

F25J

LIQUEFACTION, SOLIDIFICATION OR SEPARATION OF GASES OR GASEOUS {OR LIQUEFIED GASEOUS} MIXTURES BY PRESSURE AND COLD TREATMENT {OR BY BRINGING THEM INTO THE SUPERCRITICAL STATE (cryogenic pumps [F04B 37/08](#); gas storage vessels, gas holders [F17](#); filling vessels with, or discharging from vessels, compressed, liquefied or solidified gases [F17C](#); refrigeration machines, plants, or systems [F25B](#))}

Definition statement

This place covers:

Processes or systems for liquefying or solidifying gases or gaseous mixtures and for separating the constituents of gaseous or liquid mixtures involving the use of liquefaction or solidification by rectification or partial condensation, the processes or systems use internal and/or external refrigeration to reach very low temperatures, i.e. so-called cryogenic temperatures, in general well below -50°C;

Arrangements of cold exchangers or cold accumulators in cryogenic separation or liquefaction plants.

Relationships with other classification places

If the principal aspect of the application concerns the liquefaction or solidification of a gaseous feed stream but comprises also purification aspects of the feed or product stream in general then the main group concerned is [F25J 1/00](#).

Similarly, if the principal aspect of the application concerns the separation of a feed stream but comprises also the withdrawal of a liquid or solid product stream then the main group concerned is [F25J 3/00](#).

If the application, however, concerns details both about liquefaction or solidification techniques as well as separation techniques than both main groups [F25J 1/00](#) and [F25J 3/00](#) are concerned.

References

Informative references

Attention is drawn to the following places, which may be of interest for search:

Separation processes in general	B01D
Production of chemical compounds in general	C01B
Cryogenic pumps	F04B 37/08
Filling vessels with, or discharging from vessels, compressed, liquefied or solidified gases	F17C
Refrigeration machines, plants, or systems	F25B
Heat exchangers in general	F28C , F28D , F28F

F25J 1/00

Processes or apparatus for liquefying or solidifying gases or gaseous mixtures {(recovering volatile solvents by condensation [B01D 5/00](#); vapor recovery systems combined with filling nozzles [B67D 7/54](#); solidification of carbonic acid [C01B 32/55](#); for ammonia in general [C01C 1/00](#)}}

Definition statement

This place covers:

Processes or systems wherein a gaseous feed or feed mixture is liquefied or solidified using internal and/or external refrigeration and withdrawn as liquefied or solidified product or product mixture. The gases or gaseous mixtures comprises so-called "permanent gases", e.g. noble gases, hydrogen and primary air constituents, and gases or main components of gaseous mixtures having boiling points equal to or lower than -78°C , i.e. the boiling point of carbon dioxide, e.g. natural gas, carbon monoxide.

- Processes or apparatus characterised by the gas or gas mixture to be liquefied or solidified.
- Processes or apparatus characterised by the kind of cold generation for compensating heat leaks and liquid production.
- Processes or apparatus characterised by the refrigerant fluid used.
- Processes or apparatus characterised by details and kind of the refrigeration system used, e.g. by using a single or multi-component vapour compression cycle or a refrigeration cascade; coupling or integration with other units or processes; controlling aspects.

References

Limiting references

This place does not cover:

Recovering volatile solvents by condensation	B01D 5/00
Vapour recovery systems combined with filling nozzles	B67D 7/54
Solidification of carbonic acid	C01B 32/55
Production of ammonia	C01C 1/00
Cryogenic pumps	F04B 37/08
Pipe-line systems	F17D 1/00

Application-oriented references

Examples of places where the subject matter of this place is covered when specially adapted, used for a particular purpose, or incorporated in a larger system:

Separation of a feed stream and withdrawal of a liquid product	F25J 3/00
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Informative references

Attention is drawn to the following places, which may be of interest for search:

Floating working-up processes	B63B 35/44
Refrigerant materials per se	C09K 5/04
Buildings forming part of cooling plants	E04H 5/10
Adaptations of expansion engines for refrigeration plants or for driving	F01D 15/00
Steam engine plants in combination with an industrial process	F01K 23/064

Gas turbine plants in combination with other processes	F02C 6/00
Control of compressors in general	F04D 27/00

Glossary of terms

In this place, the following terms or expressions are used with the meaning indicated:

Refrigeration cascade	The feed stream is cooled by two or more subsequent refrigeration means
Natural gas	Substitute natural gas, gas obtained from a crude oil well, i.e. associated or petroleum gas, or from a gas well, i.e. non-associated gas, gas recovered from a tertiary oil recovery process, mine or coal-bed-seam gas, landfill gas
BOG	Boil-off gases i.e. evaporated gases from cryogenic liquid storage vessels
MCR	Multi-component refrigerant
SCR	Single-component refrigerant

Synonyms and Keywords

In patent documents, the following abbreviations are often used:

LNG	Liquefied natural gas
C3MR	Propane pre-cooled mixed refrigerant LNG process (APC)
DMR	Mixed refrigerant pre-cooled mixed refrigerant LNG process (Shell, APC, Liquefin)
MFC®	Three level cascade mixed refrigerant LNG process (Linde)
OCLP	Optimised cascade LNG process (Concoco-Phillips)

F25J 3/00

Processes or apparatus for separating the constituents of gaseous {or liquefied gaseous} mixtures involving the use of liquefaction or solidification

Definition statement

This place covers:

Processes or apparatus for separating the constituents of a feed stream at cryogenic temperatures involving the use of liquefaction or solidification by rectification or partial condensation. The feed stream can be a gas, a gaseous mixture, a cryogenic liquid or a cryogenic liquid mixture.

- Cryogenic separation of gaseous or liquid mixtures, e.g. gaseous or liquefied natural gas, refinery off-gases, gaseous mixtures comprising hydrogen and/or carbon monoxide, carbon dioxide or nitrogen, by rectification in a column or dephlegmator, i.e. by continuous interchange of heat and material between a vapour stream and a liquid stream.
- Cryogenic separation of atmospheric air into its primary components, i.e. nitrogen, oxygen, argon, krypton, xenon, neon and/or helium.
- Cryogenic separation of gaseous or liquid mixtures, e.g. gaseous or liquefied natural gas, refinery off-gases, gaseous mixtures comprising hydrogen and/or carbon monoxide, carbon dioxide or nitrogen, by partial condensation, i.e. by condensation or anti-sublimation of the high-boiling components and subsequent simple phase separation of the liquefied or solidified components

from the remaining low-boiling gaseous components. The high-boiling liquid components can be withdrawn in gaseous or liquid phase.

- Cryogenic separation of gaseous impurities from an almost pure feed stream (i.e. the concentration of the impurities is in generally less than 5 vol%) wherein the main component of the feed stream and the impurities do have similar volatilities and wherein the product stream has a high or ultra high purity, i.e. with only some ppm or ppb of remaining impurities.

References

Limiting references

This place does not cover:

Distillation or related processes other than cryogenic processing	B01D 3/00
Recovering volatile solvents by condensation	B01D 5/00
Production of hydrogen containing gas not using cryogenic processing	C01B 3/00
Preparation of oxygen not using cryogenic processing	C01B 13/02
Production or purification of nitrogen not using cryogenic processing	C01B 21/04
Purification or separation of noble gases not using cryogenic processing	C01B 23/00
Production of carbon monoxide containing gas not using cryogenic processing	C01B 32/40 , C10J , C10K
Production of carbon dioxide	C01B 32/50
Purification of hydrocarbons	C07C 7/00
Distillation of hydrocarbon oils	C10G 7/00
Working-up liquefied petroleum gas	C10L 3/12
Treating radioactively contaminated gases	G21F 9/00

Application-oriented references

Examples of places where the subject matter of this place is covered when specially adapted, used for a particular purpose, or incorporated in a larger system:

Purification of a gas stream during its liquefaction	F25J 1/00
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Informative references

Attention is drawn to the following places, which may be of interest for search:

Separation of gases or vapours by condensation	B01D 53/002
Separation of gases or vapours by absorption	B01D 53/14
Separation of isotopes	B01D 59/04
Packing elements	B01J 19/32
Preparation or purification of gas mixtures for synthesis	C01B 3/025
Separation of hydrogen at low temperatures	C01B 3/506
Purge gas treatment from ammonia synthesis	C01C 1/0476
Recovery of liquid hydrocarbon mixtures from gases by cooling	C10G 5/06
Working-up undefined normally gaseous hydrocarbon mixtures	C10G 70/04
Working-up natural gas	C10L 3/10
Buildings forming part of cooling plants	E04H 5/10

Adaptations of expansion engines for refrigeration plants or for driving	F01D 15/00
Steam engine plants in combination with an industrial process	F01K 23/064
Steam engine plants in combination with a gasification process and an oxygen producing plant	F01K 23/068
Gas turbine plants supplying working fluid to a user	F02C 6/10
Control of compressors in general	F04D 27/00

Glossary of terms

In this place, the following terms or expressions are used with the meaning indicated:

Cold box	Housing comprising all the cold equipments of the separation/liquefaction process, i.e. working normally under cryogenic temperatures conditions
Natural gas liquids	C2+ hydrocarbons
Liquefied petroleum gas	C3+ hydrocarbons

Synonyms and Keywords

In patent documents, the following abbreviations are often used:

ASU	Air separation unit
BAC	Booster air compressor
MAC	Main air compressor
LNG	Liquefied natural gas
NGL	Natural gas liquids
LPG	Liquefied petroleum gas
HYCO	Synthesis gases comprising hydrogen and carbon monoxide as main constituents

F25J 5/00

Arrangements of cold exchangers or cold accumulators in separation or liquefaction plants (heat exchangers [F28C](#), [F28D](#), [F28F](#))

Definition statement

This place covers:

Particular configuration and constructional design of cold exchangers and cold accumulators for use in cryogenic separation or liquefaction plants (in contrast to the description of the general functioning of said exchangers and accumulators as found in the flowsheet of the cryogenic process which are to be classified in the corresponding main groups [F25J 1/00](#) and [F25J 3/00](#))

- Cold regenerators, i.e. cold exchange means cools the feed stream and removes higher boiling impurities by liquefaction/solidification, e.g. H₂O, CO₂ from the feed gas by alternating purification and regeneration phase, either as reversing heat exchangers or as cold accumulators.
- Recuperative heat exchangers for continuously recuperating cold from separated components in separation plants or from refrigerant streams in cryogenic liquefaction plants.
- Reboiler and/or Condensers in a cryogenic separation or liquefaction apparatus.

- Reflux heat exchangers or dephlegmators, i.e. cold exchangers with continuous interchange of heat and material between a vapour stream and a liquid stream.

References

Informative references

Attention is drawn to the following places, which may be of interest for search:

Heat exchangers in general	F28C , F28D , F28F
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Glossary of terms

In this place, the following terms or expressions are used with the meaning indicated:

Reversing heat exchanger	Recuperative ("counter-current") heat exchanger with continuous heat exchange during the purification phase followed by a regeneration phase; there is no cold accumulation; can be arranged in a single, compact heat exchanger
Cold accumulator	Heat exchange means containing a cold regenerative material for storing and exchanging the cold in a discontinuous manner, i.e. alternating purification and regenerating phase; always at least two heat exchange vessels are necessary
Bath type reboiler	Thermo-siphon reboiler, with natural or forced liquid circulation, or core-in-kettle reboiler with pool boiling
Down-flowing type reboiler	Thin falling liquid film flowing down the heat exchange surface, plate or tube, and is subsequently vaporised

Synonyms and Keywords

In patent documents, the following abbreviations are often used:

BA-PFHE	Brazed aluminium - plate fine heat exchanger
MCHE	Main cryogenic heat exchanger
MHE	Main heat exchanger
REVEX	Reversing heat exchanger
SWHE / CWHE	Spiral-/coil wound heat exchanger

In patent documents, the following words/expressions are often used as synonyms:

- "kettle", "bath" and "pool-boiling"