[006] There is still a need for improved catalysts with balanced material costs, while still offering excellent morphology, structure and catalytic activity. There is also a need for improved processes to prepare catalysts for use in the conversion of heavy oils and residua. There is a further a need for improved heavy oil upgrade processes with reduced build-up of heavy metal contaminants.

SUMMARY OF THE ~~INVENTION~~ DISCLOSURE

[007] In one aspect, the ~~invention~~ disclosure relates to a catalyst feed system for use in the upgrade of heavy oil feedstock. The catalyst feed system comprises: a) a deoiled spent catalyst comprising a plurality of dispersed particles slurried in a hydrocarbon medium as a slurry, the deoiled catalyst retaining less than 80% but more than 10% of its original catalytic activity; and b) a fresh slurry catalyst comprising a plurality of dispersed particles in a hydrocarbon medium as a slurry. The deoiled spent catalyst is present in an amount of at least 10% the catalyst feed system to trap metal contaminants in the system and reduce metal deposits.

[007a] In another aspect, the disclosure relates to a method to reduce deposit of at least a metal contaminant from a heavy oil feedstock in a system to upgrade the heavy oil feedstock, comprising: providing a fresh slurry catalyst comprising a plurality of dispersed particles in a hydrocarbon medium as a slurry at a total concentration of 500 wppm to 3 wt.% of metals to heavy oil feedstock; providing a deoiled spent catalyst comprising a plurality of dispersed particles slurried in a hydrocarbon medium as a slurry, at a ratio of fresh slurry catalyst to deoiled spent catalyst ranging from 1:5 to 5:1, the deoiled spent catalyst having less than 80% but more than 10% of original catalytic activity; and contacting the heavy oil feedstock with the fresh slurry catalyst and the deoiled spent catalyst under hydrocracking conditions to convert at least a portion of the heavy oil feedstock to lower boiling hydrocarbons, forming upgraded products; wherein the deoiled spent catalyst being present in the catalyst feed system in a sufficient amount to reduce the deposit of the metal contaminant in the upgrade system of at least 5% compared to an upgrade system without the deoiled spent catalyst.

[007b] In another aspect, the disclosure relates to a method to reduce deposit of at least a metal contaminant from a heavy oil feedstock in a system to upgrade the heavy oil

feedstock, the method comprising: replacing at least a portion X of a catalyst feed system comprising a fresh slurry catalyst with a deoiled spent catalyst as a replacement, the deoiled spent catalyst comprising a plurality of dispersed particles slurried a hydrocarbon medium as a slurry, the deoiled spent catalyst having less than 80% but more than 10% of original catalytic activity; contacting the heavy oil feedstock with the catalyst feed system comprising the fresh slurry catalyst and the replacement deoiled spent catalyst; wherein the replacement deoiled spent catalyst being present in an amount of at least 2X for the system to have a reduction of at least 5% in deposit from the at least one metal contaminant.

~~[008]~~

~~[009]~~[008] In another aspect, the ~~invention~~ disclosure relates to a method to trap metal contaminants from a heavy oil feedstock in a system to upgrade the heavy oil feedstock. The method comprises providing to the heavy oil upgrade system a catalyst feed, which contains: a) a fresh slurry catalyst comprising a plurality of dispersed particles in a hydrocarbon medium as a slurry; and b) a deoiled spent catalyst comprising a plurality of dispersed particles slurried a hydrocarbon medium as a slurry. The deoiled spent catalyst has less than 80% but more than 10% of original catalytic activity, and the deoiled spent catalyst is present in the catalyst feed in a sufficient amount to trap the metal contaminants for the upgrade system to have a reduction of at least 5% in metal contaminant deposit.

~~[010]~~[009] In yet another aspect, the ~~invention~~ disclosure relates to a method to prepare a catalyst feed for a heavy oil upgrade system. The method comprises the steps of: providing spent catalyst with a solid content ranging from 5 to 50 wt. % in soluble hydrocarbons and having less than 80% but more than 10% of original catalytic activity; removing at least 50% of the soluble hydrocarbons removed in a deoiling step, generating a deoiled spent catalyst with at least a metal contaminant; treating the deoiled spent catalyst with a treating solution to reduce the concentration of metal contaminants; slurring the treated deoiled spent catalyst in a hydrocarbon medium, generating a treated deoiled spent catalyst slurry; and feeding the treated deoiled spent catalyst slurry to a heavy oil upgrade system with a fresh slurry catalyst.

[009a] In yet another aspect, the disclosure relates to a method to prepare a catalyst feed for a system to upgrade a heavy oil feedstock, comprising: providing a first

slurry catalyst that has been used in a hydroprocessing operation with a solid content ranging from 5 to 50 wt. % in soluble hydrocarbons and having less than 80% but more than 10% of original catalytic activity; removing at least 50% of the soluble hydrocarbons in a deoiling step, generating a deoiled spent catalyst comprising at least 1 wt. % of at least a metal contaminant; treating the deoiled spent catalyst with a treating solution containing at least one of water, a mineral acid, an oxidizing agent, and combinations thereof at a volume ratio of treating solution to deoiled spent catalyst ranging from 2:1 to 100:1 for a treated deoiled spent catalyst having a reduced concentration of the at least a metal contaminant; mixing the treated deoiled spent catalyst with a hydrocarbon diluent, generating a treated deoiled spent catalyst slurry; providing a fresh slurry catalyst comprising a plurality of dispersed particles in a hydrocarbon diluent as a slurry; and feeding the fresh slurry catalyst and the treated deoiled spent catalyst slurry to the heavy oil upgrade system as a catalyst feed.