Innovative Methane-Hydrogen Fuel Production and Application Systems

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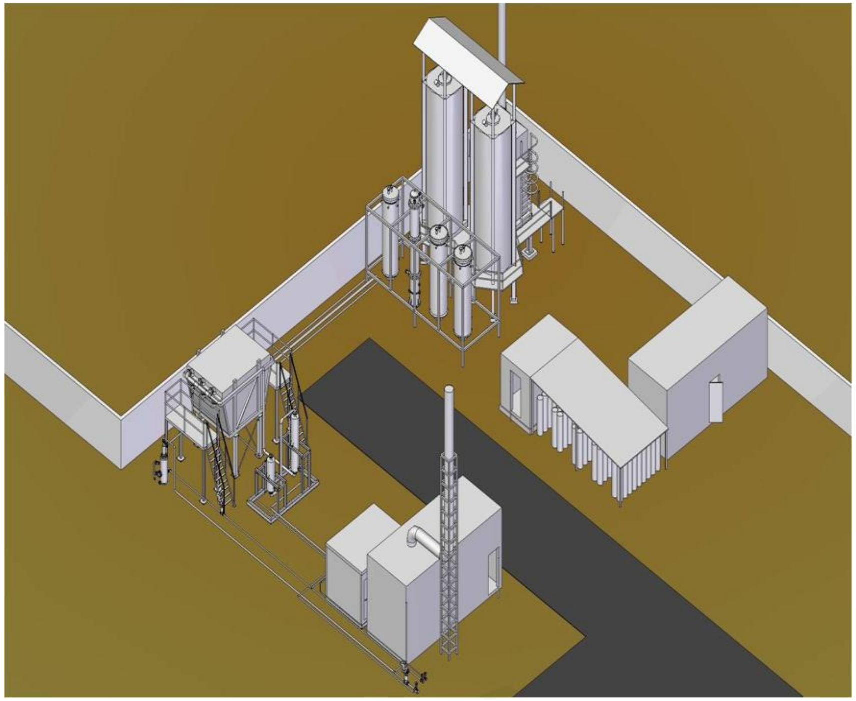
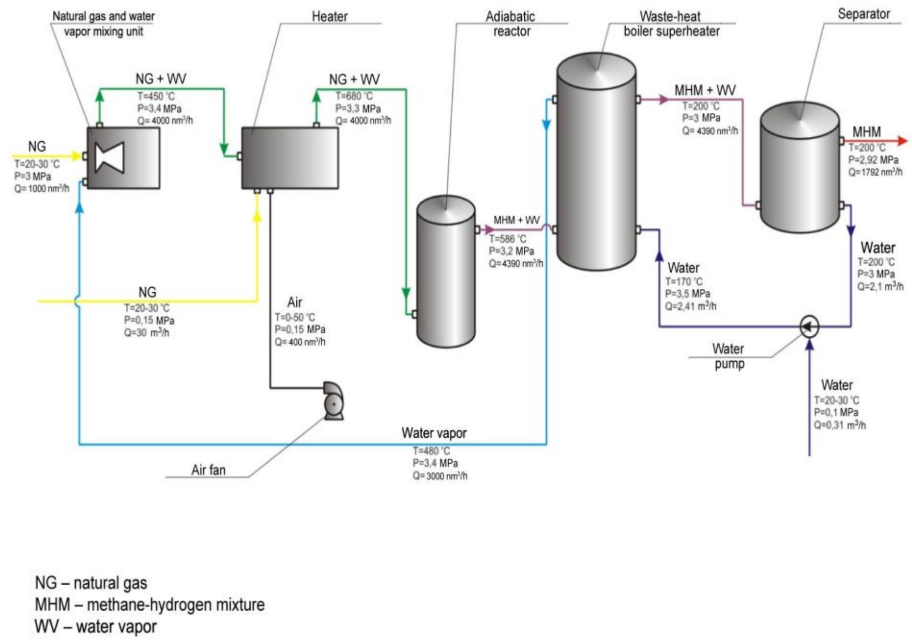
Methane&Hydrogen

In the longer term to replace natural gas, hydrogen fuel to come. Hydrogen - the most efficient and environmentally friendly fuel . World production of hydrogen exceeds 550 billion m3. At the lower heat of combustion per unit mass of it in 2.75 times higher than gasoline, has a higher lower limit and a much wider range of ignition in a mixture with air (from 4 to 75% by volume), an order of magnitude faster laminar flame propagation (approximately 3 m / s), the lower the energy to initiate the ignition of a stoichiometric mixture (0.018 mJ), and quenching distance (0.6 mm) and higher combustion temperatures (for a laminar flame in the air - 2300 K) and the ignition in the air (850 K). These unique properties of hydrogen make it possible to increase the efficiency of heat engines in the 1.5-1.7 times, and the real cycle of the engine when operating on hydrogen much closer to the theoretical than on any hydrocarbon fuel. Transfer to alternative fuels is an important step in the use of pure hydrogen as a fuel for vehicles - the creation of a hydrogen fuel cell electric vehicle .

Basic diagram of the methane-hydrogen mixture production unit using adiabatic methane conversion technology



Methane-Hydrogen Mixture Production Unit



During the development of the technological concept consideration was given to the experience accumulated in the course of commercial introduction of the two-stage oxygen-steam conversion process based on the TANDEM scheme as well as to the experience in developing the adiabatic methane conversion process with the high-temperature helium reactor MGR-T.

The adiabatic methane conversion process is used for the production of the methane-hydrogen mixture as a natural gas fuel enabling to reduce energy-material costs of methane-hydrogen mixture production as compared to traditional methods.

The energy/process flow diagram of the methane-hydrogen mixture production includes technical solutions focused on achievement of minimum energy consumption and maximum performance.

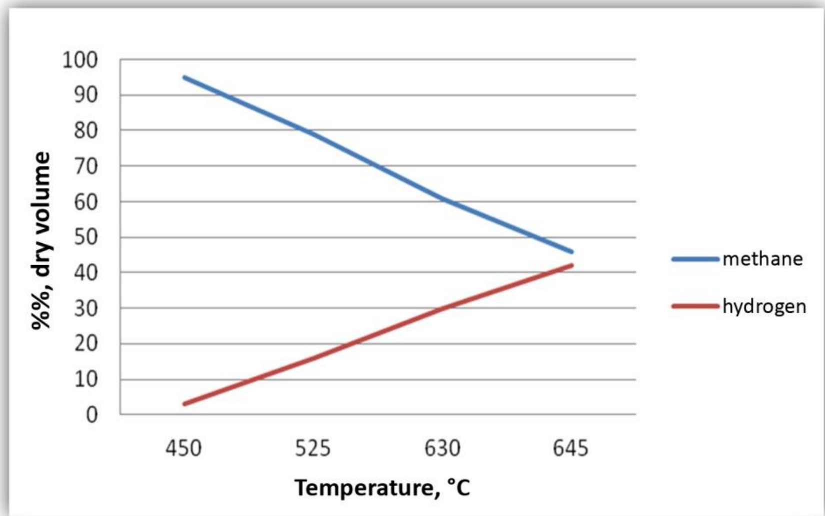
Emission reduction

Incoming product (natural gas) is mainly composed of methane (99%).

Overlooking the product is a mixture of three components: water vapor - 67.7% (vol.), hydrogen - 13.6% (vol.) and methane - 15%.

Elevated levels compared with the incoming products are: carbon dioxide - 3.3% and carbon monoxide - 0.233%.

However, when using methane-hydrogen mixture as a fuel gas the CO and CO2 emissions are reduced by half.



Component of the product in the AMC technology

Component, % vol. (wet)	Inlet	Outlet
	Natural gas	Methane-hydrogen mixture (wet)
Carbon dioxide, CO_2	0,065	3,262
Carbon monoxide, CO	0,000	0,233
Hydrogen, H_2	0,000	13,621
Nitrogen, N_2	0,780	0,145
Argon, Ar	0,000	0,000
Water, H_2O	0,000	67,694
Methane, CH_4	98,836	15,045
Ethane, C_2H_6	0,242	0,000
Propane, C_3H_8	0,055	0,000
Bhutan, C_4H_{10}	0,016	0,000
Pentane, C_5H_{12}	0,006	0,000
Total	100,000	100,000

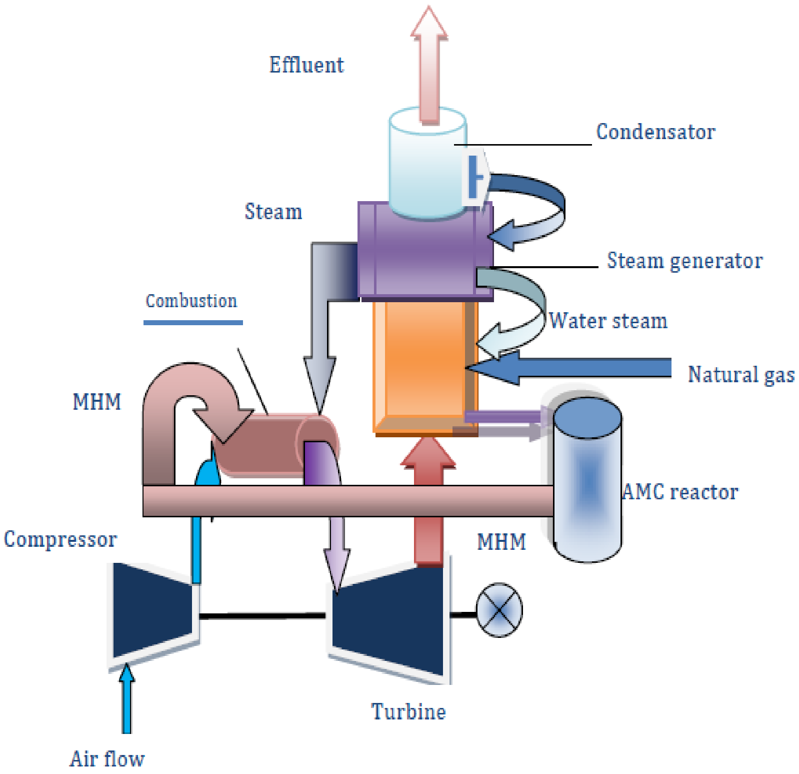
The results of GTP burner tests when using MHM

Emission reduction

N of meas.	P_1	P_2	α_Σ	O_2	NOx	NO	NO_2	CO	CO_2	Gw	Gs
	kg/cm[2]	kg/cm[2]	-	%	ppm	ppm	ppm	ppm	%	g/s	capacity, %
10	0.3	1.2	1.74	9.5	16	16	0	12	6.5	70.97	0
11	0.3	1.3	1.78	9.8	14	14	0	10	6.3	71.51	50
12	0.3	1.3	1.78	9.8	**8**	**8**	**0**	**11**	6.3	71.53	**75**
14	0.3	1.2	1.72	9.3	15	14	1	27-62	6.6	71.35	0
15	0.3	1.2	1.75	9.5	12	11	1	21	6.2	71.04	50
16	0.3	1.2	1.81	9.9	8	8	0	17	6.2	71.04	100

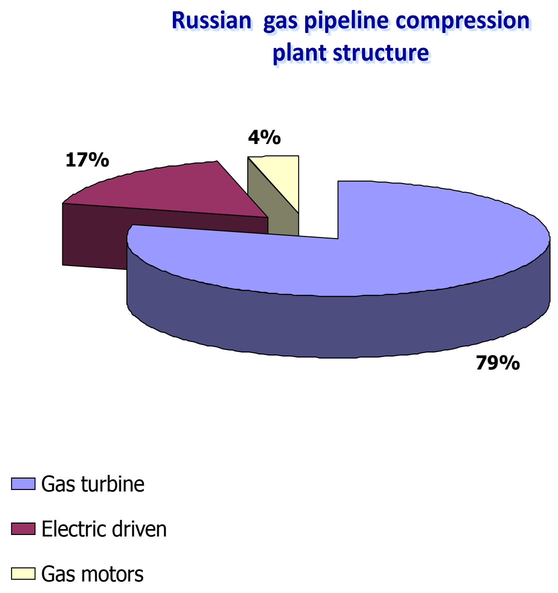
Pipeline application

Waste heat of exhaust gases is one of the main ways of increasing the efficiency of gas turbines and is being actively carried out the work in this direction. Cogeneration and combined-cycle plants can significantly increase the energy efficiency of fuel like in the developed combined gas turbine (STIG) with the generation of water in the loop "Aquarius". Further improvement of such facilities is the increasing the degree of heat recovery of exhaust gases. In this regard, the most promising - the effective use of technology of the thermochemical heat recovery, which allow the methane-hydrogen fuel, which has several advantages. Technology Integration "Aquarius" and the low-temperature steam conversion of methane gas turbine unit will create a new type of environmental view (technology "Tandem"), taking into account the experience of using hydrogen gas as a fuel gas .



Pipeline application

- Process integration of waste gas heat recovery with low-temperature adiabatic methane conversion would allow designing a gas turbine plant of a new type with high energy and environmental performance ("Tandem" process). The increase in gas turbine plant capacity as compared to basic GTP design can be up to 70-80%, fuel consumption can be reduced by 35-40%, accompanied by a sharp decrease in NO_x emissions (4 to 8 times) and simultaneous CO emissions decrease (up to 10 times).
- The use of production process and implementation of methane-hydrogen mixtures corresponds to the benefit of Gazprom, including the implementation on compressor stations, on gas production fields, in gas chemistry, as well as its use as a high-tech exportable energy carrier, being a promising direction for diversification and enhancement of natural gas efficiency.



* Источник: генеральная схема развития газовой отрасли до 2030 г.

In particular, more than 1,100 units of NK-16ST packages have been produced since the beginning of serial output in 1982; all these packages could be improved in their performance by shifting to MHM.

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THANK YOU! VIELEN DANK!
MERCI! TAK! TACK!
ありがとう！ با تشکر از شما!