CLAIMS

1. A biological conversion process comprising:
    a. feeding a substrate to a bioreactor system comprising at least a first bioreactor including a culture medium and a bacterium to metabolize a carbon source in the substrate and produce at least one fermentation product;
    b. withdrawing from the bioreactor system a permeate stream obtained from filtration of a liquid stream of the bioreactor system;
    c. withdrawing from the bioreactor system a bleed stream comprising bacterium;
    d. feeding at least a portion of the permeate stream to a high pressure separator; and
    e. feeding at least a portion of the bleed stream to a low pressure separator;

    wherein the process further comprises (i) withdrawing, from the low pressure separator, a low pressure separator overhead enriched in a desired fermentation product, relative to the bleed stream; and (ii) withdrawing, from the high pressure separator, a high pressure separator overhead and a high pressure separator bottoms, wherein the high pressure separator overhead is enriched in desired fermentation product.
2. The process of claim 1, further comprising, blending at least a second portion of the permeate stream with the bleed stream to provide a combined stream, and feeding at least a portion of the combined stream to the low pressure separator.
3. The process of claim 1, wherein the high pressure separator and the low pressure separator are a high pressure distillation column and a low pressure distillation column, respectively.
4. The process of claim 1, wherein the high pressure separator has an absolute pressure in the range from 150 kPa to 650 kPa.
5. The process of claim 1, wherein the low pressure separator has a vacuum pressure.
6. The process of claim 1, wherein desired fermentation product contained in both the low pressure separator overhead and high pressure separator overhead represents a net desired fermentation product productivity of the bioreactor system.
7. The process of claim 6, wherein the desired fermentation product is ethanol, and the net ethanol productivity is at least 55 grams/day, per liter of bioreactor volume.
8. The process of claim 6, further comprising withdrawing, from the low pressure separator, a low pressure separator bottoms.

9. The process of claim 6, wherein one or more of (i) the low pressure separator overhead, in addition to a low pressure separator overhead reflux portion, are separated from a low pressure separator vapor outlet stream withdrawn from the low pressure separator, (ii) the low pressure separator bottoms, in addition to a low pressure separator boiler portion, are separated from a low pressure separator liquid outlet stream withdrawn from the low pressure separator, (iii) the high pressure separator overhead, in addition to a high pressure separator overhead reflux portion, are separated from a high pressure separator vapor outlet stream withdrawn from the high pressure separator, and (iv) the high pressure separator bottoms, in addition to a high pressure separator boiler portion, are separated from a high pressure separator liquid outlet stream withdrawn from the high pressure separator.

10. The process of claim 9, wherein one or more of (i) the low pressure separator vapor outlet stream is fed to a low pressure separator condenser to condense at least a portion thereof, return the low pressure separator overhead reflux portion to the low pressure separator, and recover low pressure separator condenser heat, (ii) the low pressure separator liquid outlet stream is fed to a low pressure separator reboiler to vaporize at least a portion thereof, return the low pressure separator liquid reflux portion to the low pressure separator, and consume low pressure separator reboiler heat, (iii) the high pressure separator vapor outlet stream is fed to a high pressure separator condenser to condense at least a portion thereof, return the high pressure separator overhead reflux portion to the high pressure separator, and recover high pressure separator condenser heat, and (iv) the high pressure separator liquid outlet stream is fed to a high pressure separator reboiler to vaporize at least a portion thereof, return the high pressure high liquid reflux portion to the high pressure separator, and consume high pressure separator reboiler heat.

11. The process of claim 10, wherein at least a portion of the high pressure separator condenser heat is consumed as low pressure separator reboiler heat.

12. The process of claim 9, wherein the low pressure separator liquid outlet stream is fed to a low pressure separator reboiler to vaporize portions thereof, return the low pressure separator liquid reflux portion to the low pressure separator, and consume low pressure separator reboiler heat.

13. The process of claim 12, wherein at least a portion of the high pressure separator condenser heat is consumed as low pressure separator reboiler heat.
14. The process of claim 8, further comprising recycling at least a portion of the high pressure separator bottoms and/or at least a portion of the low pressure separator bottoms to the bioreactor system.
15. The process of claim 1, wherein the substrate is a C1-containing substrate, the bacterium is a C1-fixing bacterium, and the at least one fermentation product is selected from the group consisting of ethanol, isopropanol and mixtures thereof.
16. The process of claim 1 additionally comprising the step of partitioning the permeate stream into at least a first permeate portion and a second permeate portion and feeding at least a portion of the first permeate stream portion to the high pressure separator and feeding the second permeate portion to the low pressure separator.
17. The process of claim 16, wherein, in the step of partitioning, a flow rate of the second permeate portion is adjusted at least in part based on a flow rate of the bleed stream.
18. The process of claim 2, further comprising (i) withdrawing, from the low pressure separator, a low pressure separator overhead enriched in a desired fermentation product, relative to the bleed stream; and (ii) withdrawing, from the high pressure separator, a high pressure separator overhead and a high pressure separator bottoms, wherein the high pressure separator overhead is enriched in desired fermentation product.
19. The process of claim 18, wherein the low pressure separator overhead comprises desired fermentation product separated from both the second portion of the permeate stream and the bleed stream.
20. The process of claim 19, wherein desired fermentation product contained in both the low pressure separator overhead and high pressure separator overhead represents a net desired fermentation product productivity of the bioreactor system.
21. The process of claim 20, wherein the desired fermentation product is ethanol, and the net ethanol productivity is at least 55 grams/day, per liter of bioreactor volume.