| – C5) * (VD – C6) * C7 + (|TT| – C5) * (|D_{eqv}| – C8) * C9 + (VD – C6) * (|D_{eqv}| – C8) * C10 + (|D_{eqv}| – C8) * (|D_{eqv}| – C8) * C11$$

with the constants

C1 = 1946.066
C2 = 302.378
C3 = -2.178
C4 = 266.002
C5 = 1.954
C6 = 50.495
C7 = -2.004
C8 = 79.732
C9 = -1.041
C10 = 0.04631
C11 = -0.26550
$-0.2 \geq P1 \geq -0.3$
$310 \leq P2 \leq 315$
$200 \leq P3 \leq 1500$,

where the groove density VD that describes the ratio of the grooves N_T in the pipe in relation to the reference number N_{ref} of the maximum number of grooves having a groove depth TT = 1.3 mm that can be introduced in the inner surface area of a pipe having the same equivalent diameter D_{eqv} in percent is found from the following relationship:

$$VD = N_T / N_{ref} * 100$$

and the reference number N_{ref} is the greatest natural number that satisfies the relationship

$$N_{ref} \leq \frac{\pi}{arcsin\left(\frac{\left|\sqrt{2 \cdot |r_{eqv}| \cdot \frac{2 \cdot |r_2| \cdot 1.3 - 1.3^2}{2 \cdot (|r_{eqv}| - |r_2| + 1.3)} - \left(\frac{2 \cdot |r_2| \cdot 1.3 - 1.3^2}{2 \cdot (|r_{eqv}| - |r_2| + 1.3)}\right)^2}\right|}{|r_{eqv}|}\right)}$$

where

$$|r_{eqv}| = \left|\sqrt{\frac{|A_{eqv}|}{\pi}}\right|$$

$$A_{eqv} = A_1 + N_T \cdot A_T$$

$$A_1 = \pi \cdot |r_1|^2$$

$$A_T = \left[|r_2| \cdot \frac{b_2}{2} - \frac{s \cdot (|r_2| - (|TT| + h))}{2}\right] - \left[|r_1| \cdot \frac{b_1}{2} - \frac{s \cdot (|r_1| - h)}{2}\right]$$

$$b_1 = 2 \cdot |r_1| \cdot arcsin\left(\frac{\left|\sqrt{2 \cdot |r_1| \cdot \frac{2 \cdot |r_2| \cdot |TT| - |TT|^2}{2 \cdot (|r_1| - |r_2| + |TT|)} - \left(\frac{2 \cdot |r_2| \cdot |TT| - |TT|^2}{2 \cdot (|r_1| - |r_2| + |TT|)}\right)^2}\right|}{|r_1|}\right)$$

$$b_2 = 2 \cdot |r_2| \cdot arcsin\left(\frac{\left|\sqrt{2 \cdot |r_1| \cdot \frac{2 \cdot |r_2| \cdot |TT| - |TT|^2}{2 \cdot (|r_1| - |r_2| + |TT|)} - \left(\frac{2 \cdot |r_2| \cdot |TT| - |TT|^2}{2 \cdot (|r_1| - |r_2| + |TT|)}\right)^2}\right|}{|r_2|}\right)$$

$$s = 2 \cdot \left|\sqrt{2 \cdot |r_1| \cdot \frac{2 \cdot |r_2| \cdot |TT| - |TT|^2}{2 \cdot (|r_1| - |r_2| + |TT|)} - \left(\frac{2 \cdot |r_2| \cdot |TT| - |TT|^2}{2 \cdot (|r_1| - |r_2| + |TT|)}\right)^2}\right|$$

$$h = \frac{2 \cdot |r_2| \cdot |TT| - |TT|^2}{2 \cdot (|r_1| - |r_2| + |TT|)}$$

and for which there is an r_{Nref} which, with reference to the value of A_{eqv} ascertained by the above relationship, satisfies the following conditions that A_{eqv} is likewise

$$
\begin{aligned}
&A_{eqv} \\
&= \pi \cdot \left|r_{N_{ref}}\right|^2 + N_{ref} \\
&\cdot \left[\left[\left[|r_2|^2 \right. \right. \right. \\
&\cdot arcsin\left(\frac{\left| \sqrt{2 \cdot \left|r_{N_{ref}}\right| \cdot \frac{2 \cdot |r_2| \cdot 1.3 - 1.3^2}{2 \cdot \left(\left|r_{N_{ref}}\right| - |r_2| + 1.3\right)} - \left(\frac{2 \cdot |r_2| \cdot 1.3 - 1.3^2}{2 \cdot \left(\left|r_{N_{ref}}\right| - |r_2| + 1.3\right)} \right)^2 } \right|}{|r_2|} \right) \\
&- \left| \sqrt{2 \cdot \left|r_{N_{ref}}\right| \cdot \frac{2 \cdot |r_2| \cdot 1.3 - 1.3^2}{2 \cdot \left(\left|r_{N_{ref}}\right| - |r_2| + 1.3\right)} - \left(\frac{2 \cdot |r_2| \cdot 1.3 - 1.3^2}{2 \cdot \left(\left|r_{N_{ref}}\right| - |r_2| + 1.3\right)} \right)^2 } \right| \\
&\left. \left. \left. \cdot \left(|r_2| - \left(1.3 + \frac{2 \cdot |r_2| \cdot 1.3 - 1.3^2}{2 \cdot \left(\left|r_{N_{ref}}\right| - |r_2| + 1.3\right)} \right) \right) \right) \right] \\
&- \left[\left[\left[\left|r_{N_{ref}}\right|^2 \right. \right. \right. \\
&\cdot arcsin\left(\frac{\left| \sqrt{2 \cdot \left|r_{N_{ref}}\right| \cdot \frac{2 \cdot |r_2| \cdot 1.3 - 1.3^2}{2 \cdot \left(\left|r_{N_{ref}}\right| - |r_2| + 1.3\right)} - \left(\frac{2 \cdot |r_2| \cdot 1.3 - 1.3^2}{2 \cdot \left(\left|r_{N_{ref}}\right| - |r_2| + 1.3\right)} \right)^2 } \right|}{|r_1|} \right)
\end{aligned}
$$

$$-\left|\sqrt{2\cdot\left|r_{N_{ref}}\right|\cdot\frac{2\cdot|r_2|\cdot 1.3-1.3^2}{2\cdot\left(\left|r_{N_{ref}}\right|-|r_2|+1.3\right)}-\left(\frac{2\cdot|r_2|\cdot 1.3-1.3^2}{2\cdot\left(\left|r_{N_{ref}}\right|-|r_2|+1.3\right)}\right)^2}\right|$$

$$\cdot\left(\left|r_{N_{ref}}\right|-\frac{2\cdot|r_2|\cdot 1.3-1.3^2}{2\cdot\left(\left|r_{N_{ref}}\right|-|r_2|+1.3\right)}\right)\Bigg|\Bigg|$$

without infringing the boundary conditions

$$\pi \geq N_{ref}\cdot arcsin\left(\frac{\left|\sqrt{2\cdot\left|r_{N_{ref}}\right|\cdot\frac{2\cdot|r_2|\cdot 1.3-1.3^2}{2\cdot\left(\left|r_{N_{ref}}\right|-|r_2|+1.3\right)}-\left(\frac{2\cdot|r_2|\cdot 1.3-1.3^2}{2\cdot\left(\left|r_{N_{ref}}\right|-|r_2|+1.3\right)}\right)^2}\right|}{\left|r_{N_{ref}}\right|}\right),\ r_{N_{ref}}<r_{eqv}$$

and where the equivalent diameter D_{eqv} is found from the relationship $D_{eqv} = 2\ r_{eqv}$.

3. The pipe as claimed in ~~either of~~ claim~~s~~ 1 ~~or 2~~, **wherein** the inner surface of the pipe is cylindrical and the grooves are introduced into this cylindrical inner surface in such a way that portions of the inner surface that form a cylinder remain between the grooves.

4. The pipe as claimed in ~~any of~~ claim~~s~~ 1 ~~to 3~~, **wherein**, in a cross section at right angles to the longitudinal axis, the circular arc segment in the inner surface circle occupied by a portion of the inner surface arranged between two grooves is greater than 1% of the circular arc segment in the inner surface circle occupied by the groove opening of at least one of the grooves adjoining this portion of the inner surface area.

5. The pipe as claimed in ~~any of~~ claim~~s~~ 1 ~~to 4~~, **wherein** the diameter Di of the inner surface into which the grooves (2) have been introduced is within a range from 15 mm to 280 mm.

6. The pipe as claimed in ~~any of~~ claim~~s~~ 1 ~~to 5~~, **wherein** the groove depth TT is within a range from 0.1 mm to 10 mm.

7. The pipe as claimed in ~~any of~~ claim~~s~~ 1 ~~to 6~~, **wherein** the number N_T of grooves (2) results in a groove density within a range from 1% to 347%.

8. The pipe as claimed in ~~any of~~ claim~~s~~ 1~~ to 7~~, **wherein** the grooves (2) run at an angle of 20° to 40°, preferably of 22.5° to 32.5°, based on the longitudinal axis (A).

9. The pipe as claimed in ~~any of~~ claim~~s~~ 1~~ to 8~~, **wherein** the pipe is a centrifugally cast pipe or has been produced from a centrifugally cast pipe by introducing grooves into a centrifugally cast pipe.

10. The pipe as claimed in ~~any of~~ claim~~s~~ 1~~ to 9~~, **wherein** the pipe includes a nickel-chromium-iron alloy having high oxidation and carburization resistance, rupture resistance and creep resistance, composed of

0.05% to 0.6% carbon
20% to 50% chromium
5% to 40% iron
2% to 6% aluminum
up to 2% silicon
up to 2% manganese
up to 1.5% niobium
up to 1.5% tantalum
up to 6.0% tungsten
up to 1.0% titanium
up to 1.0% zirconium
up to 0.5% yttrium
up to 0.5% cerium
up to 0.5% molybdenum
up to 0.1% nitrogen
balance: nickel including melting-related impurities, and especially consists of such an alloy.

11. An apparatus for thermal cracking of hydrocarbons in the presence of steam, in which ~~the~~ a feed mixture is guided through externally heated pipes, ~~**characterized by** a pipe as claimed in any of claims 1 to 10.~~wherein for at least one of said pipes, the pipe (**1**) extends along a longitudinal axis (A) and has a number N_T of grooves (**2**) that have been introduced into the inner surface of the pipe (**1**) and extend in a helix around the longitudinal axis (A) along the inner surface,
the inner surface into which the grooves (**2**) have been introduced, in a cross section at right angles to the longitudinal axis (A), has a diameter Di and a radius r_1=Di/2,
the grooves (**2**) in the cross section at right angles to the longitudinal axis (A), in their groove base (**4**), each have the form of a circular arc and the circular arc has a radius r_2,
the grooves (**2**) each have a groove depth TT which, in the cross section at right angles to the longitudinal axis (A), corresponds in each case to the smallest distance between the

circle having the diameter Di on which the inner surface lies and the center of which lies on the longitudinal axis (A), and the furthest removed point of the groove base (**4**) of the groove (**2**) from the longitudinal axis (A), wherein the numerical value $|D_{eqv}|$ of an equivalent D_{eqv} and the number N_T of grooves (**2**) and the numerical value |TT| of the groove depth TT of the grooves (**2**) measured in mm satisfy the relationship

$$P1*|D_{eqv}|^2 + P2*|D_{eqv}| + P3 = C1 + C2*|TT| + C3*VD + C4*|D_{eqv}| + (|TT| - C5)*(VD - C6)*C7 + (|TT| - C5)*(|D_{eqv}| - C8)*C9$$

with the constants

C1=1946.066
C2=302.378
C3=−2.178
C4=266.002
C5=1.954
C6=50.495
C7=−2.004
C8=79.732
C9=−1.041
−0.2≥P1≥−0.3
310≤P2≤315
200≤P3≤1500,

where the groove density VD that describes the ratio of the grooves N_T in the pipe in relation to the reference number N_{ref} of the maximum number of grooves having a groove depth TT=1.3 mm that can be introduced in the inner surface area of a pipe having the same equivalent diameter D_{eqv} in percent is found from the following relationship:

$$VD = N_T / N_{ref} * 100$$

and the reference number N_{ref} is the greatest natural number that satisfies the relationship

$$N_{ref} \leq \frac{\pi}{\arcsin\left(\frac{\left|\sqrt{2\cdot|r_{eqv}|\cdot\frac{2\cdot|r_2|\cdot\frac{1.3-1.3^2}{(|r_{eqv}|-|r_2|+1.3)}}{2\cdot}-\left(\frac{2\cdot|r_2|\cdot\frac{1.3-1.3^2}{(|r_{eqv}|-|r_2|+1.3)}}{2\cdot}\right)^2}\right|}{|r_{eqv}|}\right)}$$ where

$$|r_{eqv}| = \left|\sqrt{\frac{|A_{eqv}|}{\pi}}\right|$$

$$A_{eqv} = A_1 + N_T \cdot A_T$$

$$A_1 = \pi \cdot |r_1|^2$$

$$A_T = \left[|r_2|\cdot\frac{b_2}{2} - \frac{s\cdot(|r_2|-(|TT|+h))}{2}\right] - \left[|r_1|\cdot\frac{b_1}{2} - \frac{s\cdot(|r_1|-h)}{2}\right]$$

$$b_1 = 2\cdot|r_1|\cdot\arcsin\left(\frac{\left|\sqrt{2\cdot|r_1|\cdot\frac{2\cdot|r_2|\cdot|TT|-|TT|^2}{2\cdot(|r_1|-|r_2|+|TT|)}-\left(\frac{2\cdot|r_2|\cdot|TT|-|TT|^2}{2\cdot(|r_1|-|r_2|+|TT|)}\right)^2}\right|}{|r_1|}\right)$$

$$b_2 = 2\cdot|r_2|\cdot\arcsin\left(\frac{\left|\sqrt{2\cdot|r_1|\cdot\frac{2\cdot|r_2|\cdot|TT|-|TT|^2}{2\cdot(|r_1|-|r_2|+|TT|)}-\left(\frac{2\cdot|r_2|\cdot|TT|-|TT|^2}{2\cdot(|r_1|-|r_2|+|TT|)}\right)^2}\right|}{|r_2|}\right)$$

$$s = 2\cdot\left|\sqrt{2\cdot|r_1|\cdot\frac{2\cdot|r_2|\cdot|TT|-|TT|^2}{2\cdot(|r_1|-|r_2|+|TT|)}-\left(\frac{2\cdot|r_2|\cdot|TT|-|TT|^2}{2\cdot(|r_1|-|r_2|+|TT|)}\right)^2}\right|$$

$$h = \frac{2\cdot|r_2|\cdot|TT|-|TT|^2}{2\cdot(|r_1|-|r_2|+|TT|)}$$

and for which there is an r_{Nref} which with reference to the value of A_{eqv} ascertained by the above relationship, satisfies the following conditions that A_{eqv} is likewise

$$A_{eqv} = \pi\cdot|r_{N_{ref}}|^2 + N_{ref}\cdot\left[\left[|r_2|^2\cdot\arcsin\left(\frac{\left|\sqrt{2\cdot|r_{N_{ref}}|\cdot\frac{2\cdot|r_2|\cdot\frac{1.3-1.3^2}{(|r_{N_{ref}}|-|r_2|+1.3)}}{2\cdot}-\left(\frac{2\cdot|r_2|\cdot\frac{1.3-1.3^2}{(|r_{N_{ref}}|-|r_2|+1.3)}}{2\cdot}\right)^2}\right|}{|r_2|}\right) - \left|\sqrt{2\cdot|r_{N_{ref}}|\cdot\frac{2\cdot|r_2|\cdot\frac{1.3-1.3^2}{(|r_{N_{ref}}|-|r_2|+1.3)}}{2\cdot}-\left(\frac{2\cdot|r_2|\cdot\frac{1.3-1.3^2}{(|r_{N_{ref}}|-|r_2|+1.3)}}{2\cdot}\right)^2}\right|\cdot\left(|r_2|-\left(1.3+\frac{2\cdot|r_2|\cdot1.3-1.3^2}{2\cdot(|r_{N_{ref}}|-|r_2|+1.3)}\right)\right)\right] - \left[|r_{N_{ref}}|^2\cdot\right.$$

$$\arcsin\left(\frac{\left|\sqrt{2\cdot|r_{N_{ref}}|\cdot\frac{2\cdot|r_2|\cdot 1.3-1.3^2}{2\cdot(|r_{N_{ref}}|-|r_2|+1.3)}-\left(\frac{2\cdot|r_2|\cdot 1.3-1.3^2}{2\cdot(|r_{N_{ref}}|-|r_2|+1.3)}\right)^2}\right|}{|r_1|}\right)-$$

$$\left|\sqrt{2\cdot|r_{N_{ref}}|\cdot\frac{2\cdot|r_2|\cdot 1.3-1.3^2}{2\cdot\left(=(|r_{N_{ref}}|-|r_2|+1.3)\right.}-\left(\frac{2\cdot|r_2|\cdot 1.3-1.3^2}{2\cdot(|r_{N_{ref}}|-|r_2|+1.3)}\right)^2}\right|$$

$$\left(\left|r_{N_{ref}}\right|-\frac{2\cdot|r_2|\cdot 1.3-1.3^2}{2\cdot\left(\left|r_{N_{ref}}\right|-|r_2|+1.3\right)}\right)$$

without infringing the boundary conditions

$$\pi \geq N_{ref}\cdot\arcsin\left(\frac{\left|\sqrt{2\cdot|r_{N_{ref}}|\frac{2\cdot|r_2|\cdot 1.3-1.3^2}{2\cdot(|r_{N_{ref}}|-|r_2|+1.3)}-\left(\frac{2\cdot|r_2|\cdot 1.3-1.3^2}{2\cdot(|r_{N_{ref}}|-|r_2|+1.3)}\right)^2}\right|}{|r_{N_{ref}}|}\right),$$

$$r_{N_{ref}} < r_{eqv}$$

and where the equivalent diameter D_{eqv} is found from the relationship $D_{eqv}=2\ r_{eqv}$.

12. ~~The use of a pipe as claimed in any of claims 1 to 10 for thermal cracking of hydrocarbons in the presence of steam, in which the feed mixture is guided through externally heated pipes.~~ A method comprising:
thermal cracking of hydrocarbons in the presence of steam by guiding a feed mixture through externally heated pipes configured such that for each said pipe,
the pipe (**1**) extends along a longitudinal axis (A) and has a number N_T of grooves (**2**) that have been introduced into the inner surface of the pipe (**1**) and extend in a helix around the longitudinal axis (A) along the inner surface,
the inner surface into which the grooves (**2**) have been introduced, in a cross section at right angles to the longitudinal axis (A), has a diameter Di and a radius r_1=Di/2,
the grooves (**2**) in the cross section at right angles to the longitudinal axis (A), in their groove base (**4**), each have the form of a circular arc and the circular arc has a radius r_2,
the grooves (**2**) each have a groove depth TT which, in the cross section at right angles to the longitudinal axis (A), corresponds in each case to the smallest distance between the circle having the diameter Di on which the inner surface lies and the center of which lies on the longitudinal axis (A), and the furthest removed point of the groove base (**4**) of the groove (**2**) from the longitudinal axis (A), wherein the numerical value $|D_{eqv}|$ of an equivalent

diameter $|D_{eqv}|$ and the number N_T of grooves (**2**) and the numerical value |TT| of the groove depth TT of the grooves (**2**) measured in mm satisfy the relationship

$P1*|D_{eqv}|^2 + P2*|D_{eqv}| + P3 = C1 + C2*|TT| + C3*VD + C4*|D_{eqv}| + (|TT| - C5)*(VD - C6)*C7 + (|TT| - C5)*(|D_{eqv}| - C8)*C9$

with the constants

C1=1946.066
C2=302.378
C3=−2.178
C4=266.002
C5=1.954
C6=50.495
C7=−2.004
C8=79.732
C9=−1.041

−0.2≥P1≥−0.3
310≤P2≤315
200≤P3≤1500,

where the groove density VD that describes the ratio of the grooves N_T in the pipe in relation to the reference number N_{ref} of the maximum number of grooves having a groove depth TT=1.3 mm that can be introduced in the inner surface area of a pipe having the same equivalent diameter D_{eqv} in percent is found from the following relationship:

$$VD = N_T / N_{ref} * 100$$

and the reference number N_{ref} is the greatest natural number that satisfies the relationship

$$N_{ref} \leq \frac{\pi}{\arcsin\left(\frac{\left|\sqrt{2 \cdot |r_{eqv}| \cdot \frac{2 \cdot |r_2| \cdot 1.3 - 1.3^2}{2 \cdot (|r_{eqv}| - |r_2| + 1.3)} - \left(\frac{2 \cdot |r_2| \cdot 1.3 - 1.3^2}{2 \cdot (|r_{eqv}| - |r_2| + 1.3)}\right)^2}\right|}{|r_{eqv}|}\right)} \quad \text{where}$$

$$|r_{eqv}| = \left| \sqrt{\frac{|A_{eqv}|}{\pi}} \right|$$

$$A_{eqv} = A_1 + N_T \cdot A_T$$

$$A_1 = \pi \cdot |r_1|^2$$

$$A_T = \left[|r_2| \cdot \frac{b_2}{2} - \frac{s \cdot (|r_2| - (|TT| + h))}{2} \right] - \left[|r_1| \cdot \frac{b_1}{2} - \frac{s \cdot (|r_1| - h)}{2} \right]$$

$$b_1 = 2 \cdot |r_1| \cdot \arcsin\left(\frac{\left| \sqrt{2 \cdot |r_1| \cdot \frac{2 \cdot |r_2| \cdot |TT| - |TT|^2}{2 \cdot (|r_1| - |r_2| + |TT|)} - \left(\frac{2 \cdot |r_2| \cdot |TT| - |TT|^2}{2 \cdot (|r_1| - |r_2| + |TT|)} \right)^2 } \right|}{|r_1|} \right)$$

$$b_2 = 2 \cdot |r_2| \cdot \arcsin\left(\frac{\left| \sqrt{2 \cdot |r_1| \cdot \frac{2 \cdot |r_2| \cdot |TT| - |TT|^2}{2 \cdot (|r_1| - |r_2| + |TT|)} - \left(\frac{2 \cdot |r_2| \cdot |TT| - |TT|^2}{2 \cdot (|r_1| - |r_2| + |TT|)} \right)^2 } \right|}{|r_2|} \right)$$

$$s = 2 \cdot \left| \sqrt{2 \cdot |r_1| \cdot \frac{2 \cdot |r_2| \cdot |TT| - |TT|^2}{2 \cdot (|r_1| - |r_2| + |TT|)} - \left(\frac{2 \cdot |r_2| \cdot |TT| - |TT|^2}{2 \cdot (|r_1| - |r_2| + |TT|)} \right)^2 } \right|$$

$$h = \frac{2 \cdot |r_2| \cdot |TT| - |TT|^2}{2 \cdot (|r_1| - |r_2| + |TT|)}$$

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and for which there is an r_{Nref} which with reference to the value of A_{eqv} ascertained b the above relationship, satisfies the following conditions that A_{eqv} is likewise

$$A_{eqv} = \pi \cdot |r_{N_{ref}}|^2 +$$

$$N_{ref} \cdot \left[\left[|r_2|^2 \cdot \arcsin\left(\frac{\left| \sqrt{2 \cdot |r_{N_{ref}}| \cdot \frac{2 \cdot |r_2| \cdot \frac{1.3 - 1.3^2}{2 \cdot (|r_{N_{ref}}| - |r_2| + 1.3)}}{|r_2|} - \left(\frac{2 \cdot |r_2| \cdot \frac{1.3 - 1.3^2}{2 \cdot (|r_{N_{ref}}| - |r_2| + 1.3)}}{|r_2|} \right)^2 } \right|}{|r_2|} \right) \right] -$$

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$$\left| \sqrt{2 \cdot |r_{N_{ref}}| \cdot \frac{2 \cdot |r_2| \cdot 1.3 - 1.3^2}{2 \cdot (|r_{N_{ref}}| - |r_2| + 1.3)} - \left(\frac{2 \cdot |r_2| \cdot 1.3 - 1.3^2}{2 \cdot (|r_{N_{ref}}| - |r_2| + 1.3)} \right)^2} \right| \cdot \left(|r_2| - \left(1.3 + \frac{2 \cdot |r_2| \cdot 1.3 - 1.3^2}{2 \cdot (|r_{N_{ref}}| - |r_2| + 1.3)} \right) \right) \Bigg| - \left[|r_{N_{ref}}|^2 \cdot \arcsin\left(\frac{\left| \sqrt{2 \cdot |r_{N_{ref}}| \cdot \frac{2 \cdot |r_2| \cdot 1.3 - 1.3^2}{2 \cdot (|r_{N_{ref}}| - |r_2| + 1.3)} - \left(\frac{2 \cdot |r_2| \cdot 1.3 - 1.3^2}{2 \cdot (|r_{N_{ref}}| - |r_2| + 1.3)} \right)^2} \right|}{|r_1|} \right) - \left| \sqrt{2 \cdot |r_{N_{ref}}| \cdot \frac{2 \cdot |r_2| \cdot 1.3 - 1.3^2}{2 \cdot (|r_{N_{ref}}| - |r_2| + 1.3)} - \left(\frac{2 \cdot |r_2| \cdot 1.3 - 1.3^2}{2 \cdot (|r_{N_{ref}}| - |r_2| + 1.3)} \right)^2} \right| \Bigg]}{\left(\left| r_{N_{ref}} \right| - \frac{2 \cdot |r_2| \cdot 1.3 - 1.3^2}{2 \cdot \left(\left| r_{N_{ref}} \right| - |r_2| + 1.3 \right)} \right)}$$

without infringing the boundary conditions

$$\pi \geq N_{ref} \cdot \arcsin\left(\frac{\left| \sqrt{2 \cdot |r_{N_{ref}}| \frac{2 \cdot |r_2| \cdot 1.3 - 1.3^2}{2 \cdot (|r_{N_{ref}}| - |r_2| + 1.3)} - \left(\frac{2 \cdot |r_2| \cdot 1.3 - 1.3^2}{2 \cdot (|r_{N_{ref}}| - |r_2| + 1.3)} \right)^2} \right|}{|r_{N_{ref}}|} \right), \quad r_{N_{ref}} < r_{eqv}$$

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and where the equivalent diameter D_{eqv} is found from the relationship $D_{eqv}=2\ r_{eqv}$.