[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. However, it is often the case that adjustments in one or more of these may result in an improvement in one of catalyst efficiency, activity, or lifetime while yet resulting in a concurrent decrement in another. Or, any such adjustments may require conditions that cannot be produced within the epoxidation process, or if reproducible therewithin, require a reduction, or complete shut-down, in the production of the epoxidation product.

[0006] Desirably, methods would be provided that could be utilized to enhance the efficiency and/or activity of such epoxidation catalysts. Any such methods would be particularly beneficial if they could provide such enhancements over the lifetime of the catalyst, and in particular, if they could be utilized in situ, i.e., while the catalyst is in place, and/or being used in an epoxidation reaction.

SUMMARY ~~OF THE INVENTION~~

[0007] The present disclosure~~invention~~ provides methods for enhancing the efficiency of epoxidation catalysts. The enhancements to efficiency reduce raw material consumption and waste production. The efficiency enhancements may also, in turn, result in the catalysts being capable of providing commercially acceptable through-puts for a greater length of time, so that the typically expensive and time-consuming catalyst change-out may be required less frequently. Advantageously, the present methods may be carried out within epoxidation equipment, thereby providing time savings in these embodiments of the invention. Additionally, the present method may be carried out during start-up, or at any point during the epoxidation process without a substantial decrease in through-put, so that additional cost-savings may be provided in certain embodiments.

[0007a] In a first aspect, there is provided a method for enhancing the efficiency of a rhenium and cesium-promoted silver based epoxidation catalyst in situ comprising contacting the catalyst with a feed comprising a gas phase epoxidation reaction promoter at an elevated temperature of from at least 240°C to less than or equal to 250°C for at least 2 hours and then reducing the temperature to a reduced temperature of less than or equal to 230°C, wherein the feed further comprises carbon dioxide at a concentration of less than 5 mole % when the temperature is at least 240°C.

[0008] In a first embodiment~~aspect~~, the present disclosure~~invention~~ provides a method for enhancing the efficiency of a rhenium-promoted epoxidation catalyst. The method comprises contacting the catalyst with a feed comprising a gas phase epoxidation reaction promoter at an elevated temperature of at least about 240°C, or, in some embodiments of less than or equal to 250°C, for at least about 2 hours, or for at least about 6 hours, preferably for at least about 12 hours, or even for at least about 24 hours, or longer. The temperature is then reduced to a temperature of less than or equal to about 230°C. Advantageously, the gas-phase promoter concentration can be maintained during the period at elevated temperature, or if desired, the promoter concentration can be caused to differ. Application of the present method to epoxidation catalysts may result in increases in the efficiency of the catalyst of at least about 0.1%, or even at least about 1.0%, relative to the efficiency of the catalyst prior to initiation of the method.

[0009] Advantageously, the method of the present disclosure~~invention~~ may be carried out in situ, i.e., within epoxidation equipment during start-up or normal operation of the epoxidation process. Because the method may provide the catalysts with an enhanced lifetime, the time period between catalyst change-outs may be lengthened and cost and time savings may be realized.

[0009a] In a second aspect, there is provided a method for the epoxidation of ethylene comprising contacting a rhenium promoted silver-based epoxidation catalyst with a feed comprising a gas phase epoxidation reaction promoter, oxygen and one or more alkylenes at an elevated temperature of from at least 240°C to less than or equal to 250°C for at least 2 hours, and subsequently reducing the temperature to a reduced temperature of less than or equal to 230°C , wherein the feed further comprises carbon dioxide at a concentration of less than 5 mole % when the temperature is at least 240°C.

[0010] In a second embodiment~~aspect~~ then, the present disclosure~~invention~~ provides a method for the epoxidation of one or more alkylenes. The method comprises contacting the catalyst with a feed comprising a gas phase epoxidation reaction promoter, oxygen and one or more alkylenes at an elevated temperature of at least about 240°C for at least about 2 hours, or for at least about 6 hours, or at least about 12 hours, or even at least about 24 hours, or longer. The temperature is subsequently reduced to a temperature of less than or equal to about 230°C. Advantageously, the concentration of the promoter, oxygen and one or more alkylenes may remain constant, or if desired, may be altered during one or more of the temperature stages.

[0010a] In a third aspect, there is provided a method for making a 1,2-diol, a 1,2-diol ether, a 1,2-carbonate, or an alkanolamine comprising converting an alkylene oxide into the 1,2-diol, a 1,2-diol ether, a 1,2-carbonate, or alkanolamine, wherein the alkylene oxide has been prepared by a method for the epoxidation of alkylenes comprising contacting a rhenium promoted silver-based epoxidation catalyst with a feed comprising a gas phase epoxidation reaction promoter, oxygen and one or more alkylenes at an elevated temperature of from at least 240°C to less than or equal to 250°C for at least 2 hours, and subsequently reducing the temperature to a reduced temperature of less than or equal to 230°C, wherein the feed further comprises carbon dioxide at a concentration of less than 5 mole % when the temperature is at least 240°C.