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(54) Title: BRANCHED FLOW FILTRATION AND SYSTEM

(57) **Abstract:** A cross flow filtration apparatus for nanofiltration or reverse osmosis has pressure vessels with a plurality of filter cartridges in each vessel. A feed port is provided at an intermediate position on the side of the vessel, and two permeate flows or branches exit opposite ends of the vessel, and the first branch has a characteristically high "upstream" flux and quality, while the second is of lesser flux and/or quality. The system provides a high degree of modularity, enhancing flux or yield at a reduced driving pressure or overall pressure drop. Centered or off-center port, and a stop or valve in the permeate stream may apportion flows between the two outlets. Staged systems may employ a first stage bypass to achieve a target quality with increased yield. A flow divider or adaptor permits the cartridges to fit and seal in the vessel, and an installation tool or sleeve may facilitate installation or replacement of cartridges having a directional perimeter seal. A tool permits modules to be bi-directional installed in the pressure vessel. Other embodiments involve adapting a conventional vessel designed for end-to-end feed flow utilizing a restrictor, obstruction or valve inside the filter cartridge to bifurcate or otherwise split or apportion the permeate. RO elements may be modified to movably position an obstruction or valve along a string of the elements and vary the take-off to two or more permeate outlets, or to provide pressure relief valves that present different pressure conditions for different elements of a string. A pressure vessel may have an intermediate inlet, with symmetric or asymmetric branching of permeate flow to opposed ends of the vessel, enhancing permeate flux, permeate quality and/or energy efficiency.



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