CLAIMS:

1. A biological conversion process comprising:

   feeding a substrate to a bioreactor system comprising at least a first bioreactor including a culture medium and bacterium to metabolize a carbon source in the substrate and produce at least one fermentation product;

   withdrawing from the bioreactor system a bleed stream comprising bacterium;

   withdrawing from the bioreactor system a permeate stream obtained from filtration of a liquid stream of the bioreactor system; and

   feeding at least a portion of the bleed stream and at least a portion of the permeate stream to a low pressure separator comprising a divider, the divider being configured to isolate, in a lower section, a liquid fraction of the bleed stream from a liquid fraction of the permeate stream and also configured to combine, in an upper section, a gaseous fraction of the bleed stream with a gaseous fraction of the permeate stream.

2. The process of claim 1 further comprising

   partitioning the permeate stream into at least a first permeate portion and a second permeate portion;

   feeding the first permeate portion–to a high pressure separator and feeding the second permeate portion to the low pressure separator;

   withdrawing, from the high pressure separator, a high pressure separator overhead and a high pressure separator bottom wherein the high pressure separator overhead is enriched in desired fermentation product relative to the first permeate portion; and

   withdrawing a low pressure separator overhead enriched in desired fermentation product, relative to both the second permeate portion and the bleed stream.

3. The process of claim 2 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 2, wherein the high pressure separator has an absolute pressure in the range from 150 kPa to 650 kPa.

5. The process of claim 2, wherein the low pressure separator has a vacuum pressure.

6. The process of claim 2, further comprising withdrawing, from the low pressure separator, both a low pressure separator bleed bottoms and a low pressure separator permeate bottoms.

7. 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to a low pressure separator overhead reflux portion, are separated from a low pressure separator vapor outlet stream withdrawn from the low pressure separator, (ii) the low pressure separator bleed bottoms, in addition to a low pressure separator bleed boilup portion, are separated from a low pressure separator bleed liquid outlet stream withdrawn from the low pressure separator, (iii) the low pressure separator permeate bottoms, in addition to a low pressure separator permeate boilup portion, are separated from a low pressure separator permeate liquid outlet stream withdrawn from the low pressure separator, (iv) 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 (v) the high pressure separator bottoms, in addition to a high pressure separator boilup portion, are separated from a high pressure separator liquid outlet stream withdrawn from the high pressure separator.

8. The process of claim 7, 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 bleed liquid outlet stream is fed to a low pressure separator bleed reboiler to vaporize at least a portion thereof, return the low pressure separator bleed boilup portion to the low pressure separator, and consume low pressure separator bleed reboiler heat, (iii) the low pressure separator permeate liquid outlet stream is fed to a low pressure separator permeate reboiler to vaporize at least a portion thereof, return the low pressure separator permeate boilup portion to the low pressure separator, and consume low pressure separator permeate reboiler heat, (iv) 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 (v) 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 separator boilup portion to the high pressure separator, and consume high pressure separator reboiler heat.

9. The process of claim 8, wherein at least a portion of the high pressure separator condenser heat is consumed as low pressure separator permeate reboiler heat or as low pressure separator bleed reboiler heat.

10. The process of claim 7, wherein the low pressure separator bleed liquid outlet stream and the low pressure separator permeate liquid outlet stream are fed to a low pressure separator reboiler to vaporize portions thereof, return a low pressure separator bleed liquid reflux portion and a low pressure separator permeate liquid reflux portion to the low pressure separator, and consume low pressure separator reboiler heat.

11. The process of claim 10, wherein 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 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 2, wherein the divider is in the form of a vertically oriented plate, extending to a height that is less than an axial height of the low pressure separator.

13. The process of claim 6, wherein the liquid fraction of the bleed stream provides a first liquid volume in fluid communication with the low pressure separator bleed bottoms and the liquid fraction of the second permeate portion provides a second liquid volume in fluid communication with the low pressure separator permeate bottoms, and wherein the first volume is smaller than the second volume.

14. The process of claim 6, further comprising recycling at least a portion of the high pressure separator bottoms and at least a portion of the low pressure separator permeate 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. A biological conversion apparatus comprising:

a bioreactor system comprising (i) an inlet for introducing a substrate to the bioreactor system, (ii) at least a first bioreactor for containing a culture medium and bacterium to metabolize a carbon source in the substrate and produce a product, (iii) a filtration system for filtering a liquid product of the bioreactor system, (iv) a bleed stream outlet for withdrawing a bleed stream comprising bacterium, and (v) a permeate stream outlet in fluid communication with a permeate side of the filtration system for withdrawing a permeate stream from the bioreactor system; and

a low pressure separator having a divider disposed in a lower section thereof and configured for isolating (i) a first liquid volume in fluid communication with both (A) the bleed stream outlet, at a low pressure separator bleed stream inlet positioned in the lower section and (B) a low pressure separator bleed bottoms outlet positioned below the low pressure bleed stream inlet from (ii) a second liquid volume in fluid communication with both (A) the permeate stream outlet, at a low pressure separator permeate stream inlet positioned in the lower section and (B) a low pressure separator permeate bottoms outlet positioned below the low pressure separator permeate stream inlet;

wherein the low pressure separator is configured for combining, in an upper section thereof, a first gaseous fraction above the first liquid volume with a second gaseous fraction above the second liquid volume and to provide a combined gaseous volume in fluid communication with a low pressure separator overhead outlet,

the apparatus optionally further comprising a high pressure separator having (i) a first permeate portion inlet in fluid communication with the permeate stream outlet, for receiving a first permeate portion of the permeate stream and passing a second permeate portion of the permeate stream to the low pressure separator permeate stream inlet, (ii) a high pressure separator overhead outlet, and (iii) a high pressure separator bottoms outlet, wherein the first permeate portion inlet is positioned below the high pressure separator overhead outlet and above the high pressure separator bottoms outlet;

the apparatus optionally further comprising a dehydration column having (i) a dehydration column inlet in fluid communication with both the low pressure separator overhead outlet and the high pressure separator overhead outlet, (ii) a dehydration column overhead outlet, and (iii) a dehydration column bottoms outlet, wherein the dehydration column

inlet is positioned below the dehydration column overhead outlet and above the dehydration column bottoms outlet; and

the apparatus optionally further comprising a second filtration system in fluid communication with the low pressure separator bleed bottoms outlet for filtering a low pressure separator bleed bottoms stream.