[0005] Research in this area has been wide ranging, and improvements that may provide the catalysts with increased efficiency and/or an extended useful life have been sought in the areas of components of the catalyst, e.g., carriers, promoters, and catalytic species, methods of making the catalyst and even the epoxidation processes themselves. And yet, further improvement would be welcome in the art.

[0006] Desirably, methods would be provided that would be capable of producing epoxidation catalysts that exhibit an increase in efficiency relative to conventional catalysts.

SUMMARY

[0007] The present disclosure provides methods for producing epoxidation catalysts that exhibit enhanced efficiencies relative to conventionally produced epoxidation catalysts. More specifically, the present methods provide for the selective impregnation of a catalyst support. It has now been surprisingly discovered that when at least a portion of manganese is impregnated onto a support separate from other alkali metals and/or promoters, the resulting catalyst can exhibit enhanced efficiencies, e.g., of up to 1% greater than catalysts prepared according to conventional methods.

[0008] And so, a method for making an epoxidation catalyst is provided. The epoxidation catalyst comprises a support, at least one catalytic species, manganese and at least one alkali metal and/or promoter. The method comprises impregnating at least a portion of the manganese in an impregnation step separate from the at least one alkali metal and/or promoter. In some embodiments, the manganese may be impregnated onto the support in combination with at least one catalytic species, which in some embodiments may comprise silver.

[0009] An epoxidation catalyst prepared according to the method is also provided. The at least one alkali metal and/or promoter may comprise rhenium, sodium, cesium, lithium, sulfate or combinations of these. In certain embodiments,

the at least one alkali metal and/or promoter desirably comprises rhenium. In these and other embodiments, the catalytic species may comprise silver.

[0010] The epoxidation catalyst, in turn, is expected to exhibit efficiencies of up to 1% greater than epoxidation catalysts produced according to conventional methods. As such, there is also provided a method for the epoxidation of alkylenes. The epoxidation method comprises contacting an oxygen source and an alkylene in the presence of an epoxidation catalyst, wherein the epoxidation catalyst is prepared by impregnating at least a portion of a quantity of manganese in an impregnation step separate from at least one alkali metal and/or promoter.

[0011] The increased efficiencies exhibited by the epoxidation catalysts are expected to provide benefit to further downstream products, e.g., in the form of reduced use of materials, reduced time in purifying a final products, etc. There is thus also provided a method for making a 1,2-diol, a 1,2-diol ether, a 1,2-carbonate, or an alkanolamine. The method comprises converting an alkylene oxide into the 1,2-diol, a 1,2-diol ether, a 1,2-carbonate, or alkanolamine. The alkylene oxide is prepared utilizing a catalyst prepared according to the methods described.

[0011a] In one aspect, there is provided a method for the epoxidation of one or more alkylenes comprising contacting one or more feed streams comprising an oxygen source and an alkylene in the presence of an epoxidation catalyst, wherein the epoxidation catalyst comprises a support, silver, manganese and sodium, and is prepared by a method comprising the process steps of (A), (B), (C) or (D) wherein:

step (A) comprises depositing silver on the support; impregnating the support with manganese alone; and then coincidentally or sequentially impregnating the support with sodium;

step (B) comprises impregnating the support with silver and manganese and then impregnating the support with further silver, manganese and sodium;

step (C) comprises impregnating the support with manganese and then impregnating the support with silver and sodium;

step (D) comprises impregnating the support with silver and manganese and then impregnating the support with further silver and sodium.

DESCRIPTION OF THE DRAWINGS

[0012] These and other features, aspects and advantages of the present invention may be further understood and/or illustrated when the following detailed description is considered along with the attached drawings.

[0013] FIG. 1 is a graphical depiction of the % efficiency versus % outlet ethylene oxide concentration of a conventional epoxidation catalyst as well as an epoxidation catalyst produced according to one embodiment of the method;

[0014] FIG. 2 is a graphical depiction of the % efficiency versus % outlet ethylene oxide concentration of a conventional epoxidation catalyst as well as an epoxidation catalyst produced according to one embodiment of the method;

WE CLAIM:

1. A method for the epoxidation of one or more alkylenes comprising contacting one or more feed streams comprising an oxygen source and an alkylene in the presence of an epoxidation catalyst, wherein the epoxidation catalyst comprises a support, silver, manganese and sodium, and is prepared by a method comprising the process steps of (A), (B), (C) or (D) wherein

step (A) comprises depositing silver on the support; impregnating the support with manganese alone; and then coincidentally or sequentially impregnating the support with sodium;

step (B) comprises impregnating the support with silver and manganese and then impregnating the support with further silver, manganese and sodium;

step (C) comprises impregnating the support with manganese and then impregnating the support with silver and sodium;

step (D) comprises impregnating the support with silver and manganese and then impregnating the support with further silver and sodium.

2. The method of claim 1, wherein the catalyst is made by process step (A).

3. The method of claim 1, wherein the catalyst is made by process step (B).

4. The method of claim 1, wherein the catalyst is made by process step (C).

5. The method of claim 1, wherein the catalyst is made by process step (D).

6. The method of claim 1, wherein the manganese comprises Mn-EDTA complex.

7. The method of claim 1, wherein between each successive impregnation step the impregnated support is dried, or calcined and/ or roasted.

METHODS FOR PRODUCING EPOXIDATION CATALYSTS AND EPOXIDATION METHODS UTILIZING THEM

ABSTRACT

[0111] A method for producing epoxidation catalysts is provided. Advantageously, catalysts produced by the present method may exhibit efficiencies of up to or more than 1% greater than catalysts produced by conventional methods. A method for the epoxidation of alkylenes using the catalysts so produced is provided as is a method for using the alkylene oxides for the production of 1,2-diols, 1,2-carbonates, 1,2-diol ethers, or alkanolamines.

Figure 1