CLAIMS

1. A process comprising

continuously contacting an alkane feed at a temperature within a range from 300°C to 600°C and a pressure within the range from 50 psig to 500 psig with one or more reactive ceramic membranes to form an alkene with some remaining alkane and hydrogen, the hydrogen in physical isolation from the alkane and alkene, the one or more reactive ceramic membranes comprising one or more proton-conducting electrolyte films, one or more porous anode supports and one or more porous cathodes,

separating the alkene from the remaining alkane, and

recycling the alkane to contact the reactive ceramic membrane,

wherein the alkane is fed to the one or more porous anode supports and an electrical field is applied across the one or more reactive ceramic membranes in order to electrochemically deprotonate the alkane to produce the corresponding alkene.

2. The process of claim 1, wherein the alkene and remaining alkane are cooled to a temperature with a range from -30°C to 40°C prior to separating the alkene from the remaining alkane.

3. The process of claim 1, wherein the separating step comprises a deethanizer column followed by a C2 splitting column.

4. The process of claim 1, wherein the alkane feed comprises at least 80 wt%, by weight of the feed, or ethane, the remaining portion comprising methane, propylene, and butane.

5. The process of claim 1, wherein the alkane feed is first passed to a demethanizer column prior to contacting with the reactive ceramic membrane.

6. The process of claim 5, wherein the alkane feed is at a pressure within a range from 400 psig to 1800 psig, and a temperature within a range from 0°C to 80°C prior to entering the dementhanizer column.

7. The process of claim 1, wherein the reactive ceramic membranes comprise Group 2-Rare Earth complex oxides.

8. The process of claim 1, wherein contacting takes place in a membrane reactor comprising the one or more reactive ceramic membranes, the membrane reactor a) comprising one or more tubes lined with the reactive ceramic membranes, b) comprising one or more tubes comprising the reactive ceramic membranes, c) comprising one or more tubes having the reactive ceramic membranes layered throughout the one ore more tubes, or d) a combination thereof.

9. An apparatus comprising a membrane reactor comprising one or more reactive ceramic membranes, the membrane reactor having at least one inlet for the introduction of heated alkane feed, at least one first outlet for the removal of hydrogen, a cooler, at least one separating column, and at least one second outlet for the recirculation of unreacted alkane and alkene product first to the cooler then to the at least one separating column to allow recirculation of alkane back to the membrane reactor,
wherein the alkane is fed to the one or more porous anode supports and an electrical field is applied across the one or more reactive ceramic membranes in order to electrochemically deprotonate the alkane to produce the corresponding alkene.

10. The apparatus of claim 9, also having a demethanizer column upstream of the inlet.

11. The apparatus of claim 9, also having a demethanizer column downstream of the inlet.

12. The apparatus of claim 10, also having a feed-product exchanger upstream of the inlet and downstream of the demethanizer column.

13. The apparatus of claim 9, wherein there are two separating columns downstream of the cooler.

14. The apparatus of claim 13, wherein one of the columns is a deethanizer column, and the other column is a C2 splitter column.