used HBr or a mixture of $H_2S$ and $NH_3$ as a homogeneous catalyst to promote selectivity of isoprene in a thermal cracking reaction. Goodyear tests with HBr showed single pass yields of 54.5% mol. isoprene from 2–methy- 2-pentene. The isoprene then can be separated from this mixture by using extractive distillation. This work is discussed in Lloyd M. Elkin, Isoprene, Stanford Research Institute Process Economics Report No. 28 (p. 60), 1967.

An alternate isoprene production route is to dehydrogenate isoamylenes (methyl butenes). The dehydrogenation step has been practiced commercially by Air Products using their Catofin process. Isoamylenes typically have been recovered by steam cracking $C_5$ product streams. In those cases however, the process is complicated by the presence of cyclopentadiene. The $C_5$ product stream requires selective hydrogenation to remove the dienes that would rapidly foul a dehydrogenation catalyst. The dehydrogenation step is also very costly, requiring vacuum operation and significant capital expense. Isoamylenes can also be formed by the metathesis of butenes and propylene, as is described in Ind. & Eng. Chemistry Prod. Res. Develop., Vol. 10, No. 1, 1071 pg. 46). These isoamylenes can then be dehydrogenated to isoprene as above.

It would be useful to develop a process that results in a high yield of 2-methyl-2-pentene from mixed $C_4$ olefin streams, combined with high butenes conversion. The 2-methyl-2-pentene can then be used to produce isoprene.

## Summary

In one aspect, there is provided a process comprising:

obtaining a mixed $C_4$ stream comprising isobutylene, 1-butene and 2-butene,

removing at least a portion of the 2-butene,

isomerizing the removed portion of the 2-butene in an isomerization reactor to obtain additional 1-butene, and combining the additional 1-butene with the remainder of the mixed $C_4$ stream to form a mixed $C_4$ metathesis feed stream comprising isobutylene and 1-butene,

reacting the mixed $C_4$ metathesis feed stream in a first metathesis reactor in the presence of a first metathesis catalyst under conditions sufficient to produce an intermediate product stream comprising at least 30 wt. % 2-methyl-2-pentene based upon the olefin content of fresh feed in the mixed $C_4$ metathesis feed stream, and at least one of ethylene and propylene,

separating the 2-methyl-2-pentene,

subjecting the separated 2-methyl-2-pentene to pyrolysis to produce a reaction product stream comprising isoprene, and

separating the isoprene into an isoprene product stream using fractionation.

In another aspect, there is provided a process comprising:

obtaining a mixed $C_4$ stream comprising isobutylene, 1-butene and 2-butene,

separating the mixed $C_4$ stream to form a 2-butene stream and a mixed $C_4$ metathesis feed stream comprising isobutylene and 1-butene,

reacting the mixed $C_4$ metathesis feed stream in the presence of a first metathesis catalyst under conditions sufficient to produce an intermediate product stream comprising at least 30 wt. % 2-methyl-2-pentene based upon the olefin content of fresh feed in the mixed $C_4$ metathesis feed stream and at least one of ethylene and propylene,

fractionating the intermediate product stream to form a 2-methyl-2-pentene stream and at least one of an ethylene stream and a propylene stream,

subjecting the separated 2-methyl-2-pentene stream to pyrolysis to produce a reaction product stream comprising isoprene, and

separating the isoprene to form an isoprene product stream using fractionation.

In another aspect, there is provided a process comprising:

obtaining a mixed $C_4$ stream comprising isobutylene, 1-butene and 2-butene,

reacting the mixed $C_4$ stream and ethylene in a second metathesis reactor to obtain a metathesis product stream comprising ethylene, propylene, isobutylene and 1-butene, and removing at least a portion of the ethylene and propylene to form the mixed $C_4$ metathesis feed stream,

reacting the mixed $C_4$ metathesis feed stream in a first metathesis reactor in the presence of a first metathesis catalyst under conditions sufficient to produce an intermediate product stream comprising at least 30 wt. % 2-methyl-2-pentene based upon the olefin content of fresh feed in the mixed $C_4$ metathesis feed stream, and at least one of ethylene and propylene,

separating the 2-methyl-2-pentene,

subjecting the separated 2-methyl-2-pentene to pyrolysis to produce a reaction product stream comprising isoprene, and

separating the isoprene into an isoprene product stream using fractionation.

One embodiment is a process comprising reacting a mixed $C_4$ metathesis feed stream comprising isobutylene and at least one of 1-butene and 2-pentene in a first metathesis reactor in the presence of a first metathesis catalyst under conditions sufficient to produce an intermediate product stream comprising at least 30 wt. % 2-methyl-2-pentene based upon the olefin content of fresh feed in the mixed $C_4$ metathesis feed stream, and at least one of ethylene and propylene, separating the 2-methyl-2-pentene, subjecting the separated 2-methyl-2-pentene to pyrolysis to produce a reaction product stream comprising isoprene, and separating the isoprene into an isoprene product stream using fractionation.

Another embodiment is a process comprising reacting a mixed $C_4$ metathesis feed stream comprising isobutylene and 1-butene in the presence of a first metathesis catalyst under conditions sufficient to produce an intermediate product stream comprising 2-methyl-2-pentene and at least one of ethylene and propylene, fractionating the intermediate product stream to form a 2-methyl-2-pentene stream and at least one of an ethylene stream and a propylene stream, subjecting the separated 2-methyl-2-pentene stream to pyrolysis to produce a reaction product stream comprising isoprene, and separating the isoprene to form an isoprene product stream using fractionation.