oxide tends to polymerize to form extremely high molecular materials when DMC catalysts are used.

Although much of the patent literature concerning DMC catalysis mentions 1,2-butylene oxide as an alkylene oxide which can be polymerized using those catalyst, virtually no examples of such polymerizations are described in the literature. This may be due to the fact that 1,2-butylene oxide does not form significant quantities of monofunctional species when anionically polymerized under conventional basic conditions, so much of the impetus that drove the adoption of DMC catalysis into making poly(propylene oxide) does not exist in the case of 1,2-butylene oxide polymerization. JP H6-248069 (1994) contains examples of propylene oxide copolymerized with small amounts of 1,2- or 2,3-butylene oxide. The resulting polyethers contain about 5% or less of polymerized butylene oxide.

Therefore, the polymerization behavior of 1,2-butylene oxide in the presence of a polyfunctional initiator compound and a DMC catalyst is heretofore unknown.

This disclosure is a process for producing poly(1,2-butylene oxide) polymers, comprising polymerizing 1,2-butylene oxide or a mixture of at least 50% by weight 1,2-butylene oxide and up to 50% by weight of a copolymerizable alkylene oxide in the presence of a double metal cyanide catalyst and in the presence of a hydroxylic initiator compound to form a polymer or copolymer of 1,2-butylene oxide having at least one block of homopolymerized or randomly copolymerized 1,2-butylene oxide having a number average weight of at least 500 atomic mass units.

In one aspect, the present disclosure provides a semi-batch or continuous process for producing poly(1,2-butylene oxide) polymers, comprising polymerizing 1,2-butylene oxide or a mixture of at least 50% by weight 1,2-butylene oxide and up to 50% by weight of a copolymerizable alkylene oxide at a polymerization temperature of 110 to 140°C in the presence of enough of a double metal cyanide catalyst to provide a cobalt concentration of 1 to 6 parts per million in the product and in the presence of a hydroxylic initiator compound having 2 to 6 hydroxyl groups, while maintaining a concentration of unreacted alkylene oxides at 2 to 6% by weight, to form a polymer or copolymer of 1,2-butylene oxide having at least one block of homopolymerized

or randomly copolymerized 1,2-butylene oxide having a number average weight of 800 to 2500 atomic mass units and which contains no more than 25 microequivalents per gram of monofunctional, unsaturated species.

Mass of a block in atomic mass units is equivalent to the same number of grams of such block per mole of the poly(1,2-butylene oxide) polymer.

Applicants have found that when 1,2-butylene oxide is homopolymerized using a DMC catalyst, very little butadiene is produced. This is a distinct advantage over the conventional anionic polymerization of 1,2-butylene oxide. However, the product very surprisingly contains a significant amount of monofunctional species. This result is exactly contrary to what is seen when propylene oxide is polymerized with those catalysts, and is quite unexpected in view of the experience with propylene oxide polymerization. The formation of monofunctional species is of course a very substantial disadvantage for the reasons discussed above.

WHAT IS CLAIMED IS:

1. A semi-batch or continuous process for producing poly(1,2-butylene oxide) polymers, comprising polymerizing 1,2-butylene oxide or a mixture of at least 50% by weight 1,2-butylene oxide and up to 50% by weight of a copolymerizable alkylene oxide at a polymerization temperature of 110 to 140°C in the presence of enough of a double metal cyanide catalyst to provide a cobalt concentration of 1 to 6 parts per million in the product and in the presence of a hydroxylic initiator compound having 2 to 6 hydroxyl groups, while maintaining a concentration of unreacted alkylene oxides at 2 to 6% by weight, to form a polymer or copolymer of 1,2-butylene oxide having at least one block of homopolymerized or randomly copolymerized 1,2-butylene oxide having a number average weight of 800 to 2500 atomic mass units and which contains no more than 25 microequivalents per gram of monofunctional, unsaturated species.

2. A poly(1,2-butylene oxide) polymer made in accordance with claim 1.

3. The process of claim 1 wherein 1,2-butylene oxide is homopolymerized to form at least one block of homopolymerized 1,2-butylene oxide.

4. The process of claim 1 or 3 wherein enough of the zinc hexacyanocobaltate catalyst complex is present to provide a cobalt concentration of 1 to 3 parts per million in the product.

5. The process of claim 4 wherein the polymerization temperature is 110 to 120°C.