CLAIMS

What is claimed:

~~1.A process for the production of alkylbenzene, the process comprising:~~

~~feeding a C_1 to C_6 alcohol and benzene to a catalytic distillation reactor system comprising an upper reaction zone containing an alkylation catalyst and a lower reaction zone containing a transalkylation catalyst, which may be the same or different than the alkylation catalyst;~~

~~concurrently in the catalytic distillation reactor system:~~

~~reacting a portion of the alcohol with the benzene within the upper reaction zone to form a reaction mixture containing water, alkylbenzene, dialkyl ether, unreacted alcohol, unreacted benzene, and polyalkylate including dialkylbenzene;~~

~~reacting a portion of the polyalkylate with benzene in the lower reaction zone to form additional alkylbenzene; and~~

~~fractionally distilling the reaction mixture;~~

~~recovering an overheads fraction from the catalytic distillation reactor system comprising benzene, unreacted alcohol, water, and dialkyl ether;~~

~~recovering a bottoms fraction from the catalytic distillation reactor system comprising benzene, alkylbenzene, and polyalkylate.~~

~~2.The process of claim 1, wherein the alcohol is ethanol and the alkylbenzene is ethylbenzene.~~

~~3.The process of claim 1, wherein the alcohol is isopropanol and the alkylbenzene is cumene.~~

~~4.The process of claim 1, further comprising:~~

~~operating the catalytic distillation reactor system such that the bottoms fraction comprises less than 0.03 wt.% benzene; and~~

~~fractionating the bottoms fraction to recover an overheads fraction comprising alkylbenzene and benzene and a bottoms fraction comprising polyalkylate.~~

~~6.The process of claim 4, wherein the overheads fraction comprising ethylbenzene comprises at least 99.95 wt.% alkylbenzene.~~

~~6.~~1.A process for the production of ethylbenzene, the process comprising:

feeding ethanol and benzene to a catalytic distillation reactor system comprising an upper reaction zone containing an alkylation catalyst and a lower reaction zone containing a transalkylation catalyst, which may be the same or different than the alkylation catalyst;

concurrently in the catalytic distillation reactor system:

reacting a portion of the ethanol with the benzene within the upper reaction zone to form a reaction mixture containing water, ethylbenzene, diethyl ether, unreacted ethanol, unreacted benzene, and polyalkylate including diethylbenzene;

reacting a portion of the polyalkylate with benzene in the lower reaction zone to form additional ethylbenzene; and

fractionally distilling the reaction mixture;

recovering an overheads fraction from the catalytic distillation reactor system comprising benzene, ethanol, water, and diethyl ether;

recovering a bottoms fraction from the catalytic distillation reactor system comprising benzene, ethylbenzene, and polyalkylate;

condensing and phase separating the overheads fraction to form a first liquid fraction comprising benzene and a second liquid fraction comprising the water, ethanol, and diethyl ether;

separating the bottoms fraction from the catalytic distillation reactor system in a first distillation column to recover an overheads fraction comprising benzene and a bottoms fraction comprising ethylbenzene and polyalkylate;

feeding at least a portion of the first liquid fraction to the catalytic distillation reactor system as a reflux;

separating the second liquid fraction in a second distillation column to recover an overheads fraction comprising ethanol and diethyl ether and a bottoms fraction comprising water;

feeding the ethanol feed and at least a portion of the overheads fraction from the second distillation column to the catalytic distillation reactor system intermediate the upper and lower reaction zones.

~~7.~~2. The process of claim 61, further comprising feeding a portion of the first liquid fraction to the catalytic distillation reactor system intermediate the upper and lower reaction zones.

~~8.~~3. The process of claim ~~6~~1, further comprising separating the bottoms fraction from the first distillation column in a third distillation column to recover an overheads fraction comprising ethylbenzene and a bottoms fraction comprising polyalkylate.

~~9.~~4. The process of claim ~~6~~1, further comprising separating the bottoms fraction from the first distillation column to recover an overheads fraction comprising ethylbenzene, a sidedraw fraction comprising diethylbenzene, and a bottoms fraction comprising polyalkylate.

~~10.~~5. The process of claim ~~9~~4, further comprising feeding at least a portion of the sidedraw fraction to the catalytic distillation reactor system intermediate the upper and lower reaction zones.

~~11.~~6. The process of claim ~~10~~5, wherein the sidedraw fraction further comprises triethylbenzene.

~~12.~~7. The process of claim ~~9~~4, further comprising using the bottoms fraction comprising polyalkylate as a fuel blend stock.

~~13.~~8. The process of claim ~~6~~1, wherein the condensing and phase separating the overhead fraction comprises indirect heat exchange of the overheads fraction from the catalytic distillation reactor system with at least one of:

at least a portion of the bottoms fraction comprising water;

at least a portion of the overhead fraction from the second distillation column;

water; and

steam.

~~14.~~9. The process of claim ~~6~~1, wherein the catalyst in the upper reaction zone is the same as the catalyst in the lower reaction zone.

~~15.~~10. The process of claim ~~6~~1, further comprising feeding the benzene feed, at least a portion of the first liquid fraction, and at least a portion of the overheads fraction from the first distillation column to the catalytic distillation reactor system as a reflux;

~~16.~~11. The process of claim ~~6~~1, further comprising:

combining benzene and at least a portion of the overheads fraction from the second distillation column to form a mixture;

phase separating the mixture to recover a third liquid fraction comprising benzene, ethanol, and diethyl ether and a fourth liquid fraction comprising water, ethanol, and diethyl ether;

recycling the fourth liquid fraction to the second distillation column; and

feeding the third liquid fraction and a portion of the first liquid fraction to the catalytic distillation reactor system intermediate the upper and lower reaction zones.

~~17.~~12. The process of claim ~~16~~11, comprising combining at least a portion of the overheads from the first distillation column, benzene, and at least a portion of the overheads fraction from the second distillation column to form the mixture.

~~18.~~13. A process for the production of cumene, the process comprising:

feeding isopropanol and benzene to a catalytic distillation reactor system comprising an upper reaction zone containing an alkylation catalyst and a lower reaction zone containing a transalkylation catalyst, which may be the same or different than the alkylation catalyst;

concurrently in the catalytic distillation reactor system:

reacting a portion of the isopropanol with the benzene within the upper reaction zone to form a reaction mixture containing water, cumene, diisopropyl ether, unreacted isopropanol, unreacted benzene, and polyalkylate including diisopropylbenzene;

reacting a portion of the polyalkylate with benzene in the lower reaction zone to form additional cumene; and

fractionally distilling the reaction mixture;

recovering an overheads fraction from the catalytic distillation reactor system comprising benzene, isopropanol, water, and diisopropyl ether;

recovering a bottoms fraction from the catalytic distillation reactor system comprising benzene, cumene, and polyalkylate;

condensing and phase separating the overheads fraction to form a first liquid fraction comprising benzene and a second liquid fraction comprising the water, isopropanol, and diisopropyl ether;

separating the bottoms fraction from the catalytic distillation reactor system in a first distillation column to recover an overheads fraction comprising benzene and a bottoms fraction comprising cumene and polyalkylate;

feeding at least a portion of the first liquid fraction to the catalytic distillation reactor system as a reflux;

separating the second liquid fraction in a second distillation column to recover an overheads fraction comprising isopropanol and diisopropyl ether and a bottoms fraction comprising water;

feeding the isopropanol feed and at least a portion of the overheads fraction from the second distillation column to the catalytic distillation reactor system intermediate the upper and lower reaction zones.

~~19.~~14.The process of claim ~~18~~13, further comprising feeding a portion of the first liquid fraction to the catalytic distillation reactor system intermediate the upper and lower reaction zones.

~~20.~~15.The process of claim ~~18~~13, further comprising separating the bottoms fraction from the first distillation column in a third distillation column to recover an overheads fraction comprising cumene and a bottoms fraction comprising polyalkylate.

~~21.~~16.The process of claim ~~18~~13, further comprising separating the bottoms fraction from the first distillation column to recover an overheads fraction comprising cumene, a sidedraw fraction comprising diisopropylbenzene, and a bottoms fraction comprising polyalkylate.

~~22.~~17.The process of claim ~~21~~16, further comprising feeding at least a portion of the sidedraw fraction to the catalytic distillation reactor system intermediate the upper and lower reaction zones.

~~23.~~18.The process of claim ~~22~~17, wherein the sidedraw fraction further comprises tricumene.

~~24.~~19.The process of claim ~~21~~16, further comprising using the bottoms fraction comprising polyalkylate as a fuel blend stock.

~~25.~~20.The process of claim ~~18~~13, wherein the condensing and phase separating the overhead fraction comprises indirect heat exchange of the overheads fraction from the catalytic distillation reactor system with at least one of:

at least a portion of the bottoms fraction comprising water;

at least a portion of the overhead fraction from the second distillation column;

water; and

steam.

~~26.~~21.The process of claim ~~18~~13, wherein the catalyst in the upper reaction zone is the same as the catalyst in the lower reaction zone.

~~27.~~22.The process of claim ~~18~~13, further comprising feeding the benzene feed, at least a portion of the first liquid fraction, and at least a portion of the overheads fraction from the first distillation column to the catalytic distillation reactor system as a reflux;

~~28.~~23.The process of claim ~~18~~13, further comprising:

combining benzene and at least a portion of the overheads fraction from the second distillation column to form a mixture;

phase separating the mixture to recover a third liquid fraction comprising benzene, isopropanol, and diisopropyl ether and a fourth liquid fraction comprising water, isopropanol, and diisopropyl ether;

recycling the fourth liquid fraction to the second distillation column; and

feeding the third liquid fraction and a portion of the first liquid fraction to the catalytic distillation reactor system intermediate the upper and lower reaction zones.

~~29.~~24.The process of claim ~~28~~23, comprising combining at least a portion of the overheads from the first distillation column, benzene, and at least a portion of the overheads fraction from the second distillation column to form the mixture.