numbers 1 , 2 and 3). The system is capable of supplying refrigeration at temperature levels from below -140C to near ambient temperature level.

U.S. Patent 6,705,113 teaches the use of a single refrigeration system, again with three components, utilizing a different process configuration than U.S. Patent 6,637,237. However, both U.S. Patent 6,637,237 and U.S. Patent 6,705,113 require three components to supply the required refrigeration duties at the required temperature levels. Using three components means that the composition at any given system temperature and pressure does not correspond to a unique composition but rather to a range of compositions. Thus, the composition of the refrigerant mixture at any given point in the system can vary. While this variation is small and does not appreciably detract from the performance of the refrigeration system, it may be preferable to operate a system that has no refrigerant composition variation at a given temperature and pressure to more easily adjust to changes in ethylene plant operating conditions.

**Summary**

~~It is an object of the~~ Embodiments disclosed herein seek to provide a simplified, single refrigeration system utilizing a mixture of methane with a C3 hydrocarbon as a binary refrigerant. As this binary system is not a continuous mixture of carbon number hydrocarbons but rather has only C1 and C3 hydrocarbon components, this system is referred to as an extended binary refrigerant. This extended binary system can be used to replace the separate propylene, ethylene and methane refrigeration systems associated with a recovery process using a low pressure demethanizer, or the binary or tertiary refrigeration systems utilizing hydrocarbons with consecutive carbon numbers. One use for the system is in an olefins plant.

Disclosed herein ~~One embodiment~~ is a method comprising cooling a feed gas using an extended binary refrigerant containing a mixture of methane and a C3 hydrocarbon selected from the group consisting of propylene and propane, the extended binary refrigerant being compressed in a multistage compressor having a first stage and a last stage with a last stage discharge containing at least 60 mol % of the C3 hydrocarbon, and being divided into

a liquid coolant stream and a gaseous coolant stream after compression.

The C3 hydrocarbon preferably is propylene. The last stage discharge typically contains at least 70 mol % propylene and sometimes at least 75 mol % propylene. In some cases, the last stage discharge contains 10-40 mol % methane and 60-90 mol % C3 hydrocarbon.

Often, at least 90 wt % of the C3 hydrocarbon is propylene with the remainder being propane. Typically, the extended binary refrigerant contains 15-25 mol % methane and 75-85 mol % propylene, and sometimes 18-22 mol % methane and 78-82 mol % propylene. In many cases, the feed gas contains an olefin and the method comprises removing the olefin from the cooled feed gas by fractionation.

Also disclosed herein~~A further embodiment~~ is a method for cooling with an extended binary refrigerant comprising: (a) compressing a mixture comprising 10-40 mol % methane and 60-90 mol % of at least one C3 hydrocarbon selected from the group consisting of propylene and propane in a compressor to produce an extended binary refrigerant vapor, (b) cooling the extended binary refrigerant vapor to condense a portion thereof and provide a vaporous methane-rich binary refrigerant stream and a liquid C3 hydrocarbon-rich binary refrigerant stream, (c) employing the methane-rich binary refrigerant stream and the C3 hydrocarbon-rich binary refrigerant stream to effect cooling, and (d) returning the methane-rich binary refrigerant stream and the C3 hydrocarbon-rich binary refrigerant stream to the compressor.

Sometimes, in (c), the methane-rich binary refrigerant stream and the C3 hydrocarbon-rich binary refrigerant stream cool a charge gas comprising hydrogen, methane and ethylene. The charge gas typically is used to produce ethylene.

Also disclosed herein~~Yet another embodiment~~ is a method to be used in the production of olefins from a charge gas containing hydrogen, methane, ethylene and optionally including other C2 and heavier hydrocarbons, wherein the charge gas is cooled by a refrigeration system having a series of heat exchangers. The charge gas is cooled in a method comprising: (a) compressing an extended binary refrigerant vapor comprising a mixture of methane and a

vapor, at low pressure, is injected into the liquid refrigerant stream entering an ethylene fractionator condenser, downstream of a valve regulating flow of the liquid refrigerant stream into the ethylene fractionator condenser. Optionally, the direct refrigeration duty of the extended binary refrigerant is decreased by heat exchange between an ethane recycle to a cracking heater that is produced at the bottom of the fractionating tower, after pressure letdown, and a gross overhead vapor flowing from the top of the fractionating tower. T~~In another embodiment, t~~he direct refrigeration duty of the extended binary refrigerant is decreased by heat exchange between an ethane recycle to a cracking heater that is produced at the bottom of the fractionating tower, after pressure letdown, and the refrigerant flowing to the ethylene fractionator condenser.

In some cases, the first light hydrocarbon separation tower is a depropanizer, and the depropanization is split into two towers, with one at a higher pressure. Sometimes the higher pressure tower overhead vapor is at least partially condensed in an interreboiler to provide reflux for the high pressure tower.

T~~In one embodiment, t~~he method may further comprise~~s~~ the step of deethanizing the charge gas, wherein no deethanizer condenser is provided and reflux for the deethanizer is withdrawn proximate a feed tray where a deethanizer gross overhead enters the fractionating tower. The charge gas typically is derived from refinery offgases, the catalytic hydrogenation of propane, or steam cracking of hydrocarbons.

In an aspect, there is provided~~A further embodiment is~~ an extended binary refrigerant comprising a mixture of methane and a C3 hydrocarbon selected from the group consisting of propylene and propane, the extended binary refrigerant containing 10-40 mol % methane, 60-90 mol % of at least one C3 hydrocarbon selected from the group consisting of propylene and propane. The refrigerant contains no more than about 2 mol % hydrogen, with the total mol % of methane, C3 hydrocarbon and hydrogen being 100 %. Usually, the extended binary refrigerant can provide refrigeration within the temperature range of about -136 Deg. C to about 25 Deg. C.