What these two processes have in common is that in each case only one component is recovered from the dehydrogenation mixture.

Besides the linear butenes, the reaction mixture obtained in the dehydrogenation of n-butane comprises n-butane and 1,3-butadiene. The recovery of pure 1-butene and pure 1,3-butadiene, the latter being amenable to reaction in further step to give downstream products, from mixtures of this kind by distillation is uneconomic, owing to the small differences between them in boiling point. Similarly, the removal of the 1,3-butadiene by extraction or extractive distillation is complex and expensive.

The object of the present embodiments disclosed hereininvention is to provide a process which allows 1-butene and a butadiene derivative to be prepared economically from n-butane.

This object is achieved by means of the process described hereinafter.

A process for preparing 1-butene and a 1,3-butadiene derivative, comprising the steps of:
a) non-oxidatively catalytically dehydrogenating a feedstock gas stream comprising n-butane, hydrogen, other low-boiling secondary constituents, high boilers and optionally water, to form a product mixture comprising unreacted n-butane, 1-butene, the two 2-butenes, 1,3-butadiene, hydrogen, other low-boiling secondary constituents, high boilers and optionally water, the feedstock gas stream containing no C_4 iso compounds;
b) removing hydrogen, other low boilers, high boilers and, if present, water, to give a product mixture comprising n-butane, 1-butene, the two butenes and 1,3-butadiene;
c) reacting some of the 1,3-butadiene obtained in step b), to form a derivative;
d) removing the 1,3-butadiene derivative obtained in step c);
e) selectively hydrogenating the 1,3-butadiene not derivatized in step c), to form 1-butene;
f) distillatively removing 1-butene from the hydrocarbon stream obtained in step e), to leave a residual stream.

In one aspect, there is provided a process for preparing 1-butene and a 1,3-butadiene derivative, comprising the steps of:

a) non-oxidatively catalytically dehydrogenating a feedstock gas stream comprising n-butane, hydrogen, other low-boiling secondary constituents and high boilers, to form a product mixture comprising unreacted n-butane, 1-butene, the two 2-butenes, 1,3-butadiene, hydrogen, other low-boiling secondary constituents and high boilers;

b) removing hydrogen, other low boilers and high boilers, to give a product mixture comprising n-butane, 1-butene, the two butenes and 1,3-butadiene;

c) reacting some of the 1,3-butadiene obtained in step b), to form a derivative;

d) removing the 1,3-butadiene derivative obtained in step c);

e) selectively hydrogenating the 1,3-butadiene not derivatized in step c), to form 1-butene;

f) distillatively removing 1-butene from the hydrocarbon stream obtained in step e), to leave a residual stream.

In one embodiment of the process, the residual stream obtained in step f) is supplied wholly or partly to the feedstock gas stream, in other words back into the dehydrogenating unit in which step a) of the process takes place.

The present disclosure~~invention~~ has the advantage that 1-butene and a butadiene derivative can be prepared inexpensively from n-butane. The proportion of the two target products here can be varied by adjusting the dehydrogenating conditions and the butadiene conversion rate. The specific version of the invention is notable, furthermore, for the fact that a very high fraction of the olefins formed during the dehydrogenation are converted into valuable products, and so only a small amount of butenes is introduced with the recycle stream into the dehydrogenation reactor.

In one embodiment of the disclosure~~invention~~, the linear butenes present in the residual stream are at least partly reacted prior to the supplying, and the reaction products are removed from the residual stream prior to the supplying.

In one embodiment of the disclosure~~invention~~, this reaction is an oligomerization.

Feedstocks

Feedstocks which can be used for the process of the invention include the n-butane fraction from field butanes, mixtures of linear C_4 hydrocarbons produced in the processing of C_4 cuts from steam crackers or FC crackers, or other mixtures of linear C_4 hydrocarbons that are produced in other industrial operations.

Field butanes is the term used for the C_4 fraction of the "wet" fractions of natural gas and also of the gases accompanying petroleum, said fractions being removed in liquid form from the gases by cooling to around -30°C. Low-temperature distillation produces the field butanes, their composition varying according to deposit, but generally containing about 30% by mass of isobutane and 65% by mass of n-butane. Other constituents are generally about 2% by mass of hydrocarbons with fewer than 4 C atoms, and about 3% by mass of hydrocarbons with more than 4 C atoms. Following distillative removal of the isobutane, this mixture can be used in the process of the invention. As an option, before the dehydrogenating step in the process of the invention, the hydrocarbons that do not have 4 C atoms can be removed wholly or partly as well.

In one embodiment of the process, the feedstock gas stream from step a) is the n-butane fraction from field butanes.