CLAIMS

1. A high-selectivity, continuous process for converting aldohexose in an aldohexose-yielding carbohydrate-containing feed to ethylene glycol comprising:

a. continuously or intermittently passing said carbohydrate-containing feed into a reaction zone having an aqueous, hydrogenation medium containing retro-aldol catalyst, hydrogen and hydrogenation catalyst;

b. maintaining the aqueous, hydrogenation medium in the reaction zone at hydrogenation conditions to provide a product solution comprising ethylene glycol, propylene glycol, glycerin and hexitol, said hydrogenation conditions comprising a temperature in the range of between about 230° C. to 300° C., a ratio of retro-aldol catalyst to hydrogenation catalyst, and hydrogen partial pressure that, in combination, are sufficient to:

i. convert at least about 95 percent of the aldohexose-yielding carbohydrate,

ii. provide a conversion efficiency of said aldohexose to ethylene glycol of at least about 60 percent, and

iii. provide a mass ratio of ethylene glycol to hexitol greater than about 10:1 in the product solution; and

c. continuously or intermittently withdrawing product solution from said reaction zone,

wherein said carbohydrate feed is at least partially hydrated and is under a pressure sufficient to maintain partial hydration; wherein said carbohydrate feed is below a temperature of about 170° C.; and wherein said carbohydrate feed is heated to above 230° C. immediately prior to or in the reaction zone and the rate of heating of the carbohydrate feed from below 170° C. to above 230° C. is sufficient to provide a product solution having at least one of:

A. a mass ratio of ethylene glycol to propylene glycol from said aldohexose of at least about 15:1, and

B. a mass ratio of glycerin to propylene glycol of less than about 0.5:1.

2. The process of claim 1 wherein the aldohexose-yielding carbohydrate being passed to the aqueous medium is in an aqueous solution.

3. The process of claim 2 wherein the aqueous solution contains retro-aldol catalyst.

4. The process of claim 3 wherein the aqueous solution is maintained at a temperature of greater than about 170° C. and less than 230° C. for less than about 15 seconds prior to being passed into the aqueous, hydrogenation medium.

5. The process of claim 4 wherein the aqueous solution contains retro-aldol catalyst at least during the heating from below 170° C. to above 230° C.

6. The process of claim 1 wherein the heating of the carbohydrate feed from below 170° C. to above 230° C. is at least in part by direct heat exchange by admixing the carbohydrate feed with a warmer fluid.

7. The process of claim 6 wherein the warmer fluid comprises the aqueous, hydrogenation medium.

8. The process of claim 6 wherein the admixing of the carbohydrate feed and warmer fluid involves high shear mixing.

9. The process of claim 6 wherein the admixing of the carbohydrate feed and warmer fluid involves rapid diffusional mixing.

10. The process of claim 6 wherein a portion of the withdrawn product solution is provided at a temperature of at least about 180° C. and is admixed with the carbohydrate feed prior to the carbohydrate feed being passed to the aqueous, hydrogenation zone.

11. The process of claim 10 wherein the portion of the recycled withdrawn product solution is an aliquot portion.

12. The process of claim 11 wherein the withdrawn product solution is degassed to remove at least a portion of the hydrogen to provide a degassed product solution, and then an aliquot portion of the degassed product solution is recycled.

13. The process of claim 1 wherein the heating of the carbohydrate feed from below 170° C. to above 230° C. is at least in part by indirect heat exchange.

14. The process of claim 1 wherein the heating of the carbohydrate feed from below 170° C. to above 230° C. occurs whereupon the carbohydrate is contacted with an aqueous, retro-aldol solution containing retro-aldol catalyst in the substantial absence of hydrogenation catalyst for a time sufficient to provide a the mass ratio of ethylene glycol to hexitol greater than about 25:1 in the product solution.

15. The process of claim 1 wherein the carbohydrate feed is in a solution containing at least one of ethylene glycol and propylene glycol in a mass ratio of total ethylene glycol and propylene glycol to carbohydrate is in the range of about 10:1 to 1:20.

16. The process of claim 1 wherein the carbohydrate-containing feed contains between about 120 and 800 grams of carbohydrate per liter of aqueous, hydrogenation medium.

17. A high-selectivity, continuous process for converting aldohexose in an aldohexose-yielding carbohydrate-containing feed to ethylene glycol comprising:

a. continuously or intermittently passing said carbohydrate feed into a reaction zone having an aqueous, hydrogenation medium containing retro-aldol catalyst, hydrogen and hydrogenation catalyst;

b. maintaining the aqueous, hydrogenation medium in the reaction zone at hydrogenation conditions to provide a product solution comprising ethylene glycol, propylene glycol, glycerin and hexitol, said hydrogenation conditions comprising a temperature in the range of between about 230° C. to 300° C., a ratio of retro-aldol catalyst to hydrogenation catalyst, and hydrogen partial pressure that, in combination, are sufficient to convert at least about 95 percent of the aldohexose-yielding carbohydrate; and

c. continuously or intermittently withdrawing product solution from said reaction zone,

wherein said carbohydrate feed is at least partially hydrated and is under a pressure sufficient to maintain partial hydration; wherein said carbohydrate feed is below a temperature of about 170° C.; and wherein said carbohydrate feed is heated at least in part by direct heat exchange with a warmer fluid to above 230° C. immediately prior to or in the reaction zone and the rate of heating of the carbohydrate feed from below 170° C. to above 230° C. is sufficient to provide a product solution having at least one of:

A. a mass ratio of glycerin to propylene glycol of less than about 0.5:1, and

B. a mass ratio of ethylene glycol to hexitol greater than about 20:1 and a mass ratio of ethylene glycol to propylene glycol from said aldohexose of at least about 15:1.

18. The process of claim 17 wherein rate of heating is sufficient to raise the temperature of the entire carbohydrate feed from about 170° C. to at least 230° C. in less than about 5 seconds.

19. The process of claim 17 wherein rate of heating is sufficient to raise the temperature of the entire carbohydrate feed from about 170° C. to at least 230° C. in less than about 1 second.