Patent claims

1. Screw elements for multi-shaft screw machines with paired co-directionally rotating screw shafts, characterized in that
   - adjacent screw elements have an unlike, unsymmetrical profile,
   - the screw elements have in each case a single flight land region,
   - the sum *SKW* of all the flight land angles of an adjacent pair of screw elements is greater than 0 and less than $2\pi - 4 \cdot \arccos\left(\frac{A}{DE}\right)$,
   - the free cross-sectional areas F_1^{frei} and F_2^{frei} of the profiles of adjacent screw elements differ from each other in their size.

2. Screw elements according to Claim 1, characterized in that the sum *SKW* of the flight land angles of the generated screw profile and the generating screw profile is less than $0.8 \cdot (2\pi - 4 \cdot \arccos\left(\frac{A}{DE}\right))$, preferably less than $0.6 \cdot (2\pi - 4 \cdot \arccos\left(\frac{A}{DE}\right))$, particularly preferably less than $0.4 \cdot (2\pi - 4 \cdot \arccos\left(\frac{A}{DE}\right))$.

3. Screw elements according to either of Claims 1 and 2, characterized in that the ratio of the larger free cross-sectional area to the smaller free cross-sectional area of adjacent profiles is at least 1.2, particularly preferably at least 1.5 and most particularly preferably at least 2.

4. Screw elements according to one of Claims 1 to 3, characterized in that the profile of one element of a pair of elements has a tapering region which extends over an angle, with respect to the point of rotation of the profile, which is greater than 90°, preferably greater than 120°, particularly preferably greater than 180°, the tapering region comprising one or more circular arcs, and all of the points that lie on the arcs of the tapering region have a distance from the point of rotation of the profile that lies between (*RA*+*RI*)/2 and *RA*, *RA* being the outer screw radius and *RI* the inner screw radius.

5. Screw elements for multi-shaft screw machines with paired co-directionally rotating screw shafts, characterized
   - in that adjacent screw elements have an identical, unsymmetrical profile,

- the profile comprises a single flight land region with a flight land angle less than $\pi - 2\arccos\left(\frac{A}{2 \cdot RA}\right)$, and
- in the profile, the flight land region is adjoined on one side by a tapering region, which comprises one or more circular arcs, all of the points that lie on the arcs of the tapering region have a distance from the point of rotation of the profile that lies between $(RA+RI)/2$ and RA, A being the centreline distance, RA the outer screw radius. RI the inner screw radius and π the mathematical constant of a circle.

6. Screw elements according to Claim 5, characterized in that the land flight angle is less than $0.8 \cdot (\pi - 2\arccos\left(\frac{A}{2 \cdot RA}\right))$, preferably less than $0.6 \cdot (\pi - 2\arccos\left(\frac{A}{2 \cdot RA}\right))$, particularly preferably less than $0.5 \cdot (\pi - 2\arccos\left(\frac{A}{2 \cdot RA}\right))$.

7. Screw elements according to either of Claims 5 and 6, characterized in that the tapering region extends over an angle, with respect to the point of rotation of the profile, which is greater than 30°, preferably greater than 45°, particularly preferably greater than 90°.

8. Screw elements for multi-shaft screw machines with paired co-directionally rotating screw shafts, characterized in that
   - adjacent screw elements have an unlike profile,
   - in the case of an adjacent pair of elements, one profile has just one flight land region and the adjacent profile has just two flight land regions,
   - the free cross-sectional areas F_1^{frei} and F_2^{frei} of adjacent profiles differ from each other in their size.

9. Screw elements according to Claim 8, characterized in that the ratio of the larger free cross-sectional area to the smaller free cross-sectional area of adjacent profiles is at least 1.2, particularly preferably at least 1.4 and most particularly preferably at least 1.6.

10. Screw elements according to either of Claims 8 and 9, characterized in that the profiles are in each case mirror-symmetrical.

11. Screw elements according to one of Claims 1 to 10, characterized in that the ratio of the outer screw radius *RA* to the centreline distance *A* preferably lies in the range from 0.51 to 0.7, particularly preferably in the range from 0.52 to 0.66 and most particularly preferably in a range from 0.57 to 0.63.

12. Screw elements according to one of Claims 1 to 11, which are derived from fully wiping profiles by having clearances between the screw elements and the barrel and/or between adjacent screw elements.

13. Use of screw elements according to one of Claims 1 to 12 in a multi-shaft screw machine, preferably in a twin-shaft screw machine.

14. Process for the extrusion of viscoelastic compositions in a twin-screw or multi-shaft extruder using the screw elements according to the invention as provided by one of Claims 1 to 12.

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1. Screw elements for multi-shaft screw machines with paired co-directionally rotating screw shafts, characterized in that
   - adjacent screw elements have an unlike, unsymmetrical profile,
   - the screw elements have in each case a single flight land region,
   - the sum *SKW* of all the flight land angles of an adjacent pair of screw elements is greater than 0 and less than $2\pi - 4 \cdot \arccos\left(\frac{A}{DE}\right)$,
   - the free cross-sectional areas F_1^{frei} and F_2^{frei} of the profiles of adjacent screw elements differ from each other in their size,
   - the screw profiles of adjacent screw elements are fully wiping.

2. Screw elements according to Claim 1, characterized in that the sum *SKW* of the flight land angles of the generated screw profile and the generating screw profile is less than $0.8 \cdot (2\pi - 4 \cdot \arccos\left(\frac{A}{DE}\right))$, preferably less than $0.6 \cdot (2\pi - 4 \cdot \arccos\left(\frac{A}{DE}\right))$, particularly preferably less than $0.4 \cdot (2\pi - 4 \cdot \arccos\left(\frac{A}{DE}\right))$.

3. Screw elements according to either of Claims 1 and 2, characterized in that the ratio of the larger free cross-sectional area to the smaller free cross-sectional area of adjacent profiles is at least 1.2, particularly preferably at least 1.5 and most particularly preferably at least 2.

4. Screw elements according to one of Claims 1 to 3, characterized in that the profile of one element of a pair of elements has a tapering region which extends over an angle, with respect to the point of rotation of the profile, which is greater than 90°, preferably greater than 120°, particularly preferably greater than 180°, the tapering region comprising one or more circular arcs, and all of the points that lie on the arcs of the tapering region have a distance from the point of rotation of the profile that lies between (*RA*+*RI*)/2 and *RA*, *RA* being the outer screw radius and *RI* the inner screw radius.

5. Screw elements for multi-shaft screw machines with paired co-directionally rotating screw shafts, characterized in that

- adjacent screw elements have an unlike profile,
- in the case of an adjacent pair of elements, one profile has just one flight land region and the adjacent profile has just two flight land regions,
- the free cross-sectional areas F_1^{frei} and F_2^{frei} of adjacent profiles differ from each other in their size,
- the screw profiles of adjacent screw elements are fully wiping.

6. Screw elements according to Claim 5, characterized in that the ratio of the larger free cross-sectional area to the smaller free cross-sectional area of adjacent profiles is at least 1.2, particularly preferably at least 1.4 and most particularly preferably at least 1.6.

7. Screw elements according to either of Claims 5 and 6, characterized in that the profiles are in each case mirror-symmetrical.

8. Screw elements according to one of Claims 1 to 7, characterized in that the ratio of the outer screw radius *RA* to the centreline distance *A* preferably lies in the range from 0.51 to 0.7, particularly preferably in the range from 0.52 to 0.66 and most particularly preferably in a range from 0.57 to 0.63.

9. Screw elements according to one of Claims 1 to 8, characterized in that the profile of screw elements can be uniquely described by an arrangement of circular arcs.

10. Screw elements according to one of Claims 1 to 9, which are derived from fully wiping profiles by having clearances between the screw elements and the barrel and/or between adjacent screw elements.

11. Use of screw elements according to one of Claims 1 to 10 in a multi-shaft screw machine, preferably in a twin-shaft screw machine.

12. Process for the extrusion of viscoelastic compositions in a twin-screw or multi-shaft extruder using the screw elements according to the invention as provided by one of Claims 1 to 10.

13. Multi-shaft screw machines with paired co-directionally rotating screw shafts, characterized in that

- adjacent screw elements have an unlike, unsymmetrical profile,
- the screw elements have in each case a single flight land region,
- the sum *SKW* of all the flight land angles of an adjacent pair of screw elements is greater than 0 and less than $2\pi - 4 \cdot \arccos\left(\frac{A}{DE}\right)$,
- the free cross-sectional areas F_1^{frei} and F_2^{frei} of the profiles of adjacent screw elements differ from each other in their size
- the screw profiles of adjacent screw elements are fully wiping.

14. Multi-shaft screw machines with paired co-directionally rotating screw shafts, characterized in that

- adjacent screw elements have an unlike profile,
- in the case of an adjacent pair of elements, one profile has just one flight land region and the adjacent profile has just two flight land regions,
- the free cross-sectional areas F_1^{frei} and F_2^{frei} of adjacent profiles differ from each other in their size,
- the screw profiles of adjacent screw elements are fully wiping.