have focused on providing a support having a combination of these properties that not only provides a sufficiently robust support to be commercially useful, but that also may readily be impregnated with the desired amount of catalytic species.

[0005] Very little attention has been paid to the particular conditions of the impregnation, and the impact of the same on the amount of catalytic species ultimately deposited, although it is generally thought that conducting the impregnations under conditions of a fairly high vacuum is required. More particularly, high vacuum levels, i.e., vacuum levels having low minimum residual pressures, e.g., of no more than 1–2 inches mercury, absolute (34–68 mbar), are recognized in the art as being required in order to remove trapped air from the pores of the support and to thus assist in the permeation of the catalytic species, or a precursor thereof, therein.

[0006] However, the use of excessive vacuum levels can add undesirable equipment cost, as well as time, to a catalyst production process. It would be beneficial to provide a method of providing such catalysts that can utilize supports having the desired characteristics, achieve the desired level of catalytic species loading, while yet, utilizing fewer resources.

SUMMARY ~~OF THE INVENTION~~

[0007] The present ~~invention~~ disclosure provides such methods. More particularly, it has now been surprisingly discovered that desired levels of catalyst species loading, e.g., from 80% to 98% of a maximum loading, can be obtained even if the supports upon which the catalytic species, or a precursor thereof, is to be impregnated upon are evacuated to a lesser level of vacuum having a higher minimum residual pressure than appreciated by the art as being required to achieve the same. This is unexpected since it has previously been thought that as surface areas trend upward and pore sizes commensurately trend downward in the art, higher vacuums having lower minimum residual pressures would need to be drawn in order to evacuate air therefrom, and to assist in the permeation of the impregnation solution there into in

order to provide the desired loading levels. The present methods are able to produce catalysts having the desired loading levels of catalytic species at a lesser vacuum level (having a higher minimum residual pressure) than previously appreciated by the art, thereby providing equipment cost and time savings.

[0008] In a first aspect, there is provided a method for providing an ethylene oxide epoxidation catalyst comprising exposing a carrier to a vacuum having a minimum residual pressure of greater than 200 mbar, absolute, and less than 1000 mbar, absolute, and thereafter contacting the carrier with an impregnation solution comprising a catalytic species or precursor thereof comprising silver. In a first ~~aspect~~embodiment, the present ~~invention~~ disclosure provides a method of providing an epoxidation catalyst. The method comprises exposing a porous carrier to a vacuum having a minimum residual pressure of greater than 135 mbar, absolute, and contacting the carrier with an impregnation solution comprising a catalytic species, or a precursor thereof, while so exposed. And, in some embodiments, the contact may also occur at temperatures of less than 50°C, or less than 40°C, or less than 35°C. Further, the exposing, the contacting, or both, may be carried out more than once, if desired, and in some embodiments, may be carried out two or more times. The minimum residual pressure of the vacuum may typically be less than 1000 mbar, absolute. The carrier so prepared may be further processed by exposing the same to an elevated temperature of, e.g., at least 200°C following separation from the excess, i.e. non-impregnated, impregnation solution.

[0009] The method is expected to be beneficial to any carrier useful as a catalyst support, regardless of the physical properties thereof. However, in some embodiments, particular benefit may be provided to carriers i) having a surface area of at least 1.1 m^2/g and/or ii) having at least 5% of its total pore volume being present in pores having a pore diameter of greater than 3 microns and/or iii) having at least two pore size distribution peaks in the pore diameter range of from 0.01 microns to 100 microns and having a median pore diameter of greater than 1.1 micron.

[0010] Furthermore, the method is expected to be useful to provide any desired catalyst, comprising any desired catalytic species. In a second aspect, there is provided an epoxidation catalyst prepared as defined above. In some embodiments, an epoxidation catalyst is provided, and in such embodiments, the catalytic species may desirably comprise silver. In such cases, and depending on the properties of the

carrier, a catalytic species loading of at least 10 wt.% Ag, or at least 14 wt.% Ag, or even at least 18 wt.% Ag, the weight percentages being based on the total weight of the epoxidation catalyst, can be provided on the carrier after a single sequence of exposing, contacting, and processing at elevated temperature. Epoxidation catalysts typically comprise one or more promoters, and so, the impregnation solution may include the same. In some embodiments, the one or more promoters may include rhenium, molybdenum, tungsten, lithium, sulfur, manganese, rubidium, cesium, sodium, potassium, or combinations of these. In other embodiments, the one or more additional promoters may comprise rhenium and/or cesium.

[0011] Epoxidation catalysts produced by the present method are expected to exhibit advantageous properties due to the inclusion thereupon of a desirable catalytic species loading, and are further expected to be capable of production at a cost savings relative to conventional methods that employ much higher vacuum levels having much lower minimum residual pressures. And so, in another ~~aspect~~embodiment, an epoxidation catalyst prepared according to the method is provided.

[0012] The advantageous catalytic species loading, and cost savings provided by the present method are not only expected to translate to improvements in one or more catalyst properties, but also, are expected to provide improvements to the processes in which the catalysts are utilized. As a result, and in yet another ~~aspect~~embodiment, the present ~~invention~~ disclosure provides a process for the epoxidation of an alkylene. In a third aspect, there is provided a method for the epoxidation of one or more alkylenes comprising contacting an oxygen source and an alkylene in the presence of an epoxidation catalyst prepared as defined above, wherein the alkylene comprises ethylene. The process comprises reacting a feed comprising one or more alkylenes and oxygen in the presence of a catalyst prepared according to the method.

[0012a] In a fourth 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 prepared as defined above into the 1,2-diol, a 1,2-diol ether, a 1,2-carbonate, or alkanolamine

[0013] The advantages provided to such processes can be further leveraged by utilization of the alkylene oxides produced thereby in further downstream processes, and such processes are thus provided in yet another ~~aspect~~ embodiment of the invention. More specifically, the present ~~invention~~ disclosure also provides a process for preparing a 1,2-diol, a 1,2-diol ether, a 1,2-carbonate, or an alkanolamine. The process comprises converting an alkylene oxide into the 1,2-diol, 1,2-diol ether, a 1,2-carbonate, or