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,
   - 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.

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,
   - the screw profiles of adjacent screw elements are fully wiping, 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.

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 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, characterized in that the profile of screw elements can be uniquely described by an arrangement of circular arcs.

5. Screw elements according to Claim 4, 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.

6. Screw elements according to either of Claims 4 and 5, characterized in that the profiles are in each case mirror-symmetrical.

7. Screw elements according to one of Claims 1 to 6, 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.

8. Screw elements according to one of Claims 1 to 7, which are derived from fully wiping profiles by having clearances between the screw elements and the barrel and/or between adjacent screw elements.

9. Use of screw elements according to one of Claims 1 to 8 in a multi-shaft screw machine, preferably in a twin-shaft screw machine.

10. 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 8.

11. 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, 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.

12. 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, characterized in that the profile of screw elements can be uniquely described by an arrangement of circular arcs.