ГУБКИНСКИЙ УНИВЕРСИТЕТ

ДАЙДЖЕСТ НАУЧНО-ТЕХНИЧЕСКИХ ПУБЛИКАЦИЙ ПО НАПРАВЛЕНИЮ:

СЖИЖЕННЫЙ ПРИРОДНЫЙ ГАЗ

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О нас

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Матералы конференций:

1. SNAME 25th Offshore Symposium, Houston, Texas, February 2020.

I. Производство / Production

1.1. Технологии сжижения / Liquefaction Technology

1.1.1 Статьи / Articles

1. NOVEL INTEGRATED HELIUM EXTRACTION AND NATURAL GAS LIQUEFACTION PROCESS CONFIGURATIONS USING ABSORPTION REFRIGERATION AND WASTE HEAT

Authors: Zaitsev A., Mehrpooya M., Ghorbani B., Sanavbarov R., Naumov F., Shermatova F.
Journal: International Journal of Energy Research, volume: 44, number: 8, pp.: 6430-6451(22)
DOI: 10.1002/er.5377
Abstract:

Conceptual design and modeling of novel-integrated process configurations for helium extraction and natural gas liquefaction is investigated. Mixed fluid cascade (MFC) refrigeration system is considered for providing the needed refrigeration in the natural liquefaction section. Using an absorption refrigeration system as the precooling cycle is investigated in one of the introduced processes. Integrated flash and distillation method is used for helium extraction. Purity of the extracted crude helium is 50% (mole). Process streams operational condition and specifications of the devices are presented and explained. Composite curves of the heat exchangers demonstrate that thermal design has been done properly. Ratio of the power consumption to the produced liquefied natural gas (LNG) of the MFC process is 0.265 kWh per kg LNG and applying absorption refrigeration system instead of the pre-cooling cycle decreases it to 0.1849 kWh per kg LNG. For the modified process with absorption refrigeration system helium extraction rate and power consumption ratio are 0.951 and 132.9 (kWh/[kgmole Helium]) respectively. Exergy method is applied on the under consideration processes. The results show that the compressors have the highest rate of exergy destruction among the other process equipment. An extensive economic analysis is done on the proposed processes. The results show that prime cost of the product (US$/kg LNG) for MFC and modified MFC processes are 0.1939 and 0.2069, respectively. Finally, a sensitivity analysis is done based on the economic factors such as electrical energy price and prime cost of the product.

2. THERMODYNAMIC ANALYSIS OF A NOVEL COMBINED COOLING AND POWER SYSTEM UTILIZING LIQUEFIED NATURAL GAS (LNG) CRYOGENIC ENERGY AND LOW-TEMPERATURE WASTE HEAT

Authors: Li YY, Liu YJ, Zhang GQ, Yang YP
Journal: Energy, volume: 199
DOI: 10.1016/j.energy.2020.117479
Abstract:

A novel combined cooling and power (CCP) system utilizing liquefied natural gas (LNG) cryogenic energy and low-temperature waste heat was presented. The proposed system consists of two subsystems, absorption refrigeration/power cycle (ARP) subsystem and LNG refrigeration/power cycle (LRP) subsystem. The Rankine cycle and absorption refrigeration cycle were connected in series to form the ARP and they showed mutual enhancement in the integration. The operating performance of the system was calculated and analyzed. And the effects of generator pressure and circulation ratio on the performance were analyzed. Furthermore, a typical application case, in which the proposed system is integrated into the gas-steam combined cycle system as an LNG pre-processing and power enhancement unit, had been studied. The results showed that the net power generation efficiency, comprehensive energy utilization ratio, and exergy efficiency of the proposed CCP system reached 32.70%, 81.63%, and 35.14%, respectively. The feasibility and performance of the integrated system with combined cycle gas turbine were proved. And suggestions for the parameter design were presented.

3. DESIGN AND OPTIMIZATION OF NITROGEN EXPANSION LIQUEFACTION PROCESSES INTEGRATED WITH ETHANE SEPARATION FOR HIGH ETHANE-CONTENT NATURAL GAS

Authors: He T., Lin W.S.
Journal: Applied thermal engineering, volume: 173
DOI: 10.1016/j.applthermaleng.2020.115272
Abstract:

Compared to ordinary natural gas, ethane has higher market value. Thus, recovery of ethane can increase the economic value of high ethane-content natural gas. This paper proposes a new liquefaction method for high ethane-content natural gas. Natural gas liquefaction and cryogenic distillation are combined to separate high-purity liquid ethane (no less than 99.95%) in the process of producing liquefied natural gas (LNG), which maximizes the economic benefits. And self-supply of the required heat of the distillation column is achieved by heat integration. For this new method, three nitrogen expansion processes are designed, and each process is simulated and optimized by HYSYS and genetic algorithm. Based on the optimization results, the specific power consumption and exergy efficiency of the three processes are analyzed. The results show that the specific power consumption of the three processes decrease with the increase of the ethane content. When the ethane content is 10% similar to 40%, the specific power consumption of the three processes is 0.5969 similar to 0.6060 kWh/Nm(3) (NG), 0.5371 similar to 0.5592 kWh/Nm(3)(NG), 0.5015 similar to 0.5403 kWh/Nm(3)(NG), respectively, and the exergy efficiency of the proposed three processes is 33.3 similar to 35.4%, 37.1 similar to 38.3%, 39.7 similar to 39.9%, respectively.

1.1.2. Патенты / Patents.

4. SYSTEM FOR PREPARING LNG (LIQUEFIED NATURAL GAS) FROM MEDIUM-LOW-TEMPERATURE DRY DISTILLATION RAW GAS THROUGH SULFUR-RESISTANT UNIFORM-TEMPERATURE METHANATION

Authors: Wang Xiaolong, Gao Shiwang, He Zhong, Cheng Achao, Xiao Tiancun
Publication number: 210885949
Publication date: 30.06.2020
Abstract:

The utility model discloses a system for preparing LNG (Liquefied Natural Gas) by carrying out sulfur-resistant uniform-temperature methanation on medium-low-temperature dry distillation raw gas, andbelongs to the technical field of clean and efficient utilization of coal. Carrying out tar recovery after dedusting, deamination and purification on the dry distillation raw coke oven gas to obtain ahigh-value by-product; and pressurizing, liquefying and separating to directly prepare higher hydrocarbons such as propane, butane and the like into LPG. H2S gas desorbed by the desulfurization and decarburization device is high in purity, and sulfur can be recovered by adopting a Claus sulfur recovery process. The CH4 content of the LNG component obtained after cryogenic liquefaction separationis high and is larger than 95%, and the requirement of a first-grade natural gas product is met. The system is easy and convenient to operate, clean and efficient utilization of low-rank coal is achieved through the low-temperature dry distillation poly-generation technology of coal, liquefied natural gas with the high calorific value is produced, byproducts such as tar, LPG, sulfur and carbon dioxide are produced, energy is saved, and economic benefits are high.

5. LNG RESIDUAL GAS RECOVERY DEVICE

Authors: Wang Zhengxin, Wang Jiajun, Yang Lei
Publication number: 211694346
Publication date: 16.10.2020
Abstract:

The utility model provides an LNG residual gas recovery device. The system comprises an LNG storage tank used for storing natural gas, a gas transmission device used for connecting the LNG storage tank with a medium-pressure pipe network, and a recovery device connected to a gas transmission pipeline and used for recovering residual gas, the gas transmission device comprises a plurality of sets ofair temperature type gasifiers connected with the LNG storage tank, a pressure regulating cabinet connected through a pipeline, and a turbine meter flow meter located between the pressure regulatingcabinet and the medium-pressure pipe network. The recovery device comprises a heating tank, and the heating tank is connected with a gas conveying pipeline in the gas conveying device through a firstpipeline and a second pipeline. The natural gas recycling device is beneficial to environmental protection, protects the environment from being damaged, can save energy, fully recycles and utilizes natural gas originally discharged into the atmosphere, improves economic benefits, and further reduces manpower and material resource cost and power consumption of residual gas recycling.

6. A SYSTEM FOR LIQUEFYING NATURAL GAS FEED STREAM TO PRODUCE LNG PRODUCT

Authors: Gowri Krishnamurthy, Mark Julian Roberts
Publication number: 210773045
Publication date: 16.06.2020
Abstract:

A system for liquefying a natural gas feed stream to produce an LNG product. The system uses a refrigeration circuit and cycle that uses two or more turbo expanders to expand two or more streams of gaseous refrigerant to a different pressure to provide a cold stream that is at least predominantly gaseous refrigerant at a different pressure for providing refrigeration to pre-cool and liquefy natural gas. The resulting liquefied natural gas stream is then flashed to produce an LNG product and a flashed gas, which is recycled to the natural gas feed stream.

1.2. Оборудование / Equipment

1.2.1. Патенты / Patents

1. УСТАНОВКА ДЛЯ ПРОИЗВОДСТВА СЖИЖЕННОГО ПРИРОДНОГО ГАЗА. PLANT FOR PRODUCTION OF LIQUEFIED NATURAL GAS

Author: Kurochkin A.V.
Publication number: 0002720506
Publication date: 30.04.2020
Abstract:

FIELD: heat exchange; gas industry.
SUBSTANCE: disclosed is an apparatus for producing liquefied natural gas, comprising gas drying and cleaning units, a heat exchanger, a separator, a reducing device, as well as an expander and a compressor, connected to each other, where on the production gas line are successively arranged a first compressor, connected to an expander, a first cooler, first section of heat exchanger, cleaning unit, second section of heat exchanger, reducing device and separator, equipped with liquefied natural gas output line and return gas line, which is connected to process gas line after expander, with formation of low pressure gas line, on which heat exchanger is located, wherein on the process gas line a bypass line is made, on which the refrigerating machine is installed, and the low pressure gas line is connected to the process gas line to the expander with a circulating gas supply line, on which the second compressor and the second cooler are installed.
EFFECT: technical result is increased output of LNG due to optimization of heat exchange and provision of constant output due to equipping of unit with refrigerating machine and circulating compressor. 1 cl, 1 dwg

Автор: Курочкин А.В.
Номер публикации: 0002720506
Дата публикации: 30.04.2020
Аннотация:

Предложена установка для производства сжиженного природного газа, включающая блоки осушки и очистки газа, теплообменник, сепаратор, редуцирующее устройство, а также детандер и компрессор, соединенные между собой, где на линии продукционного газа последовательно расположены первый компрессор, соединенный с детандером, первый холодильник, первая секция теплообменника, блок очистки, вторая секция теплообменника, редуцирующее устройство и сепаратор, оснащенный линией вывода сжиженного природного газа и линией обратного газа, которая соединена с линией технологического газа после детандера, с образованием линии газа низкого давления, на которой расположен теплообменник, при этом на линии технологического газа выполнена байпасная линия, на которой установлена холодильная машина, а линия газа низкого давления соединена с линией технологического газа до детандера линией подачи циркуляционного газа, на которой установлены второй компрессор и второй холодильник. Технический результат - увеличение выхода СПГ за счет оптимизации теплообмена и обеспечение постоянства выхода за счет оснащения установки холодильной машиной и циркуляционным компрессором. 1 ил.

II. Хранение / Storage

2.1. Резервуары/ Containment Systems

2.1.1 Статьи / Articles

1. OPTIMUM ARRANGEMENT DESIGN OF MASTIC ROPES FOR MEMBRANE-TYPE LNG TANKS CONSIDERING THE FLATNESS OF THERMAL INSULATION PANEL AND PRODUCTION COST

Authors: Chun D.H., Roh M.I., Ham S.H.
Journal: Marine science and engineering, volume: 8, number: 5
DOI: 10.3390/jmse8050353
Abstract:

Thermal insulation panels are installed on the inner walls of liquefied natural gas (LNG) tanks of an LNG carrier to maintain the cryogenic temperature. Mastic ropes are used to attach thermal insulation panels to the inner walls and to fill the gap between the walls and panels. Because the inner walls of the LNG tanks can be corrugated owing to production errors, a large amount of mastic ropes are required to maintain the flatness of the thermal insulation panels. Therefore, in this study, an optimization method is proposed to minimize the total amount of mastic ropes for satisfying the flatness criterion of thermal insulation panels. For this purpose, an optimization problem is mathematically formulated. An objective function is used to minimize the total amount of mastic ropes considering constraints to flatten the thermal insulation panels. This function is applied to the design of membrane-type LNG tanks to verify the effectiveness and feasibility of the proposed method. Consequently, we confirm that the proposed method can provide a more effective arrangement design of mastic ropes compared with manual design.

2.1.2 Патенты / Patents

2. LNG STORAGE TANK

Authors: Zhao Zhikuan, Xu Yaling, Han Xiaofei, Feng Kun, Dang Fuping, Qu Shilei, Li Junmin
Publication number: 210800701
Publication date: 19.06.2020
Abstract:

The utility model discloses an LNG storage tank. Storage tank body, a heat conduction assembly is arranged in the storage tank body. The heat conduction assembly comprises a stand column coaxial withthe storage tank body and a plurality of radial plates evenly distributed on the outer circumferential face of the stand column in the circumferential direction of the stand column. A cooling assemblyis further arranged in the heat conduction assembly. The cooling assembly comprises a liquid nitrogen inlet pipe and a liquid nitrogen outlet pipe which are arranged in the stand column in a penetrating mode. The liquid nitrogen inlet pipe and the liquid nitrogen outlet pipe are evenly connected with a plurality of cooling pipe sets in the height direction. The heat conduction assembly can form good heat transfer between the upper-layer LNG and the lower-layer LNG; the heat of the lower-layer LNG is transferred to the upper layer; the temperature of the LNG in the storage tank body tends to be consistent; besides, when the temperature of the LNG on the lower layer is too high, liquid nitrogen can be introduced through the cooling assembly to cool the LNG with the high temperature, the violent rolling phenomenon of the LNG is avoided, the load of an original BOG system is remarkably reduced through mutual combination of the liquid nitrogen and the LNG, and the probability of the rolling phenomenon of the LNG can be reduced fundamentally.

3. LNG STORAGE TANK SYSTEM

Authors: Wang Jun, Wu Weidong, Shen Hongbing, Long Zhengxi, Wang Hao, Zheng Dongxu, Lin Xiaohui
Publication number: 210771428
Publication date: 16.06.2020
Abstract:

An LNG storage tank system comprises an LNG storage tank, a filling vaporizer and a pressurizing vaporizer. The filling vaporizer is arranged at the top of the LNG storage tank, an inlet of the filling vaporizer is connected with a gas phase filling port c in the LNG storage tank through a pipeline, and a valve V3 is connected between the inlet of the filling vaporizer and the gas phase filling port c in series. The pressurization vaporizer is arranged at the bottom of the LNG storage tank, and an inlet of the pressurization vaporizer is connected with a liquid phase outlet f of the LNG storage tank through a pipeline. An outlet of the pressurization vaporizer is connected with a pressurization gas phase opening d of the LNG storage tank through a pipeline, a valve V5 is connected betweenthe liquid phase outlet f and an inlet of the pressurization vaporizer in series, and a one-way valve V7 is connected between an outlet of the pressurization vaporizer and the pressurization gas phaseopening d in series. The equipment is compact in structure and small in occupied size.

4. LNG STORAGE TANK AND INNER TANK THEREOF

Authors: Huang Huan, Zhang Chao, Duan Pinjia, Fan Jiakun, Li Xinxin, Zhang Ying, Wang Jiayin
Publication number: 111256026
Publication date: 09.06.2020
Abstract:

The invention relates to an LNG storage tank and an inner tank thereof. The inner tank is of a cylindrical structure with an opening in the top and a flat bottom, wherein the inner tank is of a reinforced concrete structure; buttress columns are arranged on the inner wall of the cylindrical structure and protrude towards the interior of the tank on the inner wall; and the plurality of columns arearranged on the inner wall and used for assisting in arranging a prestress system. According to the LNG storage tank and the inner tank thereof, prestress ribs can be well fixed, prestress of the inner tank of the storage tank is reasonably applied, construction and installation of other structures are better facilitated through the installation structure position, safety and stability of the whole system are guaranteed, the engineering amount is small, and cost is low.

5. LIQUEFIED NATURAL GAS (LNG) TANK CONTAINER WITH HIGH HEAT PRESERVATION

Author: Xu Wei
Publication number: 111256034
Publication date: 09.06.2020
Abstract:

The invention discloses a liquefied natural gas (LNG) tank container with high heat preservation. The tank container with the high heat preservation comprises a frame and a tank body, the tank body is placed in the frame and connected with the frame through a plurality of diagonal bracing structures, the tank body comprises an external vessel and an internal vessel located in the external vessel, the frame is internally provided with a heat preservation wall, the heat preservation wall is in a hollow column shape, the tank body penetrates through the heat preservation wall, the two ends ofthe tank body are located outside the heat preservation wall, the internal vessel and the external vessel are connected through a supporting pipe, the heat preservation wall and the external vessel are connected through a supporting pipe, and the supporting pipes are internally provided with heat preservation structures. The LNG tank container is simple in structure, and the heat preservation ofthe LNG tank container can be improved.

6. COLD INSULATION EQUIPMENT FOR NEW ENERGY LNG STORAGE TANK

Authors: Chen Jindong, Lin Xiao
Publication number: 210662290
Publication date: 02.06.2020
Abstract:

The utility model relates to the technical field of LNG storage and cold insulation. The utility model further discloses cold insulation equipment for the new energy LNG storage tank. Tank comprisinga first tank body, the first tank body is mounted on the ground through two mounting mechanisms; a second tank body is jointly connected into the first tank body through a plurality of fixing mechanisms; an LNG storage tank is arranged in the second tank body; a cold insulation powder layer is filled between the second tank body and the LNG storage tank; a guide pipe is fixedly communicated with the vertical side wall of one side of the LNG storage tank, the end, away from the LNG storage tank, of the guide pipe sequentially penetrates through the cold insulation powder layer, the second tankbody and the first tank body and extends outwards, a vacuum layer is arranged between the first tank body and the second tank body, and an exhaust pipe is fixedly communicated with the outer side wallof the first tank body; the fixing mechanism comprises two connecting plates and a supporting rod, and one connecting plate is fixedly connected to the inner side wall of the first tank body. The LNGstorage tank can be kept at low temperature all the time, the actual cold insulation requirement can be met, and installation is convenient.

7. LNG STORAGE TANK GAS TRANSMISSION REPLACEMENT PROCESS

Authors: Tong Xuanmin, Xie Guangfei, Yang Lei
Publication number: 111219594
Publication date: 02.06.2020
Abstract:

The invention provides an LNG storage tank gas transmission replacement process. According to the process, an LNG storage tank and a nitrogen filling device connected with the LNG storage tank and used for replacing natural gas are involved, wherein the nitrogen filling device comprises a liquid nitrogen storage tank, a gasification assembly used for liquid nitrogen and a gas filling assembly usedfor filling the LNG storage tank with the nitrogen, and a buffer tank used for storing the nitrogen is arranged between the gasification assembly and the gas filling assembly. When natural gas replacement is carried out on the LNG storage tank, the interior of the LNG storage tank is depressurized through a vacuum pump, the LNG storage tank is filled with the nitrogen through a first nitrogen filling pipeline and a second nitrogen filling pipeline, gas exhaust is carried out through a first exhaust pipeline and a second exhaust pipeline, and gas retention at dead corners in the tank is relieved, so that the gas exhaust efficiency in the LNG storage tank is improved, the LNG storage tank has the advantages of simple structure, simplicity in operation, easiness in control, economy, practicability, high replacement efficiency and the like.

8. LNG STORAGE TANK ANTI-LAYERING DEVICE

Authors: Wang Jiajun, Yang Zhen, Wang Zhengxin
Publication number: 111207297
Publication date: 29.05.2020
Abstract:

The invention provides an LNG storage tank anti-layering device. The LNG storage tank anti-layering device comprises an LNG storage tank body used for storing LNG. An exhaust port is welded to the topof the LNG storage tank body. A pressure meter is in threaded connection with the upper portion of one side of the LNG storage tank body. A gas inlet is welded to the lower portion of one side of theLNG storage tank body. Supporting legs are welded to the bottom of the LNG storage tank body. The storage tank body is internally provided with a gas storage cavity. A motor is arranged at the bottom of the LNG storage tank body. The top of a rotary rod is welded to a stirring frame through a connecting skeleton. The stirring frame is provided with first stirring sheets. Stirring rods are welded to the upper portion of the stirring frame. Second stirring sheets are welded to the outer sides of the stirring rods. The second stirring sheets are provided with dispersion holes. The LNG storage tank anti-layering device can achieve the stirring effect on the LNG stored in the gas storage cavity in the LNG storage tank body, protects the inverted LNG against layering after long-term standing of the LNG storage tank body and is beneficial to long-term storage of the LNG in the LNG storage tank body.

9. TANK CONTAINER SPECIAL FOR LNG

Authors: Feng Kun, Xu Yaling, Zhao Zhikuan, Han Xiaofei, Dang Fuping, Qu Shilei, Li Junmin
Publication number: 210831420
Publication date: 23.06.2020
Abstract:

The utility model discloses a tank container special for LNG. The LNG storage tank comprises a supporting frame and an LNG storage tank body fixedly arranged in the supporting frame. A mounting bottomplate is arranged at the bottom of the supporting frame. A first crawling ladder is arranged on one side of the supporting frame in the vertical direction, a drawable second crawling ladder is arranged at the position, corresponding to the first crawling ladder, of the bottom of the supporting frame, a baffle is arranged at the position, corresponding to the second crawling ladder, of the supporting frame, and an arc-shaped retention top plate is arranged at the top of the LNG storage tank through an abutting device. According to the utility model, the drawable second crawling ladder is arranged at the bottom of the support frame; convenience for workers to tread and climb, due to the arrangement of the second crawling ladder, convenience is provided for people during climbing, the situation of pit collision caused by missed stepping is more effectively avoided, a very good protection effect is achieved on workers, and due to the fact that the fixing top plate is arranged at the top of the LNG storage tank through the abutting device, the firmness degree of connection between the LNG storage tank and the supporting frame is enhanced.

2.2. Отгрузочные операции / Discharge Operations

2.2.1. Статьи / Articles

1. ROBUST OPTIMIZATION AND MIXED-INTEGER LINEAR PROGRAMMING MODEL FOR LNG SUPPLY CHAIN PLANNING PROBLEM

Authors: Sangaiah A.K., Tirkolaee E.B., Goli A., Dehnavi-Arani S.
Journal: Soft computing, volume: 24, number: 11, pp.: 7885-7905
DOI: 10.1007/s00500-019-04010-6
Abstract:

A constant development of gas utilization in domestic households, industry, and power plants has slowly transformed gaseous petrol into a noteworthy wellspring of energy. Supply and transportation planning of liquefied natural gas (LNG) need a great attention from the management of the supply chain to provide a significant development of gas trading. Therefore, this paper addresses a robust mixed-integer linear programming model for LNG sales planning over a given time horizon aiming to minimize the costs of the vendor. Since the parameter of the manufacturer supply has an uncertain nature in the real world, and this parameter is regarded to be interval-based uncertain. To validate the model, various illustrative examples are solved using CPLEX solver of GAMS software under different uncertainty levels. Furthermore, a novel metaheuristic algorithm, namely cuckoo optimization algorithm (COA), is designed to solve the problem efficiently. The obtained comparison results demonstrate that the proposed COA can generate high-quality solutions. Furthermore, the comparison results of the deterministic and robust models are evaluated, and sensitivity analyses are performed on the main parameters to provide the concluding remarks and managerial insights of the research. Finally, a comparison evaluation is done between the total vendor profit and the robustness cost to find the optimal robustness level.

2.2.2 Патенты / Patents

1. STORAGE AND TRANSPORTATION TANK FOR PREVENTING LNG FROM ROLLING

Authors: Wu Zhirui, He Jie, Wang Gang, Jiang Huan, Wu Yu
Publication number: 210716946
Publication date: 09.06.2020
Abstract:

The utility model provides a storage and transportation tank for preventing LNG from rolling over. The storage and transportation tank comprises a storage and transportation tank body, a support, a motor and speed reducer all-in-one machine and a control cabinet. The section of the storage and transportation tank is circular, multiple baffles and temperature sensors are arranged on the inner wallof the storage and transportation tank, and multiple first gears sleeve the outer side wall of the storage and transportation tank; two rotating shafts are arranged on the bracket, and second gears meshed with the first gears are arranged on the two rotating shafts; a driving gear is arranged on an output shaft of the motor and speed reducer all-in-one machine, and a driven gear is arranged on onerotating shaft; a first communication module is arranged on the temperature sensor, a second communication module is arranged on the motor and speed reducer all-in-one machine, and the temperature sensor and the motor and speed reducer all-in-one machine are both in communication connection with the control cabinet. The temperature sensors are used for measuring the temperature of all positions in the storage and transportation tank body in the height direction and transmitting the temperature to the control cabinet, the control cabinet controls whether the motor and speed reducer all-in-onemachine rolls or not according to the temperature difference condition in the storage and transportation tank body, and the phenomenon that LNG in the storage and transportation tank rolls due to layering is avoided.

2. LNG TRANSPORTATION TANK

Authors: Tian Jinbiao, Liu Yanjie, Chen Huang
Publication number: 210800693
Publication date: 19.06.2020
Abstract:

The utility model belongs to the field of low-temperature equipment. The LNG transportation tank comprises a tank body, the device comprises a cold trap bag, a swash plate, a liquid inlet pipe and anair outlet pipe, the cold trap bag is arranged at the top of the LNG transportation tank; the swash plate divides the tank into a front area, a middle area and a rear area; the liquid inlet pipe comprises a lower liquid inlet pipe and a middle liquid inlet pipe, the lower liquid inlet pipe is arranged at the bottom of the tank, the middle liquid inlet pipe is arranged in the middle of the tank, the air outlet pipe is arranged on the upper portion of the tank, and the lower liquid inlet pipe, the middle liquid inlet pipe and the rear portion of the tank are provided with liquid outlets and airoutlets respectively; lNG in the whole tank is in a relatively supercooled state, and even if the LNG in the tank is layered, violent rolling cannot be formed; by arranging the immersed pump and the upper liquid inlet pipe, a set of forced backflow device and process are formed in the LNG transportation tank, and sufficient mixing of LNG in the transportation tank is achieved.

2.3. Эффекты хранения / Storage Phenomena

2.3.1. Статьи / Articles

1. LUO DY, SUN JG, LIU CG, CUI LF, WANG Z

Authors: Sangaiah A.K., Tirkolaee E.B., Goli A., Dehnavi-Arani S.
Journal: Journal of earthquake engineering
DOI: 10.1080/13632469.2020.1774443
Abstract:

Full-capacity large-scale liquefied natural gas (LNG) tanks comprise a steel inner tank and a concrete outer tank. The space between the walls of these two tanks is filled with expanded perlite and a resilient blanket as an insulation layer. It is well known that interactions between the outer tank, insulation, inner tank, and liquid occur under seismic loads. In this study, to investigate the effect of insulation on an LNG tank, a scale model of the tank was constructed, and shaking table tests were conducted with and without insulation at different liquid levels. A comparison of the displacement, acceleration, and axial strain of the tank walls at different test conditions indicates that the insulation exerts good damping effects on the responses of the inner tank wall. Additionally, it has a certain restraining effect on the acceleration of the outer tank wall. However, its damping effect on the displacement and axial strain of the outer tank wall is negligible; in fact, it can even amplify them. Furthermore, most of the maximum seismic responses occur at the full liquid level, for which the effects of the insulation on the tank are more evident than at other liquid levels.

2. ОЦЕНКА ПОТЕРЬ БУНКЕРНОГО СПГ ОТ ИСПАРЕНИЯ

Авторы: Таровик О.В., Реуцкий А.С., Топаж А.Г.
Журнал: Мир транспорта, том: 18, номер: 3 (88), стр.: 84-106
УДК: 622.692:656.065.32
Аннотация:

Анализ эффективности транспортных систем, использующих сжиженный природный газ (СПГ) в качестве топлива, невозможен без комплексного понимания объёмов потерь топливного СПГ от испарения в ходе основных технологических операций: перевозки (хранения), бункеровки и захолаживания топливных ёмкостей. Несмотря на активное развитие водного и наземного газомоторного транспорта, практические подходы для получения соответствующих оценок в широком диапазоне характеристик грузовых ёмкостей ранее не публиковались. Целью настоящей работы является анализ потерь СПГ в автомобильных, железнодорожных и судовых цистернах (вместимостью до 5600 м3), а также в танк-контейнерах при условии хранения СПГ с избыточным давлением около 5-7 атмосфер. В работе в качестве метода использовано численное моделирование. Процесс испарения СПГ описывается с помощью моделей теплообмена между жидкой фазой СПГ, его парами, а также грузовым танком и внешней средой. Это позволяет моделировать поведение и фазовые превращения СПГ при его хранении в ёмкости, а также в ходе основных технологических операций. Численное моделирование термодинамических процессов при хранении СПГ производится с помощью компьютерной имитационной модели, реализованной в среде AnyLogic. Количественные оценки потерь СПГ при бункеровке и захолаживании топливных танков получены на основе аналитических расчётов. Анализ чувствительности созданных моделей к различным параметрам, а также массовые численные расчёты позволили построить регрессионные зависимости для определения потерь СПГ в ходе рассматриваемых операций. Полученные зависимости могут быть использованы для поиска наиболее эффективных конфигураций системы малотоннажной перевозки СПГ, а также для выполнения экономических оценок целесообразности использования СПГ в качестве топлива на водном и наземном транспорте.

2.3.2. Материалы конференций / Conference Papers

3. NUMERICAL SIMULATION OF FLUID SLOSHING IN A ROLLING TANK

Authors: Wen-Huai Tsao; Spyros A. Kinnas
Conference: SNAME 25th Offshore Symposium, Houston, Texas, February 2020
Abstract:

The dynamic response of a fluid in a rolling tank is one of the most important issues for the integrity of LNG tanks and the overall stability of the vessel. When the tanks oscillate near the sloshing resonance frequencies, sloshing phenomena with strong nonlinearity and large free-surface deformations can be observed. For some liquid depths and external forcing characteristics, hydraulic jumps may form, wave component interactions would occur, and severe impacts on the walls would follow. In this paper, the formations of different types of sloshing waves as well as the impact forces on the walls are simulated by an Eulerian-Lagrangian method, which was developed on the past for the horizontal excitation problem and is extended in this paper to a tank subject to roll motions. This approach allows the use of boundary element method (BEM) and fourth-order Runge-Kutta scheme (RK4) to track the particles on the free surface. In the case of rolling excitation, some highly nonlinear waves and thin jets where the wave impacts on the boundaries of the tank are more likely to occur. Therefore these very thin wave jets would be slightly truncated to alleviate the associated numerical instability. Furthermore, the artificial damping effect, which is linearly proportional to the fluid velocity, is introduced in the dynamic boundary condition on the free surface and the impermeable condition of the walls to take the effects of viscosity into account. This has been proven to be effective in improving the numerical accuracy of the method. Correlations of our results with experimental observations and measurements will be presented.

III. Регазификация / Regasification

3.1. Статьи / Articles

1. LNG REGASIFICATION - EFFECTS OF PROJECT STAGE DECISIONS ON CAPITAL EXPENDITURE AND IMPLICATIONS FOR GAS PRICING

Authors: Agarwal R., Rainey T.J., Steinberg T., Rahman S.M.A., Perrons R.K., Brown R.J.
Journal: Journal of natural gas science and engineering, volume: 78
DOI: 10.1016/j.jngse.2020.103291
Abstract:

With mounting concerns over energy security and climate change, natural gas has seen significant growth in demand during the last two decades. Natural gas has only half of the carbon footprint of coal and has consequently become an important transition fuel as the world economy shifts away from more carbon-intensive energy sources in favour of lower-carbon alternatives. As a result, a substantial amount of capital is being invested around the world to accelerate and create natural gas and liquefied natural gas (LNG) infrastructure. LNG has become the fastest-growing sector in the international gas trading business, but its promise as a transition fuel has been complicated by the rising capital costs associated with delivering LNG projects and infrastructure around the world. Towards shining a light on this problem, this paper offers an analysis of the capital costs of LNG regasification terminals in different regions and puts forward benchmarks in several key areas to show how these spending trends vary and may be interpreted. The investigation highlights the relative importance that decisions can have on capital investment costs in the earliest stages of a project, and sheds light on the factors that most significantly affect capital expenditure and have implications on gas price. Specifically, the analysis identifies two important variables that have the most significant impact on these capital costs: (1) the ratio of LNG storage volumes to gas send-out, and (2) the "economy of scale" factor, calculated here in reference to ratio of capital expenditure per millions of tonnes per annum of capacity.

3.2. Патенты / Patents

2. APPARATUS, SYSTEM AND METHOD FOR RELIQUEFACTION OF PREVIOUSLY REGASIFIED LNG

Authors: Becker T.J., Trotter G.D.
Publication number: 1/2019/502408
Publication date: 29.06.2020
Abstract:

An apparatus, system and method for reliquefaction of previously regasified LNG are described. A natural gas reliquefaction method includes regasifying LNG onboard a FSRU to form high pressure regasified LNG (HP RLNG), delivering the HP RLNG to a natural gas pipeline that commingles with a natural gas grid, flowing the HP RLNG through a lateral, wherein the lateral diverts HP RLNG from the natural gas pipeline to an expander prior to commingling with the natural gas grid, expanding the natural gas with the expander to obtain low pressure regasified LNG (LP RLNG), liquefying the LP RLNG in a cold box of a nitrogen expansion loop to produce low pressure LNG, and transmitting the LNG to a cryogenic cargo tank onboard an LNG tanker truck.

3. LNG REGASIFICATION APPARATUS FOR ISLANDS AND HIGHLANDS AND SMALL ENGINES

Authors: Lee Jai Hong, Park Seung Seon
Publication number: 1020200072031
Publication date: 22.06.2020
Abstract:

The present invention relates to an LNG regasification apparatus having a simplified structure to be used for islands and highlands and small engines. An regasification apparatus for islands and highlands and small engines includes: a storage tank storing liquefied natural gas therein; a main supply line connected to the storage tank to receive the liquefied natural gas from the storage tank; a plurality of front branch lines branched from the main supply line to move the liquefied natural gas; gasifiers installed on the front branch lines, respectively, and gasifying the liquefied natural gas through the exchange of heat with the air; rear branch lines connected to the gasifiers, respectively, to move the gasified natural gas; a gas discharge line connected to the rear branch lines; and an alternate inflow means for making the liquefied natural gas flow into the gasifiers alternately such that the liquefied natural gas can be gasified in the gasifiers alternately.

4. LNG GASIFIER

Authors: Chen Haiping, Huang Yu, Zhang Chao, Bi Xiaoxing, Song Kun, Xu Jiawei, Lu Liang, Ming Hongfang, Guo Qi, Qiu Zaoyang
Publication number: 111306792
Publication date: 19.06.2020
Abstract:

The invention discloses an LNG gasifier. The LNG gasifier comprises a water tank, a combustion chamber, an LNG coil pipe and an air blowing mechanism, wherein a coil pipe water channel and a combustion chamber water channel are formed in the water tank; the top of the coil pipe water channel communicates with the interior of the water tank, and the top and bottom of the combustion chamber water channel both communicate with the interior of the water tank; the combustion chamber is arranged in the combustion chamber water channel; the top of the combustion chamber extends out of the water tank,and a combustor is mounted on the top of the combustion chamber; the bottom of the combustion chamber is connected with one end of a flue gas pipeline, and the other end of the flue gas pipeline communicates with the coil pipe water channel; the LNG coil pipe is arranged in the coil pipe water channel, and an inlet and an outlet of the LNG coil pipe extend out of the water tank; and the air blowing mechanism communicates with the combustor through a pipeline and is used for blowing air into the combustor. The LNG gasifier provided by the invention has multiple working modes, is compact in structure, high in gasification efficiency, economical, environment-friendly and suitable for meeting the process requirements of LNG gasification stations at different station locations. The problem ofdifficult type selection in the LNG industry at present is solved, and the investment cost is reduced.

IV. Инфраструктурные решения / Infrastructure Solutions

4.1. Статьи / Articles

1. INSULATION: IT’S ALL IN THE DETAILS

Author: Johan Sentjens
Journal: LNG Industry, May 2020, pp.: 31

Abstract:

Piping and equipment engineers have a great impact on the design, installation and choice of materials for insulation. Even in the initial design stages of an LNG project, the engineer determines whether the insulation contractor will go over his budget or not. Not only the design of the insulation system itself, but the way it is integrated within the piping and equipment design, has a big impact on whether the insulation contractor can do his job and meet the specified design quality. The following details all need to be given thought and attention: space between piping, design of pipe supports, design of insulation supports, design of rings or lugs on equipment, etc.

The CINI insulation manual is a well-known quality guideline and is often referred to in insulation specifications. However, it is not commonly known that CINI also provides many details for piping and equipment design. In this article, some of these engineering details are discussed.

2. HOW BIG IS JUST RIGHT?

Author: Richard Wheeler and John Baguley
Journal: LNG Industry June 2020, pp.: 17
Abstract:

Among the myriad of critical decisions faced by aspirational LNG export project developers, one that looms large is how big, overall, to build the facility, and whether to build it in discrete phases or all in one go. A number of factors must be considered, many of them competing or contradictory, and one size does not fit all, since different projects have different drivers. Still, there are common issues to be considered for most projects.

Getting this right or wrong can have profound impact on the feasibility and the long-term economic performance of the planned facility. Starting with fundamentals, economics drive project viability. A development project that does not provide a sufficient return on investment (ROI) is unlikely to be built – although there always seem to be exceptions. A corollary is that, when comparing multiple projects, the ones most likely to go forward are those with the most favourable economics. Obviously, developers are keen to find the economic sweet spot for their planned projects.

All things being equal, the larger a project, the better the theoretical economics. There are two primary reasons for this, with the first related to fixed infrastructure costs. A number of the significant specific capital costs associated with building an LNG export facility are largely independent of production capacity. Regardless of the size, any LNG export facility will need a large level site (including temporary construction areas), expensive large LNG storage tanks and associated loading facilities, common utilities, emergency flares, a control room, a machine shop, a warehouse, capital spare parts, operating spare parts, an administration building and the like. Since these systems, within reason, are independent of production capacity, a larger export facility is able to spread its fixed costs over a larger production base than a smaller facility, reducing LNG unit cost. Similarly, the staffing necessary to manage, operate, and maintain an LNG plant is not proportional to plant capacity, with larger facilities requiring fewer staff per unit quantity of LNG produced than smaller facilities. This is because specific functions and positions can be shared, i.e. plant manager, security manager, maintenance planning, production planning, common procurement, common utilities operation, emergency response teams, IT management, etc.

On the basis of the aforementioned logic alone, LNG liquefaction facility launch volumes should grow ever larger, and in fact they have moved in that direction over time. The general trend in LNG facility launch capacities has been increasing, as demonstrated in Figure 1. This move to larger facilities is driven by economic necessity, but itself causes a host of other complications and challenges for project developers. There is a specific story behind every individual project. For example, Dominion Cove Point was tightly constrained by available space and its capacity was limited by that. Conversely, Chevron's Gorgon had no real plot space limits but was located on an isolated island that, together with stringent environmental constraints, drove up delivery costs necessitating a large initial launch capacity to achieve satisfactory economics. Overall, the historical trend in project launch size is upward. In the period from the first commercial plant operation in 1964 until CAPEX costs began to rise significantly in 2012, the average launch capacity for a greenfield LNG facility was 5.5 million tpy. From 2014 through the current planned projects, this has more than doubled to an average of 11.8 million tpy.

V. Морские технологии / Offshore Technology

5.1. Статьи / Articles

1. THERMAL DESIGN AND PERFORMANCE EVALUATION OF A SHELL-AND-TUBE HEAT EXCHANGER USING LNG COLD ENERGY IN LNG FUELLED SHIP

Author: Lim T.W.,Choi Y.S.
Journal: Applied thermal engineering, volume: 171
DOI: 10.1016/j.applthermaleng.2020.115120
Abstract:

This study focuses on integrating the cold energy of liquid natural gas (LNG) fuelled ships with the ORC and the thermal design of the heat exchanger in the organic Rankine cycle (ORC) system. An ORC system is constructed to utilise the cold energy of the LNG and the jacket cooling water of the main engine as a low and high-temperature heat source, respectively, to exploit the large amount of energy consumed in the process of raising the temperature of the LNG to a constant value to allow its use as a fuel. Five kinds of working fluids are applied to analyse the performance of the cycle according to the change in the condensation temperature. The results of the cycle performance analysis indicate that the R123 and R227ea have the highest and lowest thermal efficiency of about 17-23% and about 15-21%, respectively. The R123 and R134a exhibit the highest and lowest exergy efficiency of about 25-31% and about 23-29%, respectively. The condensation temperature at which the maximum output is obtained is about 223 [K]. In addition, since the efficiency of the ORC system can be improved through the optimal design of the heat exchanger, the thermal design of the heat exchanger, which is a primary part of the ORC system, is performed. As the working fluid, three kinds of organic fluids, which are the most widely used among the five considered types, are selected to simulate the evaporator, condenser, and preheater. The simulation result shows that the condenser and preheater have the largest and smallest heat transfer surface area of 73 m(2) and 34 m(2) for R134a, respectively. For the condenser, it is found that the R134a and R152a have the largest and smallest heat transfer surface areas of 73 m(2) and 59 m(2), respectively. In contrast, in the case of the evaporator, the R245fa and R134a have the largest and smallest heat transfer surface areas of 42 m(2) and 36 m(2), respectively.

5.2. Материалы конференций / Conference Papers

2. PROPULSION SOLUTIONS FOR LARGE ARCTIC OFFSHORE VESSELS

Authors: Samuli Hanninen; Sampo Viherialehto; Pirjo Maattanen; Torsten Heideman
Conference: SNAME 25th Offshore Symposium, Houston, Texas, February 2020
Abstract:

With diminishing multi-year ice, the traffic volumes in arctic waters are growing substantially. Completely new fleet of double acting arctic icebreakers and cargo carriers have successfully proven their ability. The size of vessels in the arctic has also grown after introduction of 172k arctic icebreaking LNG carriers. Azipod propulsion is an attractive solution and makes innovative icebreaking ship concepts technically and commercially feasible. ABB Marine has continued the development of the Azipod propulsion concept to meet the demands of ever larger icebreaking vessels with power requirement up to 20 MW units.

Arctic operation capable vessels are the result of decades of systematic propulsion technology development work, from direct shaft lines to the azimuth thrusters. However, it wasn't until the 2006 that the arctic container vessel, the MV Norilskiy Nickel, equipped with a single 13 MW thruster was commissioned. She was the first vessel able to operate independently without icebreaker assistance even in the worst arctic ice conditions.

With growing size of the Arctic vessels there is evident need for propulsion units with power up to 20 MW and with ice classes up to IACS PC2 or even PC1.

Due to this market demand ABB has decided to take the challenge and commence development program aiming to deliver the biggest Azipod units ever built to meet these requirements. This paper will present some of the key design aspects when developing propulsion system for high power icebreaking offshore application.

New technological solutions will help ship owners to access opportunities in the Arctic areas by enabling safe and reliable operation. This paper describes the development of the Arctic vessel propulsion systems from the conventional fixed pitch propellers connected to the diesel engines to the modern electric podded drive systems

VI. Безопасность / Safety

6.1. Статьи / Articles

3. SMOOTH OPERATIONS

Author: Davide Ippolito
Journal: LNG Industry, May 2020, pp.: 29
Abstract:

LNG shipowners and operators are no strangers to the impact of hull fouling. Any surface that is immersed in seawater will experience fouling to some degree and a buildup can have severe consequences on the hydrodynamics and fuel consumption of a shipp.: Even minor fouling can increase fuel consumption by approximately 3 – 5%.One of the more robust standards to measure a vessel's performance and fuel efficiency is speed loss. If a vessel's main engine is set to a specific power output, it will propel the ship at a constant speed through the water. Over time, the accumulation of fouling will cause drag and a decrease in the vessel's speed, despite no change in the power output of the main engine. It is this reduction in speed that is termed speed loss. The rate at which a hull is fouled – and its impact on speed loss – varies depending on the trading pattern of the vessel, in addition to the oceanographic conditions in which it is operating. LNG ships trade regionally and globally; some run shuttle services in local waters, whilst others move gas over much longer routes. Consequently, it is important for a hull coating to deliver optimum protection in all conditions.