COMPRESSED NATURAL GAS (CNG) SUB-COOLING SYSTEM FOR CNG-FILLING STATIONS

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ABSTRACT

The present invention is referred to a compressed natural gas (CNG) sub-cooling system for CNG-filling stations, comprising a CNG inlet pipeline coming from the CNG compressor, a set of coils connected to an expansion heat exchanger capable of creating a Joule-Thomson cooling effect on the gas, both coils are immersed in a heat exchange facilitator solution and are also connected to outlet valves which in turn are connected to feeding hoses of a charging station.
COMPRESSED NATURAL GAS (CNG) SUB-COOLING SYSTEM FOR CNG-FILLING STATIONS

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

This invention relates generally to a cooling system especially applicable to CNG refueling stations. More particularly, the present invention is referred to a compressed natural gas cooling system for CNG refueling station which creates a sub-cooling effect on the natural gas before being delivered to a vehicle.

[0003] 2. Description of the Prior Art

Compressed natural gas, or CNG, is natural gas under pressure which remains clear, odorless, and non-corrosive. Although vehicles can use natural gas as either a liquid or gas, most vehicles use the gaseous form compressed to pressures above 3,100 pounds per square inch.

Natural gas is produced worldwide at relatively low cost and is cleaner burning than gasoline or diesel fuel. Natural gas vehicles show an average reduction in ozone-forming emissions of 80 percent compared to gasoline vehicles.

CNG vehicles have been introduced in a wide variety of commercial applications, from light-duty trucks and sedans—like taxi cabs, to medium-duty trucks, to heavy-duty vehicles like transit buses, street sweepers and school buses. Just as an example, in the state of California, transit agency buses are some of the most visible CNG vehicles.

Worldwide, there are more than 7 million vehicles using CNG on the roads as of 2008, with the largest number in Argentina, Brazil, Pakistan, Italy, India, China, Thailand, and Iran, with South America leading with a global market share of 48%.

The number of vehicles running with this fuel grows every year since any existing gasoline vehicle can be converted to a bi-fuel (gasoline/CNG) vehicle. Authorized shops can do the retrofitting. This involves installing a CNG cylinder in the trunk, installing the plumbing, installing a CNG injection system and the electronics. CNG vehicles are commonly used in South America. They represent 48% of the world’s total fleet, where these vehicles are mainly used as taxicabs in main cities of Argentina and Brazil. Normally, standard gasoline vehicles are retrofitted in specialized shops, which involve installing the gas cylinder in the trunk and the CNG injection system and electronics. Argentina and Brazil are the two countries with the largest fleets of CNG vehicles, with a total combined fleet of more than 3 million by 2008. Conversion has been facilitated by substantial price differential with liquid fuels, locally-produced conversion equipment and a growing CNG-delivery infrastructure.

Argentina has some 1.69 million NGV’s as of 2008, with 1,767 refueling stations across the nation, or 15% of all vehicles. By July 2008, there were 1.56 million retrofitted vehicles in Brazil, or about 5% of the total light vehicle fleet, with 1,585 refueling stations, and most of the fleet is comprised of taxis operating in the cities of Rio de Janeiro and São Paulo.

In the US, federal tax credits are available for buying a new CNG vehicle. Use of CNG varies from state to state. In California, CNG is used extensively in local city and county fleets, as well as public transportation (city/school buses), and there are 90 public fueling stations in Southern California alone. Compressed natural gas is available at 30-60% less than the cost of gasoline, as a rule of thumb, in much of California. Personal use of CNG is a small niche market currently, though with current tax incentives and a growing number of public fueling stations available, it is experiencing unprecedented growth. The state of Utah offers a subsidized statewide network of CNG filling stations at a rate of $0.85/gge, while gasoline is above $4.00/gal. Elsewhere in the nation, retail prices average around $2.50/gge, with home refueling units compressing gas from residential gas lines for approx $1.50/gge.

[0011] Congress has encouraged conversion of cars to CNG with tax credits of up to 50% of the auto conversion cost and the CNG home filling station cost.

[0012] With the consumption of CNG increasing nationwide 145 percent over the past six years, the fueling infrastructure for natural gas vehicles continues to grow. In 2005, California has more than 200 CNG fueling stations. In Southern California alone, there are more than 100 public fueling stations in major metropolitan areas from Los Angeles to the Mexican border. Another 50 stations are now under construction.

[0013] The Energy Commission has provided more than $4 million in grant cost-share funding for about 40 CNG fueling stations, the incremental cost of light-duty vehicles, and purchase of 369 CNG-powered school buses. The Energy Commission has also funded research and development to improve the performance of natural gas engine.

[0014] Scientists are developing methods of storing methane in a new form known as ANG (Absorbed Natural Gas) at 35 bar (500 psi), the pressure of gas in natural gas pipelines in various sponge like materials, such as activated carbon and metal-organic frameworks (MOF's). The fuel is stored at similar or greater energy density than CNG. The benefits are that vehicles can be refueled from the natural gas network without extra gas compression. The fuel tanks can be made of lighter, fewer strong materials, and the tank designed to be much slimmer.

[0015] Even though the technology involved in CNG vehicles and stations has become more and more complex and reliable, the filling process still demands some improvements. The whole filling process is still slow, requires very specialized and expensive equipment and demands an expensive and frequent maintenance program.

[0016] As such, an appropriate CNG cooling system for improving and speeding up the CNG charging process to a vehicle is still desired in the market.

SUMMARY OF THE INVENTION

[0017] A main object of the present invention is to provide a sub-cooling system for cooling down compressed natural gas dispatched using the regular CNG compressing system.

[0018] Another object of the present invention is to provide a natural gas sub-cooling system which needs the provision of no additional energy to operate.

[0019] Another object of the present invention is to provide a natural gas cooling system which improves by 15% the filling volume of a CNG recipient.
Yet another object of the present invention is to provide a CNG cooling system which improves the general performance of the CNG refueling stations.

In a further aspect of the present invention, the power of the installed compressor is used for cooling the gas, transforming the purpose device into a cooling device for cooling CNG while being dispatched.

In still a further aspect of the present invention, the purpose equipment includes a cool storage or accumulator which allows the usage of this energy during the different filling up stages of a vehicle.

In a further aspect of the present invention, the purpose system cools down the compressed natural gas up to 30°C below the temperature at which the gas enters the equipment.

The advantages of the present invention may be summarized as:

- Increases the filling volume by more than 15%
- No additional or special equipment or installations required;
- No external cooling system required;
- No maintenance required;
- Minimum installation.

In summary, the present invention is referred to a compressed natural gas (CNG) sub-cooling system for CNG-filling stations, comprising a CNG inlet pipeline coming from the CNG compressor, a set of coils connected to an expansion heat exchanger capable of creating a Joule-Thomson cooling effect on the gas, both coils are immersed in a heat exchange facilitator solution and are also connected to outlet valves which in turn are connected to feeding hoses of a charging station.

These and other aspects, features, and advantages of the present invention will become more readily apparent from the attached drawings and the detailed description of the preferred embodiments, which follow.

BRIEF DESCRIPTION OF THE DRAWINGS

The preferred embodiments of the invention will hereinafter be described in conjunction with the appended drawings provided to illustrate and not to limit the invention, where like designations denote like elements, and in which:

FIG. 1 illustrates a general perspective view of the purpose cooling system in accordance with the present invention.

FIG. 2 is a front elevational view of the purpose cooling system.

FIG. 3 is a side elevational view of the cooling system.

FIG. 4 is a top plan view.

FIG. 5 is a general perspective view of the internal parts of the present equipment.

FIG. 6 is a top plan view of the internal view of FIG. 5.

FIG. 7 is a side elevational view; and:

FIG. 8 shows schematically a circuit showing the main components of the system in accordance with the present invention.
most gases at atmospheric pressure, this temperature is quite high, much higher than room temperature, and therefore most of the expanding gases are cooled. This is the process that is experienced in the equipment of the present invention during the expansion process. An adiabatic expansion of the CNG occurs, which rapidly cools the gas. Additionally, the system is immersed in water with glycol that acts as a facilitator of a thermal exchange (is a conductive medium). The equipment has valves that allow a proper regulation of the gas flow during the expansion.

[0049] Below is a chart including the purposed device technical data is included:

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<th>Technical Data</th>
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<tr>
<td>Design Standard</td>
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<td>Maximum gas outflow</td>
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<td>Minimum delivery</td>
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<td>Average delivery</td>
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[0050] Finally, we should make a brief reference to the circuit illustrated in FIG. 8 in which the equipment 10 proposed has two gas coils 31-32, which has a cold gas inlet 58 and a hot gas outlet 59, a steam inlet 50, a vent valve 52, a steam opening and closing valve 53, respective steam traps 54, a gas inlet from the plant regulator 55, a condensate drain 56 and a steam outlet 57.

[0051] While the preferred embodiments of the invention have been described above, it will be recognized and understood that various modifications can be made in the invention and the appended claims are intended to cover all such modifications which may fall within the spirit and scope of the invention.

1. Claim:

1. Compressed natural gas (CNG) sub-cooling system for CNG-filling stations, comprising a CNG inlet from a CNG compressor, at least two independent coils through one of them circulates the gas to be cooled and through the other one the gas from the CNG line, said coil with the gas to be cooled is also connected to an expansion heat exchanger capable of creating a Joule-Thomson cooling effect on the gas, both coils are immersed in a heat exchange facilitator solution and are also connected to outlet valves which in turn are connected to feeding hoses of a charging station.

2. The sub-cooling system of claim 1, wherein each system includes two pairs of coils, each pair with a heat exchanger and an expansion heat exchanger.

3. The sub-cooling system of claim 1, wherein the solution in which the coils are immersed is a solution of water and glycol.

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