CLAIMS:

We claim:

1. A by-pass control sleeve for a spiral wound membrane element, the by-pass control sleeve comprising one or more of:

    a. asymmetrical protrusions; or

    b. protrusions having a concave curved forward face,

wherein each of the protrusions wraps circumferentially around the by-pass control sleeve.

2. The by-pass control sleeve of claim 1, wherein the protrusions wrap circumferentially around the by-pass control sleeve in discrete circles, in a helical pattern or in a spiral pattern.

3. The by-pass control sleeve of claim 1 or 2, wherein the protrusions have valleys therebetween, and the width of each of the valleys is 50-200% of the width of the protrusions.

4. The by-pass control sleeve of claim 3, wherein each of the valleys has a constant diameter across its width.

5. The by-pass control sleeve of any one of claims 1 to 4, wherein the protrusions have a forward face comprising a concave curve on the upstream side and a rear face comprising a concave curve on a downstream side.

6. The by-pass control sleeve of any one of claims 1 to 5, having asymmetrical protrusions.

7. The by-pass control sleeve of any one of claims 1 to 6, wherein the forward face of each protrusion is configured to radially deflect feed flow in a direction normal to the circumference of the sleeve.

8. The by-pass control sleeve of any one of claims 1 to 7, wherein adjacent protrusions have a peak-to-peak distance between 0.2 cm and 1.6 cm.

9. The by-pass control sleeve of claim 3 or 4, wherein the valleys have a depth of between 0.02 cm and 0.3 cm.

10. A combination comprising the by-pass control sleeve of any one of claims 1 to 9 fixed onto the membrane element, and installed within a pressurized vessel.

11. The combination of claim 10, comprising a space of between 0.02 cm and 0.2 cm between peaks of the protrusions of the by-pass control sleeve and an inside wall of the pressurized vessel.

12. The combination of claim 10, comprising a space between peaks of the protrusions of the by-pass control sleeve and an inside wall of the pressurized vessel of 0.01-0.03 inches.

13. A method of installing the by-pass control sleeve according to any one of claims 1 to 9 comprising sliding the sleeve onto an end of the spiral wound membrane element.

14. The method of claim 13, comprising heating the by-pass control sleeve before sliding the sleeve onto the end of the spiral wound membrane element.

15. The method of claim 13, comprising stretching the by-pass control sleeve while sliding the sleeve onto the end of the spiral wound membrane element and releasing the sleeve to elastically contract after sliding over the end of the element.

16. The method of claim 13, wherein the by-pass control sleeve comprises a heat shrink material, and the method comprises heating the sleeve after sliding the sleeve onto the end of the spiral wound membrane element.

17. The method of any one of claims 13 to 16, wherein sliding the sleeve onto the end of the spiral wound membrane element comprises sliding the sleeve to a position along the length of the spiral wound membrane element.

18. A method of making a by-pass control sleeve comprising molding circumferential protrusions on an outer face of the sleeve, the protrusions each having a forward face comprising a concave curve and/or the protrusions being asymmetrical.

19. The method of claim 18, wherein the by-pass control sleeve is molded before being fixed to a spiral wound membrane element.